THE KOREAN ECONOMIC REVIEW
Volume 14, Number 1, Summer 1998

CAPITAL MOBILITY, TAX COMPETITION, AND THE PROVISION OF AN INTERNATIONAL PUBLIC GOODS

GANGSUN RHEE*

This paper studies how competition among the capital-importing countries (CIC's) to attract scarce foreign capital affects the provision of an international public goods that has spillover effects to more than one country. We show that when the marginal cost to produce the public goods is different between the capital-exporting country (CEC) and the CIC's, the competition may have the CEC, where the cost to produce the public goods is higher than in the CIC's, provide the public goods. We also show that even if the CEC can use a lump sum tax to provide the international public goods, the amount of the public goods may be below the optimal level in terms of world welfare. Lastly, we briefly discuss the tax-crediting system as a possible solution to these two problems.

JEL Classification: H4
Keywords: Tax Competion, International Public Goods

I. INTRODUCTION

The growing interdependence of the world communities is increasing attention to the international spillover effects of public goods. Examples for the international spillover effects of public goods are not rare in this integrated world. Public goods of one country to fight against ecological destruction may have some positive effects to other neighboring countries. Increased military spending of one country in the military alliances such as NATO and SEATO can make other member countries get benefits by reducing their spendings for national security.

Received for publication: Aug. 8. 1997. *Revision accepted:* Nov. 26. 1997.
* Chungmam Development Institution

The literature of public economics concerned with economic integration and spillover effects of public goods has so far limited its scale and concern to a federal system comprised of a number of regions. The literature in this area may be classified into three strands.

First, Williams (1966) and Brainard and Dolbear (1967) consider a federal system of two communities. A public goods like education produced by one community has positive benefits to the other community. But since each community has an independent government that tries to maximize only the utility of its own residents, excluding the positive externality of its public goods, there is a tendency for underprovision of the local public goods relative to the optimum federal level. Pauly (1970) generalizes the results by dividing the concepts of public goods into several different groups.

The second strand emphasizes the possibility of different governments ignoring externalities that occur to other regions when a local government changes its tax policies. With a federal system of competing local governments, a change of tax policies by a local government causes some fiscal externalities to the other jurisdictions such as the changes of tax rates, tax base or population in the other jurisdictions. Since each local government tends to set its fiscal policies independently, ignoring the fiscal externalities it makes to the other jurisdictions, it is generally true that the policies are not optimal in terms of federal level. Especially, when each local government ignores the fiscal externalities and competes for scarce resources, the level of public goods tends to be below the optimal federal level. This strand includes Boskin (1973), Starrett (1980), Gordon (1983), Wilson (1986, 1987), and Wildasin (1989).

Lastly, Starrett (1980), Zodrow and Mieszkowski (1986), and Bucovetsky and Wilson (1991) focus on the method of taxation used by local governments. Starrett (1980) shows that when communities can employ more general types of taxation, they have an incentive to overexpand relative to the first best optimum. Zodrow and Mieszkowski (1986) shows that the use of a distorting property tax on mobile capital decreases the level of residential public services. Bucovetsky and Wilson (1991) demonstrates that even when competing local governments can use a wage tax in addition to a source-based tax on capital income, a local public goods is underprovided.

In this paper, we try to combine the three strands of the literature into one model to investigate possible inefficiencies in a circumstance that the world is not only tied with capital movement from a wealthy country to poor countries, but also interrelated with an international public goods. The rich country makes capital investment overseas to earn a higher rate of return in the foreign countries than can be earned domestically, while the poor countries compete to attract scarce foreign capital. This framework may be justified by the fact that in 1976, for example, investments by Canada, Germany, the Netherlands, Sweden, the U.K. and the U.S. in the Third World countries represented about 25% of their total foreign investments and the figure went up to 55%

in the case of Japan.[1] Both the CEC and the CIC's produce a homogeneous international public goods that has positive benefits to the residents of the CEC and the CIC's. Since the public goods has the traditional Samuelson-type properties of public goods such as non-rival in consumption and non-excludability and serves all the countries, it may be called international public goods.

In the model, the only revenue source for the government of each capital-importing country (CIC) is the tax on foreign capital income, but the government of the capital-exporting country (CEC) can use a domestic lump sum tax. Tax revenues are used to provide the public goods. At firat, the parpose of this paper is to show that when the constant marginal costs of the public goods between the CEC and the CIC's are different, tax competition among the CIC's may result in the wrong country providing the public goods from an efficiency perspective. This paper also demonstrates the level of the public goods under the tax competition that or which is below the optimal world level even if the CEC can use a lump sum tax. Lastly, we consider the effectiveness of the tax-crediting system adopted by the government of the CEC.

Section 2 presents the model. Section 3 derives the world planner solution as a criterion, while the solution with tax competition among the CIC is section 4. The tax-crediting system is discussed in section 5 and conclusion is the last section.

II. THE MODEL

Consider a world economy that has one capital-exporting country (CEC) and N capital-importing countries (CIC's). N will also denote the set of the CIC's and $N \geq 2$. The CIC's are identical in every respec. Each country has a representative private agent and a government.

