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COMPETITION VERSUS COOPERATION IN FISCAL POLICY GAMES WITH AND WITHOUT POLICY COMMITMENT*

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This paper studies the cooperation-versus-competition issue in two different fiscal policy games. Considering the circumstance that the wealthy capital-exporting country (CEC) unilaterally makes foreign direct investment (FDI) to the capital-importing countries (CIC's), it first shows that in the open loop policy game where long-term policy commitment is available, cooperation among the CIC's better off than competition at the expense of the CEC. Secondly, it briefly shows that the result of the open loop policy game may not hold in the closed loop policy game where any long-term policy commitment is not available.

1. INTRODUCTION

The globalization of economic activity and the interdependence of economic policy over the past several decades have drawn a lot of attention in international public economics. The attention has started with the fact that countries are linked not only by the cross-border transactions of private firms and citizens but also by the cross-border ramifications of their governments' economic policies and this has triggered an active research program in international economic policy coordination.

Since the work of Hamada (1966, 1976), one main conclusion of the research is that increasing policy cooperation is desirable for interdependent countries. More recently, however, some authors have challenged this view. For example, Rogoff (1985) and Kehoe (1989) conclude that competition may be better than cooperation in terms of welfare when monetary and fiscal policies have international spillover effects. Using a two-country version of Fischer's (1980) optimal tax model, Kehoe (1989) shows that cooperation in setting the capital income tax rate between two symmetric countries can lead to a lower level of welfare than competition does.

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One shortcoming of Kehoe (1989) is that he, as many others do, considers only the open loop case so that all the governments can make a precommitment about tax rates at the beginning of the first period. However, the fact is that many countries can not make a precommitment in advance and they change their tax rates frequently.[1]

This paper first studies the competition-versus-cooperation argument in the open loop case. Then, it extends the argument to include the closed loop case. The main result of the paper is that cooperation is better than competition for the capital importing countries (CIC's), but the reverse is true for the capital-exporting country (CEC) in the open loop game, and that cooperation is equivalent to competition for the CIC's and the CEC in the closed loop game. Since MacDougall (1960), papers dealing with international capital movements have usually considered two-country models, in which capital movement occurs between the two countries and they compete or cooperate with each other to maximize their respective welfare function or national income. In this paper, however, we will see competition and cooperation in a different way. We construct a model in which the number of countries is generalized to more than two and the capital movement occurs between the CEC and the CIC's, but competition or cooperation occurs between the CIC's, not between the CEC and the CIC's. This model reflects a situation in international capital movements where even if a country exports and imports capital, the country can be classified as a CEC or CIC in net terms. The model also makes it easier to analyze the competition-vs.-cooperation issue among the CIC's in the two different policy games.

The contents of the paper are as follows. The model is introduced in section 2. Section 3 summarizes the decision problems of the private agents under the noncooperative and cooperative regimes. The open and closed loop policy games under the two different regimes are discussed in sections 4 and 5, respectively. The conclusion is in section 6.

2. THE MODEL

The economy lasts for two periods and consists of one CEC and N CIC's. N will also denote the set of the CIC's. The CIC's are identical in every respect. Only the governments in the CIC's will impose a policy and each government behaves in a perfectly benevolent way. Each country contains the same fixed population that is normalized to one representative private agent.

There is one good available. The private agent in the CEC is endowed with Y

1) This is a typical example of the time inconsistency problem of government policy. Since Kydland and Prescott (1977) originally discussed this problem, it became a hot issue in the literature of economic policies. Some papers concerning this issue in the area of tax policies include Fischer (1980), Rogers (1986, 1987), Staiger and Tabellini (1987), Lapan (1988), Maskin and Newbery (1990), and Batina (1990, 1991, 1992). Persson and Tabellini (1990) is a good text for this issue.

units of the good in period t and the private agent in each CIC is endowed with y_t units in period t. We will assume that $Y_1>Y_2$ and $Y_t>y_t>0$ for all t. Each private agent in both the CEC and the CIC's is also endowed with one unit of labor at the beginning of the second period.

The preferences of the CEC private agent are represented by a well behaved utility function of the form

$$u_1(C_1)+\delta u_2(C_2), \tag{1}$$

where δ is a discount factor and C_t is CEC consumption in period t. Here, we assume that the utility functions are twice continuously differentiable, strictly quasi-concave, $\partial u_t(C_t)/\partial C_t>0$ for $C_t\geq 0$, and $\partial u_t(C_t)/\partial C_t\to 0(\infty)$ as $C_t\to\infty(0)$.

The private agent of the CEC allocates the first period endowment to investments and first period consumption. The second period consumption comes from the second period endowment, the invested capital, the after-tax return of the investments, and wage income. The agent's budget constraints are

$$Y_1-\sum_i k_i-k_h-C_1=0, \tag{2}$$

$$Y_2+\sum_i R_i k_i+(1+r_h)k_h+w_h-C_2=0, \tag{3}$$

where k_i is the amount of foreign direct investment (FDI) in the ith CIC, k_h is the amount of domestic investment, and R_i is the after-tax rate of return from the FDI to the ith CIC. Note that $R_i=1+r_i-\tau_i$ is the gross rate of return from the FDI of the ith CIC and τ_i is the capital income tax rate imposed by the government of the ith CIC. r_i is endogenously determined by the amount of foreign capital in the ith CIC. r_h is the rate of return from the domestic investment that is also endogenously determined by the amount of capital invested in the CEC. w_h is the wage income that the CEC agent earns working in the firm created by the domestic firm.