The economy lasts for two periods. The time structure of the model is as follows. The first period has two stages. In the first stage, all the governments of the CEC and the CIC's simultaneously choose their future tax rates and expenditure level. The government of the CEC determines a domestic lump sum tax rate and the governments of the CIC's choose capital income tax rate on foreign capital investment. It is assumed that the governments can commit to their policies, but they choose them noncooperatively. In the second stage, private agents make their decisions after the governments' decisions are known. The private agent of the CEC chooses how to divide the first period endowment between current consumption and foreign investments to N CIC's. On the other hand, the private agent of each CIC chooses how much capital to demand and consume. In addition to the perfect knowledge about the future government policies, the private agents correctly forecast the market-clearing returns to capital when they make their first period decisions. In the second

[1] OECD (1982).

period, the governments collect their tax revenues and use the proceeds to supply an international public goods.

There is one goods available. The private agent in the CEC is endowed with Y_t units of the goods in period t and the private agent in each CIC is endowed with y_t units in period t. It is assumed that $Y_1 > Y_2$, $y_1 > y_2$, and $Y_t > y_t$, and $Y_t > y_t$ for all t.

The preferences of the private agents in both the CEC and the CIC's are represented by a well behaved utility function of the form

$$u_1(x_1) + \delta(u_2(x_2) + m(G + \sum_i g_i)), \tag{1}$$

where $x_t = C_t$ is CEC consumption in period t, or x_t is consumption in period t in the ith CIC; δ is a discount factor; G and g_i denote the amounts of public goods, which are provided by the governments of the CEC and the CIC's, respectively, in the second period. All countries produce the same public goods. Notice that the public goods has an international benefit spillover effect so that the residents of the CEC and the CIC's get utility not only from the public goods provided by his own domestic government but also from the public goods provided by the other foreign governments. We assume that both u_t $(\cdot)$ and m$(\cdot)$ are continuously twice differentiable, strictly quasi-concave, strictly increasing, and indifference curves are asymptotic to both axes.

The budget constraints of the CEC agent are

$$Y_1 - \sum_i k_i^s - c_1 = 0, \tag{2}$$

$$Y_2 - \sum_i R_i k_i^s - T - C_2 = 0. \tag{3}$$

In the constraints, k is the amount of foreign investment as a loan from the CEC to the ith CIC. $R_i = 1 + r - \tau_i$ is after-tax interest rate from the foreign investment, where τ_i is capital income tax rate imposed by the ith CIC and $1 + r$ is the gross interest rate from the investment. r is not fixed, but endogenously determined by the demand and supply of capital in the world capital market. T is a lump sum tax imposed by his own government to finance G.

The budget constraints of the private agent of the ith CIC are

$$y_1 + k_i^d - c_{i1} = 0, \tag{4}$$

$$y_2 - (1+r)k_i^d - c_{i2} = 0, \tag{5}$$

where k_i^d is the demand for foreign investment in the ith CIC. Since there is no explicit production, each CIC just consumes the foreign investment as a loan in the first period and returns it with interest in the second period.

The government of the CEC is benevolent in the sense that it tries to maximize the utility function of its private agent. The government budget constraint of the CEC is

$$T = G. \tag{6}$$

In the CEC, the government collects a lump sum tax imposed on its own resident and uses the proceeds to provide a public goods. The government can produce the public goods on a one for one basis with government spending so that the marginal cost of the public goods is one.

The governments of the CIC's are also benevolent, and the typical ith government has the following budget constraint

$$\tau_i k_i^s = \theta g_i . \tag{7}$$

The budget constraint implies that the government of the ith CIC has tax revenue from foreign capital income tax, which is used to finance one public goods. We assume that even if the governments of the CEC and the CIC's produce the same public goods, the governments of the CIC's can do it more efficiently than the counterpart of the CEC. This assumption implies that $\theta < 1$, where θ is the constant marginal cost of the public good when it is produced in the CIC's. This difference in the production cost of the public good reflects the fact that it is usually cheaper for the pollution to be cleaned up at the source (CIC's) or it is cost-saving for the CIC to use its military to fight communism than for the CEC to do it.

III. THE WORLD PLANNER SOLUTION

First, suppose there is a world planner, who can allocate the world resources to maximize a world welfare function. His objective function is a weighted sum of the utility functions of the whole countries and the only constraints he faces are the world resources.[2] We define the world planner's solution as the set $\{C_1, C_2, c_{i1}, c_{i2}, G\}$, $i=1, 2, \ldots$ N, which is to

$$\begin{aligned} \text{max.} \quad & u_1(C_1) + \delta(u_2(C_2) + m(G + \textstyle\sum_i g_i)) + \sum_i \alpha_i [u_1(c_{i1}) + \\ & \delta(u_2(c_{i2}) + m(G + \textstyle\sum_i g_i))], \end{aligned} \tag{8}$$

$$\text{s.t.} \quad Y_1 + Ny_1 - C_1 - \textstyle\sum_i c_{i1} = 0 \tag{9}$$

$$Y_2 + Ny_2 - C_2 - \textstyle\sum_i c_{i2} - G - \theta \sum_i g_i = 0. \tag{10}$$

[2] Gordon (1990) derives a similar result in a model with fixed r.

The first order conditions are

$$\frac{\partial \Omega}{\partial C_1}=\frac{\partial u_1(C_1)}{\partial C_1}-\lambda_1=0, \tag{11}$$

$$\frac{\partial \Omega}{\partial C_2}=\delta\frac{\partial u_2(C_2)}{\partial C_2}-\lambda_2=0, \tag{12}$$

$$\frac{\partial \Omega}{\partial c_{i1}}=\alpha_i\frac{\partial u_1(c_{i1})}{\partial c_{i1}}-\lambda_1=0, \qquad i=1, 2 \ldots N, \tag{13}$$

$$\frac{\partial \Omega}{\partial c_{i2}}=\delta\alpha_i\frac{\partial u_2(c_{i2})}{\partial c_{i2}}-\lambda_2=0, \qquad i=1, 2 \ldots N, \tag{14}$$

$$\frac{\partial \Omega}{\partial G}=\delta\frac{\partial m}{\partial G}+\delta\textstyle\sum_i \alpha_i\frac{\partial m}{\partial G}-\lambda_2\leq 0 \text{ and } G\frac{\partial \Omega}{\partial G}=0, \tag{15}$$

$$\frac{\partial \Omega}{\partial g_i}=\delta\frac{\partial m}{\partial g_i}+\delta\textstyle\sum_i \alpha_i\frac{\partial m}{\partial g_i}-\lambda_2\theta\leq 0 \text{ and } g_i\frac{\partial \Omega}{\partial g_i}=0, \quad i=1, 2, \ldots \text{N}, \tag{16}$$

where λ_1 and λ_2 are the Lagrange multiplier of the constraints (9) and (10) respectively.

Using these first order conditions, we have the following proposition.

Proposition 1: At the world planner's solution, the CEC does not produce any of the public goods, and all of the public goods is produced by the CIC's. That is, $G=0$ and $g_i>0$ for any $i\in N$.

Proof: Since the CIC's are all identical, (15) and (16) can be written as $\delta m'+\delta\alpha Nm'-\lambda_2\leq 0$ and $\delta m'+\delta\alpha Nm'-\lambda_2\theta\leq 0$ respectively, where $m'=\partial m/\partial G =\partial m/\partial g$. If we define $\Psi\equiv\delta m'+\delta\alpha Nm'$, the three cases (to be) considered are

i. $\Psi=\lambda_2$ and $\Psi=\lambda_2\theta$,
ii. $\Psi=\lambda_2$ and $\Psi<\lambda_2\theta$,
iii. $\Psi<\lambda_2$ and $\Psi=\lambda_2\theta$,

Since $\theta<1$, the only feasible case is the third one. With the third case, we have that $\partial\Omega/\partial G$ and $\partial\Omega/\partial g_i=0$ for all $i\in N$, which means $G=0$ and $g_i=0$ for all $i\in N$. That is, all of the public goods is provided by the CIC's at the world planner's optimum. Q.E.D.

Now we should note that if we divide (16) by λ_2 and use the results from (12) and (14) that $\lambda_2=\delta(\partial u_2(C_2)/\partial C_2)=\delta\alpha_i(\partial u_2(c_{i2})/\partial c_{i2})$, we obtain

$$\frac{m'}{u_2'(C_2)}+\sum_i \frac{m'}{u_2'(c_{i2})}=\theta. \tag{17}$$

Equation (17) represents the famous Samuelson rule of $\sum_i MRS_i = MRT$.

IV. THE COMPETITIVE SOLUTION

Now consider a situation where tax competition exists among the CIC governments to attract more capital from the CEC. Assuming that every government can make a commitment to its tax policy at the beginning of the time horizon, we study a Nash equilibrium of the open loop policy game among the CIC's governments.

4.1. The Private Agent of the CEC

At the beginning of the first period, the private agent of the CEC chooses C_1, C_2 and $\mathbf{k}^s=(k_1^s, \ldots, k_N^s)$ to

$$\max. \quad u_1(C_1)+\delta(u_2(C_2)+m(G+\textstyle\sum_i g_i)), \tag{18}$$

subject to the budget constraints (2) and (3). From the budget constraints, $C_1 = Y_1 - \sum_i k_i^s$ and $C_2 = Y_2 - \sum_i R_i k_i^s - T$. Substituting C_1 and C_2 into (18), we reduce the decision problem of the CEC private agent to choosing k_1^s, k_2^s, $\ldots$, k_N^s to

$$\max. \quad u_1(Y_1-\textstyle\sum_i k_i^s)+\delta(u_2(Y_2+\sum_i R_i k_i^s-T)+m(G+\sum_i g_i)), \tag{19}$$

where Y_1, $Y_2 - T$, $\mathbf{R}=(R_1, R_2, \ldots, R_N)$ and $G+\sum_i g_i$ are given to the private agent.

Differentiating (19) with respect to k_i^s, we have the first order condition,

$$\frac{u_1'(Y_1-\sum_i k_i^s)}{u_2'(Y_2-\sum_i R_i k_i^s)}=\delta R_i, \qquad \forall i \in N, \tag{20}$$

where $u_1'=\partial u_1/\partial(Y_1-\sum_i k_i^s)$ and $u_2'=\partial u_2/\partial(Y_2-\sum_i R_i k_i^s-T)$. Notice that the left-hand side (LHS) of equation (20) is independent of any particular CIC. Hence, if LHS$<\delta R_i$, utility can be improved by increasing k_i^s until LHS $=\delta R_i$, If LHS$>\delta R_i$, utility can be improved by reducing k_i^s until LHS$=\delta R_i$, or $k_i^s=0$. Therefore, if LHS$=\delta \max_{\sim} R_j$, then LHS$>R_i<\max R_j$ so that k_i^s will be reduced until $k_i^s=0$. Let $\tilde{N}$ be the number of i such as $R_i<\max R_j$. Then, the CEC's agent will supply the investment k^s to each CIC with R

$<\max R_j$ such that $u_1'/u_2'=\delta R$ and will supply $k_i^s=0$ to any CIC's with $R_i<R$.