Now let us look at the capital-importing economies. Since they are assumed to be identical except for tax policy, we consider the economy of the representative ith CIC. The preferences of the ith CIC agent are

$$u_1(C_{i1})+\delta(u_2(C_{i2})+m(g_i)), \tag{4}$$

where c_{it} is the amount of consumption in period t, g_i is a local public good provided by the ith CIC government. We assume $u_t(\cdot)$ has the same properties as in the CEC preferences and $m(g_i)$ is also twice continuously differentiable, strictly quasi-concave, $\partial m(g_i)/\partial g_i>0$ for $g_i\geq 0$, and $\partial m(g_i)/\partial g_i\to 0(\phi)$ as $g_i\to\infty(0)$, where $\phi>0$ and finite.

The private agent of the ith CIC just consumes the endowment in the first period. In the second period, however, he works at the firm created by the FDI. He finances the second period consumption through the second period endowment and the wage income he earns by providing a unit of labor to the multinational firm. He has the following budget constraints,

$$y_1 - c_{i1} = 0, \tag{5}$$
$$y_2 + w_i - c_{i2} = 0, \tag{6}$$

where w_i is the wage income he earns at the multinational firm.

The foreign and domestic investments from the CEC construct a large number of identical firms in each CIC and the CEC. We normalize them to one typical firm so that there is one firm in each CIC and the CEC. The firm combines one unit of local labor with capital to produce output, all of which can be sold in the competitive world market at a fixed price of one. The technology of each firm is a homogeneous production function of the first degree. The firms in the ith CIC and the CEC respectively choose k_i and k_h to maximize

$$\pi_i = f(k_i) - r_i k_i - w_i, \tag{7}$$
$$\pi_h = f_h(k_h) - r_h k_h - w_h, \tag{8}$$

where f and f_h are respectively the production functions in the CIC's and the CEC. While the technology is generally different at the firms in the CIC's and the CEC, i·e., $f \neq f_h$, we assume that $f(0)=f_h(0)=0$, f and f_h are twice continuously differentiable, strictly concave, strictly increasing, and satisfy the Inada conditions. We also assume f satisfies the condition[2] that $\varepsilon \equiv -kf''/f' \leq 1$, where ε is the capital elasticity of marginal product. In equilibrium, we have

$$r_i = f'(k_i) \text{ and } w_i = f(k_i) - k_i f'(k_i), \tag{9}$$
$$r_h = f_h'(k_h) \text{ and } w_h = f_h(k_h) - k_h f_h'(k_h). \tag{10}$$

To focus on government policy games, we assume that all markets are competitive in the sense that except for the governments of the CIC's, all private agents and firms regard as beyond their control the aggregate variables and government policies such as the wage rates, the rates of return of investment, the price level, the behavior of the other private agents and the other firms, and tax rates. The governments of the CIC's, however, can affect the aggregate variables and governemnt policies and take into account the responses of the variables and policies when they set their choice variables.

The government of each CIC is benevolent in the sense that its objective function is the utility function of its domestic private agent. The government budget constraint of the ith CIC is

$$\tau_i k_i = g. \tag{11}$$

For simplicity, we assume that one unit of the public good can be produced by

2) This condition is needed to guarantee the inequality (48). However, notice that it always holds for the Cobb-Douglas production function, a typical homogeneous production function of the first degree.

one unit of the private good.

3. THE DECISION PROBLEMS OF THE PRIVATE AGENTS

Before we discuss the government policy games, it is useful to summarize the decision problems of the private agents of the CEC and the CIC's. We consider two different regimes, the noncooperative regime and the cooperative regime.

In the noncooperative regime, the government of each CIC sets its policies to maximize its domestic utility function under the Nash assumption that the policies of the other governments are inependent of its own. In the cooperative regime, however, the governments of the CIC's set their policies so as to maximize the summation of the utility functions of all of the CIC's. If the CIC's cooperate, the result is similar to a cartel. Hence, we can essentially treat them as if there is only one CIC. The decision problems of the private agents in each regime can be described recursively as follows.

3.1 A Noncooperative Regime

The representative private agent of the CEC just consumes $C_2 = Y_2+\sum_i R_i k_i+(1+r_h)k_h+w_h$, since $Y_2+\sum_i R_i k_i+(1+r_h)k_h+w_h$ is given to the agent in the second period. Thus, we get the second period indirect utility function of the CEC agent, $u_2(Y_2+\sum_i R_i k_i+(1+r_h)k_h+w_h)$.

The private agent of the ith CIC has $c_{i2}=y_2+w_i$, since y_2+w_i is given to the agent in the second period. Substituting into the utility function, we get the second period indirect utility function of the ith CIC agent, $u_2(y_2+w_i)+m(g_i)$.