Since the utility function is separable, the solution of the decision problem of the CEC agent is denoted as

$$k_i^s=k_i^s(Y_1,\ Y_2-T,\ \mathrm{R}),\qquad i=1,\ 2,\ldots,N \tag{21}$$

where $k_i^s>0$, if $R_i\geq R_j\ \ \forall\ j\in N$
$k_i^s=0$, if $R_i<R_j$ for some j,

by the non-arbitrage condition explained above.

When (21) is substituted into (19), we can write the indirect utility function of the CEC as

$$v(Y_1,\ Y_2-T,\ \mathrm{R})+m(G+\textstyle\sum_i g_i), \tag{22}$$

where $\partial v/\partial(Y_2-T)>0$, $\partial v/\partial R>0$, and $\partial m/\partial(G+\sum_i g_i)>0$.

4.2. The Private Agents of the CIC's

The private agent of the ith CIC chooses c_{i1}, c_{i2} and k_i^d to

$$\max.\qquad u_1(c_{i1})+\delta(u_2(c_{i2})+m(G+\textstyle\sum_i g_i)), \tag{23}$$

subject to the budget constraints (4) and (5). Substituting c_{i1} and c_{i2} of the budget constraints into (23), we have

$$\max.\ u_1(y_1+k_i^d)+\delta(u_2(\mathrm{u}_2(y_2-(1+r)k_i^d)+m(G+\sum_i g_i)). \tag{24}$$

Now the ith CIC private agent chooses k_i^d to maximize (24), where the private agent takes y_1, y_2, r, and $G+\sum_i g_i$ as given.

Differentiate (24) with respect to k_i^d to obtain the first order condition,

$$\frac{u_1'(y_1+k_i^d)}{u_2'(y_2-(1+r)k_i^d)}=\delta(1+r) \tag{25}$$

where $u_1'=\partial u_1/\partial(y_1+k_i^d)$ and $u_2'=\partial u_2/\partial(y_2-(1+r)k_i^d)$. This first order condition holds for every CIC in which there is a positive demand for capital. Since the right-hand side (RHS) of equation (25) is independent of i, every CIC has the same investment demand such as

$$k_i^d=k^d(y_1,\ y_2,\ r),\qquad \forall\ i\in N, \tag{26}$$

where we assume $\partial k_i^d/\partial r<0$.

By substituting (26) into (24), the indirect utility function of the ith CIC is

$$v(y_1, y_2, r)+m(G+\sum_i g_i), \tag{27}$$

where $\partial v/\partial r<0$ and $\partial m/\partial(G+\sum_i g_i)>0$.

4.3. Equilibrium

Given the tax rates $\tau_1, \tau_2, \ldots, \tau_N$ levied by the CIC's governments and the lump sum tax T levied by the CEC's government, let r^* be the equilibrium interest rate such that the capital market clears: $\sum_i k_i^s=\sum_i k_i^d$. But we have seen that the CIC's demand for capital depends on only r, and if any CIC demands positive capital, then all CIC's demand the same amount, i.e., $k_i^d(r)=k^d(r)$, $\forall\ i\in N$. We have also seen that the CEC will supply a positive amount of capital to only those CIC's with the largest $R_i=R$, and $k_i^s=0$ for those CIC's with $R_i<R$.

Therefore, the only non-autarky equilibrium occurs where every CIC levies the same tax rate, say τ and interest rate has to adjust to clear the market. Notice the equilibrium interest rate depends on the CIC tax rate τ and the CEC lump sum tax T: That is, $r^*=r(\tau, T)$.

4.4. The Governments of the CIC's

In the competitive Nash policy game, the government of the ith CIC chooses τ_i and to

$$\begin{aligned}
\text{max.}\quad & W_i\equiv u_i(y_1+k_i^d)+\delta(u_2-(1+r)k_i^d)+m(G+\textstyle\sum_i g_i)),\\
\text{s.t.}\quad & \tau_i k_i^s=\theta g_i,\\
& (G \text{ and } g_j\ \forall\ j\neq i) \text{ given},\\
& \tau_i\geq 0,\ \forall\ i\in N.
\end{aligned}$$

Substituting the government budget constraint into the objective function and differentiating the objective function with respect to τ_i, we obtain by the envelope theorem

$$\frac{\partial W_i}{\partial \tau_i}=\delta\left(-k_i^d\frac{\partial r}{\partial \tau_i}u_2'+\frac{1}{\theta}\left(k_i^s+\tau_i\frac{\partial k_i^s}{\partial \tau_i}\right)m'\right), \tag{28}$$

where $\partial r/\partial\tau_i>0$ to clear the capital market. In the parentheses of the RHS, the first term is always negative. Hence, when τ_i goes down (up), the utility from the consumption of private goods increases (decreases). The sign of the second term in the parentheses depends on how elastic k_i^s is to the change of

τ_i. If k_i^s is very elastic, the second term is also negative so that when τ_i goes down (up), the amount of public goods moves up (down) and the utility from the public good increases (decreases). Therefore, the more elastic k_i^s is, the more likely the $\tau_i = 0$.