In the first period, the private agent of the CEC chooses C_1, $\mathbf{k}=(k_1, \cdots, k_N)$, and k_h to

$$\max.\ u_1(c_1)+\delta u_2(Y_2+\sum_i R_i k_i+(1+r_h)k_h+w_h), \tag{12}$$

subject to (2), where Y_1, Y_2, $\mathbf{R}=(R_1, \cdots, R_N)$, r_h, and w_h are given to the agent. Substituting (2) into (12), the decision problem is reduced to choosing $\mathbf{k}$ and k_h to

$$\max.\ u_1(Y_1-\sum_i k_i-k_h)+\delta u_2(Y_2+\sum_i R_i k_i+(1+r_h)k_h+w_h). \tag{13}$$

The first order conditions of the maximization problem are

$$\frac{u_1'(Y_1-\sum_i k_i-k_h)}{u_2'(Y_2+\sum_i R_i k_i-(1+r_h)k_h+w_h)}=\delta R_i,\ \forall i\in N, \tag{14}$$

$$\frac{u_1'(Y_1-\sum_i k_i-k_h)}{u_2'(Y_2+\sum_i R_i k_i+(1+r_h)k_h+w_h)}=\delta(1+r_h). \tag{15}$$

Then, we have the non-arbitrage condition $R=R_1=\cdots=R_N=1+r_h$ in the capital market equilibrium. Imposing this condition, the optimal amount of savings can be determined such as

$$S(Y_1, Y_3, R, w_h) = \sum_i k_i + k_h, \tag{16}$$

where $\partial S/\partial R > 0$. We also have that in the capital market equilibrium

$$f'(k_1) - \tau_1 = \cdots = f'(k_N) - \tau_N = f'_h(k_h). \tag{17}$$

Assuming an equilibrium exists, equations (16), (17), and $w_h = f_h(k_h) - k_h f'_h(k_h)$ can be solved to obtain

$$k_i(Y_1, Y_3, \tau), \quad \forall\, i \in N, \tag{18}$$
$$k_h(Y_1, Y_3, \tau), \tag{19}$$

where $\partial k_i/\partial \tau_i < 0$, $\partial k_h/\partial \tau_i > 0$, and $\partial k_j/\partial \tau_i > 0$ for $i \neq j$.

In the first period, he just consumes his first period endowment so that $c_{i1} = y_1$. Hence, the first period indirect utility function of the ith CIC agent is $u_1(y_1) + \delta(u_2(y_2 + w_i) + m(g_i))$.

3.2 A Cooperative Regime

Since all of the CIC's cooperate, we do not need to differentiate between the CIC's so that the subscript i is dropped from the variables.

In the second period when $Y_2 + NRk + (1+r_h)k_h + w_h$ is given to the agent, the agent just consumes $C_2 = Y_2 + NRk + (1+r_h)k_h + w_h$. Then, we get the second period indirect utility function under the cooperative regime, $u_2(Y_2 + NRk + (1+r_h)k_h + w_h)$, where $\partial u_2 / \partial(Y_2 + NRk + (1+r_h)k_h + w_h) > 0$. Notice that $R = 1 + r - \tau$, in which r and τ are the common gross rate of return and the common tax rate of the CIC coalition, respectively. Since τ and f are equal throughout the CIC's, each CIC receives the same amount of capital by (17) so that r is also equal throughout the CIC's.

In the second period, the CIC agent has $c_2 = y_2 + w$. Substituting $c_2 = y_2 + w$ into the objective function, the second period indirect utility function can be denoted as $u_2(y_2 + w) + m(g)$.

In the first period, the agent of the CEC chooses k and k_h to maximize $u_1(Y_1 - Nk - k_h) + \delta u_2(Y_2 + NRk + (1+r_h)k_h + w_h)$, where Y_1, Y_2, R, r_h, and w_h are taken as given by the agent. The first order conditions of this decision problem are

$$\frac{u_1'(Y_1 - Nk - k_h)}{u_2'(Y_2 + NRk + (1+r_h)k_h + w_h)} = \delta R, \tag{20}$$

$$\frac{u_1'(Y_1 - Nk - k_h)}{u_2'(Y_2 + NRk + (1+r_h)k_h + w_h)} = \delta(1 + r_h). \tag{21}$$

Then, we have the non-arbitrage condition $R = 1 + r_h$ in the capital market equilibrium. Imposing this condition, we have the optimal amount of savings,

$$S(Y_1, Y_2, R, w_h)=Nk+k_h. \tag{22}$$

In the capital market equilibrium, we also have

$$f'(k)-\tau=f'_h(k_h). \tag{23}$$

If an equilibrium exists, we can solve equations (22), (23), and $w_h=f_h(k_h)-k_h f'(k_h)$ to obtain

$$k(Y_1, Y_3, \tau), \tag{24}$$
$$k_h(Y_1, Y_2, \tau), \tag{25}$$

where $\partial k/\partial\tau<0$ and $\partial k_h/\partial\tau>0$.

In the first period, the agent of each CIC consumes $c_1=y_1$. Thus, the first period indirect utility function of the CIC agent is $u_1(y_1)+\delta(u_2(y_2+w)+m(g))$.

4. THE OPEN LOOP POLICY GAME

First, we consider the open loop policy game. As usual in the government policy game literature, the decision-making process between the government and the private agent is a revised version of the Stackelberg game. The government of each CIC, as leader within its own country, first chooses its tax rate on FDI in its territory and is absolutely committed to the tax rate. The savings and capital allocation decisions are then made by the private agent in the CEC. When the governments set their tax rates, each government can compete or cooperate with the group of the CIC governments. Each CIC government knows exactly the behavior of the private agent of the CEC. The private agent also knows the tax rates of the CIC governments. No government can renege on its announced tax rate later and the private agent believes the announced tax rates of the CIC governments.

4.1 A Noncooperative Regime

Consider first the regime in which the governments of the CIC's set tax rates noncooperatively. A noncooperative open loop equilibrium is a set of investments $\mathbf{k}^e=\{k^e_1, \cdots, k^e_N\}>>0$ and k^e_h and a set of rates of return $\mathbf{R}^e=\{R^e_1, \cdots, R^e_N\}$ and r^e_h such that

i. $\mathbf{k}^e=(k^e_1,\cdots, k^e_N)$ and k^e_h satisfy the first order conditions (14) and (15),

ii. $R^e_i=1+r^e_i-\tau^e_i$, $\forall\ i \in N$, where $r^e_i=f'(k^e_i$ and τ^e_i is competitively set by the government of the ith CIC to maximize the utility of the private agent of the ith CIC;

iii. if k^e_i, k^e_j, and k^e_h are positive, $R^e_i=R^e_j=1+r^e_h$, $\forall$ i, j $\in$ N, where $r^e_h=f'_h(k^e_h)$.

Now let us calculate the open loop tax rate of each CIC under the noncooperative regime. At the beginning of the first period, the government of the ith CIC chooses τ_i and g_i to

$$\begin{aligned} \max.\ & v_i \equiv u_1(y_1)+\delta(u_2(y_2+w_i)+m(g_i)), \\ & \text{s.t. } \tau_i k_i = g_i, \\ & w_i = f(k_i) - k_i f'(k_i), \\ & \tau_i \geq 0, \\ & (y_1, y_2) \text{ given.} \end{aligned}$$

Substituting the government budget constraint into the objective function and differentiating it with respect to τ_i we obtain

$$\frac{\partial v_i}{\partial \tau_i} = -k_i f''\frac{\partial k_i}{\partial \tau_i}u_2' + \left[k_i + \tau_i\frac{\partial k_i}{\partial \tau_i}\right]m' \leq 0 \quad \tau_i\frac{\partial v_i}{\partial \tau_i} = 0, \tag{26}$$

where $f''=\partial^2 f/\partial(k_i)^2<0$, $u_2'=\partial u_2/\partial(y_2+w_i)>0$, and $m'=\partial m/-\partial g_i>0$. In (26), the first term, $-kf''(\partial k/\partial\tau)u_2'$, represents the change in utility caused by the change in the wage rate when FDI responds to the tax rate. The second term, $[k_i+\tau_i(\partial k/\partial\tau)]m'$, represents the change in utility from the change in the level of the public good. Since $\partial k/\partial\tau_i<0$, the first term is always negative. The sign of the second term, however, depends on how elastic k_i is when τ_i changes. If k_i is so elastic that $\partial k/\partial\tau_i<-k/\tau_i$, the second term is also negative. Hence, it is possible to have more tax revenue by decreasing τ_i. If this Laffer case holds or the first term is larger in magnitude than the second term, the optimal tax rate is unique at zero throughout the CIC's.

To calculate the term $\partial k/\partial\tau$, substitute $(1+r_h)k_h+w_h=k_h+f_h(k_h)$ into (14) and differentiate it with respect to τ_i to obtain

$$\Phi_1\frac{\partial k_i}{\partial \tau_i}+(\Phi_2+\delta u_2')\frac{\partial R_i}{\partial \tau_i}+(N-1)\left[\Phi_1\frac{\partial k_j}{\partial \tau_i}+\Phi_2\frac{\partial R_j}{\partial \tau_i}\right]+\Phi_3\frac{\partial k_h}{\partial \tau_i}0,\ i\neq j, \tag{27}$$

where $\Phi_1=u_1''+\delta R_i^2 u_2''<0$, $\Phi_2=\delta R_i k_i u_2''<0$, and $\Phi_3=u_1''+\delta R_i(1+f_h')u_2''<0$. In (27), the first two terms on the left-hand side (LHS) represent the movement of capital between the CEC savings and the ith CIC investment, when τ_i changes with fixed $\tau_{-i}=(\tau_1, \cdots, \tau_{i-1}, \tau_{i+1}, \cdots, \tau_N)$. Since we assume that when the net rate of return increases, savings increase in the CEC, more capital is provided from the CEC to the CIC's and the sign of $\Phi_2+\delta u_2'$ should be positive. That is, we have $\Phi_2+\delta u_2'>0$ from the condition $\partial k/\partial R_i>0$. The third term of the LHS represents the transfer of capital between the investments in the ith CIC and the other CIC's. The fourth term is the transfer of capital between the investments in the ith CIC and the CEC.

Using $\partial R/\partial\tau_i=f''(\partial k/\partial\tau)-1$ and $\partial R/\partial\tau_i=f''(\partial k/\partial\tau)$, we can rewrite (27) as

$$\begin{aligned} \frac{\partial k_i}{\partial \tau_i} = & \frac{\Phi_2+\delta u_2'}{\Phi_1+(\Phi_2+\delta u_2')f''} - \frac{(N-1)(\Phi_1+\Phi_2 f'')}{\Phi_1+(\Phi_2+\delta u_2')f''}\frac{\partial k_i}{\partial \tau_i} \\ & - \frac{\Phi_3}{\Phi_1+(\Phi_2+\delta u_2')f''}\frac{\partial k_h}{\partial \tau_i} < 0,\ i\neq j. \end{aligned} \tag{28}$$