The two terms, $\partial k_i^s / \partial \tau_i$ and $\partial r / \partial \tau_i$, are derived from the equilibrium condition of the capital market,

$$k_i^s(r) = k_i^s(\mathbf{R}). \tag{29}$$

Differentiating both sides of (29) with respect to τ_i, we yield

$$\begin{aligned}\frac{\partial k_i^d}{\partial r}\frac{\partial r}{\partial \tau_i} &= \frac{\partial k_i^s}{\partial R_1}\frac{\partial R_1}{\partial \tau_1} + \ldots + \frac{\partial k_i^s}{\partial R_i}\frac{\partial R_i}{\partial \tau_i} + \ldots + \frac{\partial k_i^s}{\partial R_N}\frac{\partial R_N}{\partial \tau_i} \\ &= (N-1)\frac{\partial k_i^s}{\partial R_j}\frac{\partial r}{\partial \tau_i} + \frac{\partial k_i^s}{\partial R_i}\left(\frac{\partial r}{\partial \tau_i} - 1\right) < 0, \quad i \neq j,\end{aligned} \tag{30}$$

where the first term of the second RHS represents the movement of capital from (to) the other CIC's to (from) the ith CIC and the second term represents the movement of capital between the CEC and the ith CIC, when τ_i decreases (increases) with a fixed $\tau_{-i} = (\tau_1, \ldots, \tau_{i-1}, \ldots, \tau_{i+1}, \ldots, \tau_N)$. The first term of the second RHS is always negative and the second term can be negative or positive, depending on how big $\partial r / \partial \tau_i$ is. However, since $\partial k_i^d / \partial r_i < 0$ and $\partial r / \partial \tau_i > 0$ in the LHS, the sum of the two terms must be negative.

The second RHS of (30) is equal to $\partial k_i^s / \partial r_i$ so that we first have

$$\frac{\partial k_i^s}{\partial \tau_i} = (N-1)\frac{\partial k_i^s}{\partial R_j}\frac{\partial r}{\partial \tau_i} + \frac{\partial k_i^s}{\partial R_j}\left(\frac{\partial r}{\partial \tau_i} - 1\right) < 0, \quad i \neq j. \tag{31}$$

If we arrange (30) for $\partial r / \partial \tau_i$, we obtain

$$\frac{\partial r}{\partial \tau_i} = \frac{\dfrac{\partial k_i^s}{\partial R_i}}{(N-1)\dfrac{\partial \mathrm{k}_i^s}{\partial \mathrm{R}_j} + \dfrac{\partial k_i^s}{\partial R_i} - \dfrac{\partial k_i^d}{\partial r}} > 0. \tag{32}$$

The sign of $\partial r / \partial \tau_i$ is always positive, because if τ_i is decreased (increased), the positive-sloped supply curve shifts out (in) on the (k_i, r) space of the capital market, while the negative-sloped demand curve does not shift on the same space.

Substituting (31) and (32) into (28) and rearranging, it, we can rewrite the first order condition as

$$\frac{\partial W_i}{\partial \tau_i}=\Phi\left[\frac{\theta u_2'}{m'}-\frac{(N-1)\frac{\partial k_i^s}{\partial R_j}+\frac{\partial k_i^s}{\partial R_i}-\frac{\partial k_i^d}{\partial r}}{\frac{\partial k_i^s}{\partial R_i}}-\frac{\tau_i}{k_i^d}\frac{\partial k_i^d}{\partial r}\right],\ i\neq j, \tag{33}$$

where $\Phi=-(\delta k_i^d m'/\theta)(\partial r/\partial \tau_i)<0$. From (33), we know that if

$$\frac{\theta u_2'}{m'}>\frac{(N-1)\frac{\partial k_i^s}{\partial R_j}+\frac{\partial k_i^s}{\partial R_i}-\frac{\partial k_i^d}{\partial r}}{\frac{\partial k_i^s}{\partial R_i}}+\frac{\tau_i}{k_i^d}\frac{\partial k_i^d}{\partial r},\ i\neq j, \tag{34}$$

the sign of $\partial W_i/\partial \tau_i$ is negative. The LHS of (34) is always positive. The sign of the RHS is not clear since the first term that is equal to $1/(\partial r/\partial \tau_i)$ is positive, and the second term is negative. However, notice that when the inflow of capital to the ith CIC increases, the first term becomes smaller and the second term goes to a larger negative value.

What is the economic meaning of inequality (34)? First, suppose that the governments of the CIC's initially set $\tau_1=\ldots=\tau_N>0$. If the ith CIC government lowers τ_i from the current common tax rate, the ith CIC attracts the entire capital stock from the CEC investor and the other CIC's lose all of their capital, since $R_i>R_j$, $\forall\ j\in N$. If the new inflow of capital to the ith CIC is large, the RHS of the inequality becomes so small that the inequality is very likely to hold. If the new amount of capital the ith CIC receives is huge, the RHS can even be negative. In that case, of course, the inequality always holds.