The first term of the right-hand side (RHS) in (28) is the incresed (decreased) amount of capital from the CEC savings to the ith CIC investment, when τ_i decreases (increases). Notice that since $\Phi_1<0$, $\Phi_2<0$ and $\Phi_2+\delta u_2'>0$, the sign of the first term is negative. The second term of the RHS is the increased amount of transfer capital from (to) the other CIC's investments to (from) the ith CIC investment, when τ_i decreases (increases). The sign of the numerator, $(N-1)(\Phi_1+\Phi_2 f'')$, of the second term is not immediately clear, but since k_j decreases in the new equilibrium after τ_i decreased, the sign of $(N-1)(\Phi_1+\Phi_2 f'')$ must be negative to make the sign of the second term of the RHS negative. The reason why the sign of $(N-1)(\Phi_1+\Phi_2 f'')$ is not clear can be explained as follows. When τ_i decreases, the gap between R_i and R_j moves k_j out to the ith CIC. Next, $f'(k_j)$ increases so that R_j goes up to discourage the movement of k_j to the ith CIC. That is, because we have two opposite forces that affect the movement of k_j, the sign of $(N-1)(\Phi_1+\Phi_2 f'')$ is not clear. However, since the second effect is an indirect effect and can not exceed the first effect, the sign of $(N-1)$ $(\Phi_1+\Phi_2 f'')$ is negative. The third term represents the increased (decreased) amount of transfer capital from the CEC investment to the ith CIC investment, when τ_i decreases (increases). The sign of the third term is clearly negative.

As we will show later, the second term of the RHS in (28) disappears if all the CIC's cooperate. In the cooperative regime, only one tax rate is available so that there is no movement of capital among the CIC's. If the second term is larger in magnitude, each CIC has an incentive to lower its tax rate and it is more likely for the competitive tax rate to be unique at zero.

In addition, notice that the after-tax rate of return moves in the opposite direction of the change in the tax rate. That is, we have $\partial R_i/\partial\tau_i<0$, since $\partial R_i/\partial\tau_i=\partial R_j/\partial\tau_i$ and $\partial R_j/\partial\tau_i=\partial r_j/\partial\tau_i=f''(\partial k_j/\partial\tau_i)<0$.

4.2 A Cooperative Regime

Consider next the regime in which the CIC's set tax rates cooperatively. A cooperative open loop equilibrium is a set of investments k^e and k_h^e, and a set of rates of return R^e and r_h^e such that

i. k^e and k_h^e satisfy the first order conditions (20) and (21);

ii. $R^e=1+r^e-\tau^e$, where $r^e=f'(k^e)$ and τ^e is cooperatively set by the governments of the CIC's to maximize the summation of the utility of the CIC private agents;

iii. if k^e and k_h^e are positive, $R^e=1+r_h^e$, where $r_h^e=f_h'(k_h^e)$.

With the cooperative regime of the open loop policy game, the CIC-government coalition chooses a common tax rate τ and a common level of public good g to

$$
\begin{aligned}
\max.\ & v\equiv N[u_1(y_1)+\delta(u_2(y_2+w)+m(g))],\\
\text{s.t.}\ & \tau k=g,\\
& w=f(k)-kf'(k),\\
& \tau\geq 0,\\
& (y_1, y_2)\ \text{given.}
\end{aligned}
$$

The objective function is the summation of the first period indirect utility functions of the CIC's. The constraints include the government budget constraint and the equilibrium wage rate.

Substituting the government budget constraint into the objective function and differentiating with respect to τ, we have the first order condition,

$$\frac{\partial V}{\partial \tau} = -kf'' \frac{\partial k}{\partial \tau} u_2' + \left(k + \tau \frac{\partial k}{\partial \tau}\right) m' = 0, \tag{29}$$

where $f'' = \partial^2 f/\partial(k)^2 < 0$, $u_2' = \partial u_2/\partial(y_2 + w) > 0$, and $m' = \partial m/\partial g > 0$. The first term is always negative, since $\partial k/\partial \tau < 0$. Thus, when τ goes up (down), the utility from the consumption of private good decreases (increases). The sign of the second term depends on how elastic k is when τ changes.

To derive the term $\partial k/\partial \tau$, substitute $(1+r_h)k_h + w_h = k_h + f_h(k_h)$ into (20) and differentiate it with respect to τ to obtain

$$\phi_1 \frac{\partial k}{\partial \tau} + \left[\phi_2 + \frac{\delta u_2'}{N}\right] \frac{\partial R}{\partial \tau} + \frac{\phi_3}{N} \frac{\partial k_h}{\partial \tau} = 0, \tag{30}$$

where $\phi_1 = u_1'' + \delta R^2 u_2'' < 0$, $\phi_2 = \delta R k u_2'' < 0$, and $\phi_3 = u_1'' + \delta R(1 + f_h')u_2'' < 0$. Because of the assumption $\partial k/\partial R > 0$, we have $\phi_2 + \delta u_2'/N > 0$ in (30).

Using $\partial R/\partial \tau = f''(\partial k/\partial \tau) - 1$, we can rewrite (30) as

$$\frac{\partial k}{\partial \tau} = \frac{\phi_2 + \frac{\delta u_2'}{N}}{\phi_1 + \left[\phi_2 + \frac{\delta u_2'}{N}\right] f''} - \frac{\frac{\phi_3}{N}}{\phi_1 + \left[\phi_2 + \frac{\delta u_2'}{N}\right] f''} \frac{\partial k_h}{\partial \tau} < 0. \tag{31}$$

Since $\phi_1 < 0$, $\phi_2 < 0$, $\phi_3 < 0$, and $\phi_2 + \delta u_2'/N > 0$, the sign of each term in (31) is negative so that the sign of $\partial k/\partial \tau$ is also negative. The first term of the RHS in (31) represents the increased (decreased) amount of capital from the CEC savings to each CIC investemtn, when τ decreases (invreases). The second term represents the increased (decreased) transfer of capital from the CEC investment to each CIC investment, when τ decreases (increases). That is, if the coalition of the CIC's decreases (increases) the common tax rate, each CIC receives more (less) capital from the CEC in two different ways. Notice that there is no term representing the capital transfer between the CIC's in (31). Since all CIC's change one common tax rate together, there is no incentive to make the capital transfer between them occur.