The LHS also has some economic meaning to be mentioned. If the CIC's are very poor countries, as we implicitly suppose, the marginal utility from the private goods consumption can be much higher than the marginal utility from a public goods such as preventing air pollution or preserving a clean environment. The LHS of the inequality, then, is a large positive number so that the inequality is more likely to hold.

Now we have a proposition about the Nash tax rate of the CIC's.

Proposition 2: If inequality (34) holds, $\forall\ i\in N$, the competitive Nash tax rate is unique where $\tau=0$ for every CIC.

Proof: If inequality (34) holds, $\forall\ i\in N$, we have $\partial W_i/\partial \tau_i<0$, $\forall\ i\in N$. Then, every CIC government lowers its tax rate on foreign capital to the lowest level. This means the competitive Nash tax rate is unique at $\tau=0$. Q.E.D.

Because of the non-arbitrage condition, $R_i=R_j$, $\forall\ j\in N$, the tax vector $\tau=0$ can be a Nash equilibrium tax rate even without inequality (34), if the CIC's initially set $\tau=0$. That is, once all the CIC's begin with $\tau=0$, any CIC can not first increase its tax rate, since the arbitrage condition results in autarky to any CIC that raises its tax rate. Hence, $\tau=0$ becomes a Nash equilibrium tax rate. However, $\tau=0$ may not be unique, if all the CIC's starts with some positive tax rates. For uniqueness, inequality (34) is needed.

If $\tau=0$ throughout the CIC's as the unique Nash equilibrium tax rate, we have $g=0$, too. Hence, proposition 2 implies that the CEC government may have to provide the public goods at the competitive solution. Compared with the world planners solution, the wrong country could be providing the public goods, which means that inefficiency does exist at the competitive solution.

4.5. The Government of the CEC

Let us suppose that the government of the CEC can use a domestic lump sum tax. It uses the proceeds from the tax to finance a public good that has an international spillover effect.

Proposition 3: Even if the government of the CEC can use a lump sum tax to finance the international public goods, the competitive solution with inequality (34), $\forall\ i\in N$, generally leads to an underprovision of the public goods.

Proof: The open loop maximization problem of the CEC government is choosing T and G to

$$\begin{aligned}
\text{max.}\quad & v(Y_1,\ Y_2-T,\ R)+m(G+\textstyle\sum_i g_i),\\
\text{s.t.}\quad & T=G,\\
& \mathrm{R}=1+r,\\
& \mathrm{g}=0.
\end{aligned}$$

The first constraint is the government budget constraint, and the second and third ones come from proposition 2 above. Whatever T and G are, the competition among the CIC governments leads to $\tau=0$ so that $\mathrm{g}=0$.

If the constraints are substituted into the objective function, the CEC's decision problem is reduced to

$$\text{max.}\quad v(Y_1,\ Y_2-T,\ r)+m(T),$$

where the CEC government chooses T. Differentiate the objective function with respect to T to yield the first order condition,

$$-\mu_2+\mu_r\, r_T+m'=0, \tag{35}$$

where $\mu_2=\partial v/\partial(Y_2-T)>0$, $\mu_r=\partial v/\partial r>0$, $r_T=\partial r/\partial T$, and $m'=\partial m/\partial T>0$. In (35), the first term is the loss of utility by a marginal increase in the lump sum tax rate, and the second is the change of utility caused by an interest rate disturbance in the world capital market when the CEC tax rate is increased. Since μ_r is always positive, the sign of the second term depends on the sign of r_T. If the sign of r_T is negative, the CEC investor loses utility when his government increases T because the interest rate in the world capital market decreases. The third term is the gain of utility through a marginal increase of public goods.

Using Roy's identity, (35) can be rewritten as

$$-\mu_2+\mu_2 Nkr_T+m'=0, \tag{36}$$

where $k=k_i^s=k_i^d$ for any $i\in N$. Solving (36) for m'/μ_2 we obtain

$$\frac{m'}{\mu_2}=1-Nkr_T. \tag{37}$$

On the other hand, the equilibrium of the world capital market implies

$$k^s(Y_1,\ Y_2-T,\ r(T))=k^d(y_1,\ y_2,\ r(T)). \tag{38}$$

If we differentiate (38) with respect to T and arrange for r_T we obtain

$$r_T=\frac{k_2^s}{k_r^s-k_r^d}<0, \tag{39}$$

where $k_2^s=\partial k^s/\partial(Y_2-T)$, $k_r^s=\partial k^s/\partial r$, and $k_r^d=\partial k^d/\partial r$. Since $k_2^s<0$, $k_r^s<0$, and $k_r^d<0$, the sign of r_T is negative.

From (39), we obtain

$$\frac{m'}{\mu_2}=1-Nkr_T>1>\theta. \tag{40}$$

Now combine (40) with (17) to yield

$$\frac{m'}{\mu_2}>\frac{m'}{u_2'(C_2)}+\Sigma_i\frac{m'}{u_2'(c_{i2})}. \tag{41}$$

As long as the optimum is unique, inequality (41) implies that the amount of public goods at the world planner's solution is greater than at the competitive solution. Q.E.D.

Since Pigou (1947), Atkinson and Stern (1974), King (1986) and Batina (1990a, 1990b), the literature has implied that the first-best optimum can be obtained if lump sum finance is used. Proposition 3 suggests that if competition is a constraint in a world economy, a lump sum tax used by a country does not guarantee the first-best optimum.