Notice here that the after-tax rate of return increases (decreases), when the tax rate goes down (up). That is, we have $\partial R/\partial \tau < 0$, since $\partial k/\partial \tau = (\partial k/\partial R)(\partial R/\partial \tau) < 0$ and $\partial k/\partial R > 0$.

When we compare (28) with (31), we first notice that equation (28) has the term, $-[(N-1)(\Phi_1 + \Phi_3 f'')/(\Phi_1 + (\Phi_2 + \delta u_2')f''](\partial k/\partial \tau)$, representing the movement of capital between the ith CIC and the other CIC's. At a given tax rate where $\Phi_1 = \phi_1$, $\Phi_2 = \phi_3$, and $\Phi_3 = \phi_3$, we also notice that the first term on the RHS in (28) is larger in magnitude than the first term of the RHS in (31). Lastly, the third term of the RHS in (28) is larger in magnitude than the second term of the RHS in (31) at a given tax rate, since we assume that f is a homogenous production function with $\varepsilon \leq 1$ such as the Cobb-Douglas production function. Now that the term representing the capital movement between the ith CIC and the other CIC's is negative, and the first and third terms on the RHS in (28) is respectively larger in magnitude than the first and second terms of the RHS in (31), we know that at a given tax rate

$$\left[-\frac{\partial k_i}{\partial \tau_i}\right]^{NO} > \left(-\frac{\partial k}{\partial \tau}\right)^{CO}, \tag{32}$$

where the superscripts NO and CO represent the noncooperative and cooperative regimes, respectively. That is, the capital going to each CIC is more elastic to the change of tax rate under the noncooperative regime than under the cooperative regime. If N is a large number, the movement of capital between the CEC, the other CIC's, and the ith CIC is very sensitive to the change of τ_i so that the difference between $(-\partial k_i/\partial \tau_i)^{NO}$ and $(-\partial k/\partial \tau)^{CO}$ could be very large.

Now the tax rates under the two regimes can be summarized as a proposition.

Proposition 1 : *In the open loop policy game, the cooperative tax rate (τ^{CO}) is higher than the competitive tax rate (τ^{NO}), if the two tax rates are unique.*

Proof : By definition, τ^{NO} satisfies the first order condition (26) of the noncooperative regime. Now suppose the coalition of the CIC's set the cooperative tax rate such as $\tau = \tau^{NO}$. Then, the cooperative tax rate does not satisfy the first order condition (29) of the cooperative regime. That is, at the cooperative tax rate such as $\tau = \tau^{NO}$, the LHS of (29) is positive, because $-(\partial k)/(\partial \tau) < -(\partial k_i)/(\partial \tau_i)$ by inequality (32). If the LHS of (29) is positive, then the welfare of the coalition can be improved by increasing the cooperative tax rate. This means the equilibrium tax rate of the cooperative regime is higher than the equilibrium tax rate of the noncooperative regime such as $\tau^{CO} > \tau^{NO}$. Q. E. D.

4.3 A Welfare Comparison

Proposition 2 : *In the open loop policy game, if the tax rates are unique, cooperation leads to a higher level of welfare for the CIC's and a lower level of welfare for the CEC than does competition.*

Proof : Proposition 1 says that $\tau^{CO} > \tau^{NO}$, even if the noncooperative tax rate is available to the coalition of the CIC's under the cooperative regime. Therefore, the welfare level of the CIC's under the cooperative regime should be higher than under the noncooperative regime.

How about the CEC agent? In equilibrium, the first period utility functions of the CEC agent under the noncooperative and cooperative regimes of the open loop game are the same form,

$$V \equiv u_1(Y_1 - Nk - k_h) + \delta u_2(Y_2 + NRk + (1+r_h)k_h + w_h). \tag{33}$$

Substituting $(1+r_h)k_h + w_h = k_h + f_h(k_h)$ into (33) and differentiating it with respect to τ, we obtain by the envelope theorem

$$\begin{aligned}\frac{\partial V}{\partial \tau} &= -N(u_1' - \delta R u_2')\frac{\partial k}{\partial \tau} + N\delta k u_2' \frac{\partial R}{\partial \tau} - (u_1' - \delta(1+f_h')u_2')\frac{\partial k_h}{\partial \tau} \\ &= N\delta k u_2' \frac{\partial R}{\partial \tau} < 0.\end{aligned}$$

Since $\tau^{CO} > \tau^{NO}$ and $\partial V/\partial \tau < 0$ under the both regimes, we have $V(\tau^{NO}) > V(\tau^{CO})$. **Q. E. D.**

This section concludes that cooperation is better than competition, while Kehoe (1989) says that the reverse is true. The difference, of course, comes from the different context of the models. In Kehoe's paper, there are two identical countries. The private agent of each country can invest in both countries. The event is so sequential that even if the private agents of both countries change in advance the amoutn of total capital according to the tax rate, the total capital is already fixed, when the governments choose their tax rate on capital. If both governments compete in setting the tax rate, the tax rate on capital becomes zero because of the competition to attract more capital. If, on the other hand, they cooperate, the two countries will confiscate the capital, since the total amount of capital is already fixed. Then, in the cooperative regime, we have one more constraint such that the supply of total capital to both countries is always zero since the private agents save nothing in the cooperative regime. Therefore, Kehoe's conclusion is that competition is better than cooperation.

In this section, however, confiscation will not occur, since the decision of the total capital supply is made after the announcement of government policy so that the total capital is not fixed when the governments set their tax rates. Thus, the governments do not increase the tax rates as high as one even in the cooperative regiem so that cooperation is better than competition.

Gordon (1983) has the conclusion that fiscal cooperation is better than competition. He models a federal system of government to which a number of local governments belong. His paper points out that the tax competition among the local governments causes inefficiencies, since a local government ignores the effects of its decisions on the utility levels of nonresidents. The paper suggests that it may be preferable to have the central government take responsibility for particular activities.

In spite of the different structure of the models, the results of Gordon's paper and this section are similar. The central government of the paper is equivalent to the coalition of the CIC's of this section. In his paper, the central government reduces the cost of decentralized decision-making and increases efficiency for the federal system. In this section, on the other hand, the coalition of the CIC's gives the CIC's market power and makes it possible to increase the common tax rate and enhance the utility levels of the CIC's.

5. THE CLOSED LOOP POLICY GAME

The governments of the CIC's face different optimization problems in the second period. At the beginning of the second period, not only is the total stock of capital invested by the CEC fixed, but also the allocation of capital among the CIC's is given so that the open loop tax rates of the noncooperative regime and of the cooperative regime are not optimal for the CIC's. Even if the CIC's impose a higher tax on the FDI, the CEC investor cannot withdraw the FDI. This means that the social welfare in each CIC can be improved by increasing its tax rate once the FDI is fixed in the second period. Thus, the open loop solutions are generally time inconsistent. If there is no protective means[3] prohibiting them from reneging on their tax policies, the CIC's have an incentive to increase their tax rate, since doing so improves social welfare in the CIC's.

In the closed loop game, especially, the private agent of the CEC makes the savings and capital allocation decisions first. And then, after observing the choices of the CEC private agent, the governments of the CIC's set their tax rate. When the CEC private agent makes his decisions in the first period, however, he knows the exact tax rate in the future. As in the open loop game, we have two regimes, depending on whether the governments of the CIC's can compete or cooperate in setting the tax rate on FDI.

5.1 A Noncooperative Regime

In this regime, each CIC government sets its policies to maximize domestic utility at the beginning of the second period, taking as given the policies of the other CIC's.

Proposition 3 : *In the noncooperative equilibrium of the closed loop game, the competitive tax rate vector is* $\tau = 1 + \mathrm{r}$ *and the capital allocation is* $\mathbf{k} = (k_1, \cdots, k_N) = 0$ *and* $k_h > 0$.

Proof : In the closed loop game, the objective function of the ith CIC government is the second period indirect function. In the constraints, since k_i's are fixed, all w_i's and r_i's are also fixed. The decision problem of the ith CIC government under the noncooperative regime is choosing τ_i and g_i to

$$\begin{aligned} &\max.\ u_2(y_2 + w_i) + m(g_i), \\ &\quad \text{s.t.}\quad \tau_i k_i = g_i, \\ &\qquad\qquad \tau_i \leq 1 + r_i, \\ &\quad (y_2, w, k, r_i)\ \text{given}. \end{aligned}$$

3) Chapter 4 of Rhee (1994) studies a protective means that the CEC can have, when the CIC's renege on their policies. This paper, however, assumes that any protective means is not available to the CEC.

Substituting the government budget constraint into the objective function and differentiating the objective function with respect to τ, we have the first order condition that $km' > 0$. This inequality means the government should set τ_i as high as possible. The highest τ_i is $1+r_i$ so that $\tau = 1+r$ for all CIC's.

How does the private agent of the CEC choose the optimal **k** under the noncooperative regime of the closed loop game? In the first period when he makes the savings and capital allocation decisions, the agent of the CEC exactly knows that the tax rate will be $\tau_i = 1+r_i$ for any i belonging to N in the second period. The agent of the CEC chooses **k** and k_h to

$$\begin{aligned} \max.\ & V \equiv u_1(Y_1 - \sum k_i - k_h) + \delta u_2(Y_2 + \sum R_i k_i + (1+r_h)k_h + w_h), \\ \text{s.t. } & R_i = 1 + r_i - \tau_i = 0, \quad \forall\, i \in N, \\ & (Y_1, Y_2, \mathbf{R}, r_h, w_h) \text{ given.} \end{aligned}$$

Because of the first constraint, $\sum k_i = Nk$ and $\sum R_i k_i = 0$. Thus, the decision problem becomes choosing k and k_h to

$$\max.\ V \equiv u_1(Y_1 - Nk - k_h) + \delta u_2(Y_2 + (1+r_h)k_h + w_h).$$

The first order conditions are

$$\begin{aligned} & \partial V / \partial k = -Nu_1' < 0, \\ & \partial V / \partial k_h = -u_1' + \delta(1+r_h)u_2' = 0, \end{aligned}$$

which mean $\mathbf{k} = (k_1, \cdots, k_N) = 0$ and $k_h > 0$. Q. E. D.