V. DISCUSSION: THE TAX-CREDITING SYSTEM

One way to relieve the inefficiencies we analyzed so far is to use the tax-crediting system. The tax-crediting system is widely adopted by many developed countries to avoid double taxation on one source of income. The current tax-crediting system says that once foreign investors pay a given tax to host countries on their foreign investment income, the tax is exempted from domestic taxation as long as the foreign tax rate is equal to or less than the domestic tax rate. Thus, the total tax rate the investors have to pay is $\max(\tau_f, \tau_h)$, where τ_f is tax rate that host country imposes on foreign investment income and τ_h is tax rate that home country does.

Now suppose the CEC government uses the tax-crediting system, instead of a lump sum tax. Then, the maximization(that) the CIC governments faies is to choosing τ_i and g_i to

$$
\begin{aligned}
\text{max.} \quad & v(y_1, y_2, r)+m(G+\textstyle\sum_i g_i), \\
\text{s.t.} \quad & \tau_i k_i^s=\theta g_i, \\
& k_i^s=k^s>0, \text{ for } \tau_i \leq \tau_c, \\
& k_i^s=0, \text{ for } \tau_i > \tau_c, \\
& (r, k^s, \tau_c, G, \text{ and } g_j \ \forall \ i\neq j) \text{ given.}
\end{aligned}
$$

where τ_c is the tax credit rate imposed by the CEC government. If $\tau_i \leq \tau_c$, the amount of capital the CEC investor invests to the ith CIC is not affected by τ_i since the total tax rate, τ_c , does not change. As long as the amount of capital to each CIC remains the same, r does not change in the capital market. However, if $\tau_i > \tau_c$, τ_i becomes the effective tax rate the investor has to pay when he invests to the ith CIC. Then, because of the arbitrage condition and inequality (34), we have $k_i^s=0$.

Substitute the government budget constraint into the objective function and differentiate with respect to τ_i to obtain the first order condition,

$$m'\frac{k^s}{\theta} > 0. \tag{42}$$

(42) implies that the CIC government will set τ_i at the highest possible rate. Since autarky is the worst case, the highest possible rate is τ_c so that $\tau_i = \tau_c$.[3] That is, if the government of the CEC adopts the tax-crediting system, all CIC's set their tax rate at the tax credit rate. In another words, the government of the CEC can now control the production level of public goods from the CIC's by setting the credit rate to maximize its domestic welfare.

Under the tax-crediting system, the government of the CEC chooses τ_c to

$$\begin{aligned} \text{max.} \quad & v(y_1,\ y_2,\ R) + m(Ng), \\ \text{s.t.} \quad & N\tau_c k^s = N\theta g, \\ & R = 1 + r - \tau_c. \end{aligned}$$

Note that the government budget constraint of the CEC now includes θ which means that the CEC government can make the CIC's produce the international public goods more efficiently by permitting a tax credit. Substitute the government budget constraint into the objective function and differentiate it with respect to τ_c to obtain

$$\mu_r\left(\frac{\partial r}{\tau_c} - 1\right) + m'\frac{N}{\theta}\left(k^s + \tau_c\frac{\partial k^s}{\partial \tau_c}\right) = 0. \tag{43}$$

Using Roy's identity, rewrite (43) to yield

$$\frac{m'}{\mu_2} = \frac{r\left(1 - \dfrac{\partial r}{\partial \tau_c}\right)}{1 + \varepsilon_t}, \tag{44}$$

where $\varepsilon_t = (\tau_c / k^s)(\partial k^s / \partial \tau_c) < 0$ is the tax elasticity of capital supply. From the capital market equilibrium condition, we have

$$k^s(Y_1,\ Y_2,\ R) = k^d(y_1,\ y_2,\ r). \tag{45}$$

Differentiate (45) with respect to τ_c and arrange for $\partial r / \partial \tau_c$ to obtain

$$\frac{\partial r}{\partial \tau_c} = \frac{k_r^s}{k_r^s - k_r^d} > 0. \tag{46}$$

[3] This is similar to the setup of Devereux (1990).

$$0<1-\frac{\partial r}{\partial \tau_c}=\frac{-k_r^d}{k_r^s-k_r^d}<1. \tag{47}$$

Thus, we know in (44) that

$$0<\theta\left(1-\frac{\partial r}{\partial \tau_c}\right)<1, \tag{48}$$

$$\frac{1}{1+\varepsilon_t}>1. \tag{49}$$

From (48) and (49), it is not clear whether m'/μ_2 is greater than one or not so that we can not compare (44) directly to (41). However, (44) implies that the smaller the tax elasticity is and the more efficiently the CIC's produce the public goods, the more effective the tax-crediting system may be. If ε_t and θ are small, it is possible $m'/\mu_2<1$. This implies that distortionary taxation with tax credit leads to higher supply of public good than a lump sum taxation in the CEC. This result is different from the conclusion of Zodrow and Mieszkowski (1986), who argue that under a national system of competing local governments, the supply of public goods is lower with distorting taxation than with lump sum taxation.