5.2 A Cooperative Regime

Under the cooperative regime of the closed loop policy game, the governments of the CIC's set a common tax rate at the beginning of the second period after observing the choice variables of the private agents.

Proposition 4 : *In the cooperative equilibrium of the closed loop game, the common tax rate is $\tau = 1 + r$, the common amount of FDI to each CIC is $k = 0$, and the amount of domestic investment is $k_h > 0$.*

Proof : If the CIC's cooperate, the decision problem of the CIC governments is to choose the common tax rate τ and g to

$$\begin{aligned} \max.\ & N[u_2(y_2 + w) + m(g)] \\ \text{s.t. } & \tau k = g, \\ & \tau \leq 1 + r, \\ & (y_2, w, k, r) \text{ given.} \end{aligned}$$

By the same way as in proposition 3, it is straightforward to derive $\tau=1+r$.

In the cooperative regime of the closed loop game, the agent of the CEC chooses k and k_h to

$$\max. \quad V \equiv u_1(Y_1 - Nk - k_h) + \delta u_2(Y_2 + RNk + (1+r_h)k_h + w_h)$$
$$\text{s.t.} \quad R = 1 + r - \tau = 0.$$

Following proposition 3, we can easily show that $k=0$ and $k_h>0$ in the cooperative equilibrium of the closed loop game. Q. E. D.

5. 3 A Welfare Comparison

Proposition 5 : *In the closed loop policy game, competition is equivalent to cooperation in terms of the welfare level of the CEC and CIC's.*

Proof : Propositions 3 and 4 show that $\tau=1+r$ and $k=0$ in both the noncooperative and cooperative equilibria, which means all countries go to autarky in both equilibria. Thus, there is no difference in the welfare level of the CEC and CIC's between competition and cooperation in the closed loop game. Q. E. D.

6. CONCLUSION

This paper studied the issue of international fiscal coordination in two different policy games. The main result of the paper is that in terms of the welfare of the CIC's, competition among the CIC's is inferior to cooperation in the open loop game, but competition is equivalent to cooperation in the closed loop game.

In the first game, we explained why cooperation is beneficial to participating countries in a different framework from the existing literature. In the second game, then, considering that many CIC's increase their tax rates or confiscate foreign capital[4], once FDI's are completed and fixed, we showed that when a precommitment about the future tax rate on FDI's is not available, the argument of competition-versus-cooperation in economic policy coordination may be different from the one with a full long-term commitment.

4) Williams (1975) finds that 18.8% of the foreign investment to 40 developing CIC's between 1956 and 1972 has been nationalized. The socialist countries of them has nationalized as high as 9%.

REFERENCES

Batina, R. G. (1990), "The Optimal Provision of a Public Good when the Tax System is Time Inconsistent," Discussion Paper, Department of Economics, Washington State University.

Batina, R. G. (1991), "Equity and the Time Consistent Taxation of Income," *Scandinavian Jorunal of Economics*, 93, 407-419.

Batina, R. G. (1992), "On the Time Consistency of the Government's Social Security Benefit Policy," *Jorunal of Monetary Economics*, 29, 475-486.

Fischer, S. (1980), "Dynamic Inconsistency, Cooperation and the Benevolent Dissembling Government," *Journal of Economic Dynamics and Control*, 2, 93-107.

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

Hamada, K. (1966), "Strategic Aspects of Taxation of Foreign Investment Income," *Quarterly Journal of Economics*, 80, 361-375.

Hamada, K. (1976), "A Strategic Analysis of Monetary Interdependence," *Journal of Political Economy*, 84, 677-700.

Kehoe, P. J. (1989), "Policy Cooperation among Benevolent Governments May Be Undesirable," *Review of Economic Studies*, 56, 289-296.

Kydland, F. E., and Prescott, E. C. (1977), "Rules Rather Than Discretion : The Inconsistency of Optimal Plans," *Journal of Political Economy*, 85, 473-491.

Lapan, H. E. (1988), "The Optimal Tariff, Production Lags, and Time Consistency," *American Economic Review*, 78, 395-401.

MacDougall, G. D. A. (1960), "The Benefits and Costs of Private Investment from Abroad : A Theoretical Approach," *Economic Record*, 36, 13-35.

Maskin, E., and Newbery, D. (1990), "Disadvantageous Oil Tariffs and Dynamic Consistency," *American Economic Review*, 80, 143-156.

Persson, T., and Tabellini, G. (1990), *Macroeconomic Policy, Credibility and Politics*, Chur, Switzerland : Harwood Academic Publishers.

Rhee, G. (1994), *International Capital Mobility, Public Goods, and Tax Policies*, Ph. D. Dissertation, Washington State University.

Rogers, C. A. (1987), "The Effect of Distributive Goals on the Time Inconsistency of Optimal Taxes," *Journal of Monetary Economics*, 17, 251-269.

Rogoff, K. (1985), "Can International Monetary Policy Cooperation Be Counterproductive?," *Journal of International Economics*, 18, 199-217.

Staiger, R. W., and Tabellini, G. (1987), "Discretionary Trade Policy and Excessive Protection," *American Economic Review*, 77, 823-837.

Williams, M. L. (1975), "The Extent and Significance of the Nationalization of Foreign-Owned Assets in Developing Countries, 1956-1972", *Oxford Economic Papers*, 27, 260-273.