VI. CONCLUSION

Nowadays, every country seems to recognize the necessity of the international public goods to fight common ecological and military threats. Nevertheless, the governments of poor developing countries tend to be harder to find their tax bases to afford them than those of wealthy developed countries. As an example, Britain's then Prime Minister Margaret Thatcher hosted a 123-country London "Conference to Save the Ozone Layer" in March 1989. Poorer countries, however, resisted the call to cut back on chlorofluorocarbons (CFCs). China, India, and other populous developing countries embarking on mass production of consumer goods containing CFCs argued that since the West invented and produces most of the ozone-destroying chemicals, the West should pay to replace them.[4] They may be too poor to use domestic taxes to provide public goods that fight the world ecological problems.

This circumstance is a reason why we constrained the tax base to foreign capital income in the CIC's, entering an international public goods into the

[4] See Shaw and Stroup (1990).

utility function of each country. Contrary to the existing literature in which countries are usually assumed to exchange capital bilaterally and compete to attract it, this chapter sheds new light on the second strand of the public economics literature by considering a world economy in which capital unilaterally moves from a wealthy country to a number of poor countries and the poor countries compete for scarce capital. With this framework that may be justified by the current capital movements of the world (as explained in section 1), we showed that under some reasonable conditions the competitive solution may not be efficient and the attained level of the public goods could be below the optimal level in terms of the world economy.

Another difference between this paper and the existing literature is the explicit introduction of an international public goods whose marginal cost of production is different between countries. In the first strand literature, the public goods that have spillover effects to other jurisdictions were assumed to be produced at the same marginal cost. It may be reasonable to assume that the public goods used to fight world ecological problems can be produced more efficiently in the countries where the problems occur, even if the public goods may be produced by any country. With this assumption, we demonstrated that the tax competition between the CIC's and the lack of tax tools in the CIC's implies that the wrong country may produce the public good, even if the CEC government can use the first best tax tool, a lump sum tax. The use of a lump sum tax by one country may not be enough to result in the first best outcome, which is an extension of the third strand of the literature that attributes inefficiencies to the use of distortionary taxes.

Finally, we discussed the tax-crediting system to improve the inefficiencies under the competitive solution. We found that if the tax elasticity of capital supply is small and the cost difference is large, the tax-crediting system by the CEC could be more effective for a given tax elasticity of capital supply than a lump sum tax.

REFERENCES

Atkinson, A. B., and Stern, N. H. (1974), "Pigou, Taxation and Public Goods," *Review of Economic Studies*, 41, 119-128.

Batina, R. G. (1990a), "Public Goods and Dynamic Efficiency: The Modified Samuelson Rule," *Journal of Public Economics*, 41, 389-400.

Batina, R. G. (1990b), "On the Interpretation of the Modified Samuelson Rule for Public Goods in Static Models with Heterogeneity," *Journal of Public Economics*, 42, 125-133.

Boskin, M. J. (1973), "Local Government Tax and Product Competition and the Optimal Provision of Public Goods," *Journal of Political Economy*, 81, 203-210.

Brainard, W. C., and Dolbear, F. T., Jr. (1967), "The Possibility of Oversupply of Local Public Goods: A Critical Note," *Journal of Political Economy*, 75, 86-90.

Bucovetsky, S., and Wilson, J. D. (1991), "Tax Competition with Two Tax Instruments," *Regional Science and Urban Economics*, 21, 333-350.

Devereux, M. B. (1990), "International Cooperation, Precommitment, and Welfare," *International Economic Review*, 31, 439-456.

Gordon, R. H. (1983), "An Optimal Taxation Approach to Fiscal Federalism," *Quarterly Journal of Economics*, 98, 567-586.

Gordon, R. H. (1990), "Can Capital Income Taxes Survive in Open Economies?," NBER Working Paper, Number 3416.

King, M. A. (1986), "A Pigovian Rule for the Optimum Provision of Public Goods," *Journal of Public Economics*, 30, 273-291.

OECD (1982), *Economic and Ecological Interdependence*, Paris, France: OECD Publications Office.

Pauly (1970), "Optimality, Public Goods, and Local Governments: A General Theoretical Analysis," *Journal of Political Economy*, 78, 572-584.

Pigou, A. C. (1947), *A Study in Public Finance*, Third Edition, London, England: Macmillan.

Shaw, J. S., and Stroup, R. L. (1990), "Global Warming and Ozone Depletion," In W. E. Block (Ed.), *Economics and the Environment: A Reconciliation*, Chapter 5, 159-179.

Starrett, D. A. (1980), "On the Method of Taxation and the Provision of Local Public Goods," *American Economic Review*, 70, 380-392.

Wildasin, D. E. (1989), "Interjurisdictional Capital Mobility: Fiscal Externality and a Corrective Subsidy," *Journal of Urban Economics*, 25, 193-212.

Williams, A. (1966), "The Optimal Provision of Public Goods in a System of Local Government," Journal of Political Economy, 74, 18-33.

Wilson, J. D. (1986), "A Theory of Interregional Tax Competition," *Journal of Urban Economics*, 19, 296-315.

Wilson, J. D. (1987), "Trade, Capital Mobility, and Tax Competition," *Jour-*

nal of Political Economy, 95, 835-856.

Zodrow, G. R., and Mieszkowski, P. (1986), "Pigou, Tiebout, Property Taxation, and the Underprovision of Local Public Goods," *Journal of Urban Economics,* 19, 356-370.