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Dynamic inconsistency, falling cost of capital relocation and preferential taxation of foreign capital

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Abstract

When capital is sunk after it is invested, a host government facing heterogeneous foreign investors who differ in their cost of capital relocation (which falls over time) has a strong incentive to wait in order to gain from relatively lower cost of capital relocation and offer preferential taxes over time in order to attract less eager investors. We find that, if the government can commit to future tax rates, the tax revenue increases as the cost of relocation decreases. Moreover, under preferential taxation scheme the equilibrium tax revenue of the government is equal to what it can earn under full commitment. The tax revenue under non-preferential taxation scheme is lower compare to full commitment outcome when cost of capital relocation falls considerably over time but remains strictly positive. Under every taxation schemes considered in this paper, the equilibrium tax rate falls over time if cost of capital relocation falls considerably which offers another explanation for- "why the tax rate falls over time in tax treaties?".

JEL classification: F21, H21, H25, H87

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1 Introduction

The process of globalization has reduced the cost of capital relocation over time. Falling cost of capital relocation provide incentives for a government to

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offer tax incentives to attract footloose foreign investors. It seems that when a single country wants to attract foreign investors, both the host government and investors should gain from falling cost of capital relocation. The government should gain because it has to offer less tax discounts to attract investors while investors have to incur a lower cost to relocate to a more productive destination. But barriers to foreign investments exist due to the government's inability to commit to future tax rates. Also, when foreign investment is fully or partially irreversible, the host government has strong incentives to expropriate all returns on capital after the investment is sunk and this deter foreign investors. After the current round of foreign investment is sunk, the government has strong incentives to offer lower tax rate to attract investors who didn't invest in the past (because they have higher cost of relocation or because of better outside option), which may reduce current investments because investors wait for better policy terms. While holdup problem arising from irreversible investment have been well studied[1], the dynamic inconsistency problem (in the presence of holdup problem) have received little attention[2].

We consider a simple two periods model where a host government's objective is to maximize his revenue from taxes on capital. There is a continuum of foreign investors who differ in their cost of capital relocation. Investors who don't invest during the initial period face smaller cost of capital relocation in future. Once invested in the host country, capital is fully sunk. We use this framework to analyze if falling cost of capital relocation makes dynamic inconsistency problem resulting from preferential treatment of foreign capital more severe (relative to the outcome when the host government can commit to future tax rates). The framework is also useful for analyzing the effect of falling cost of capital relocation on tax treaties for foreign direct investments.

This paper is close to kishore and Roy(2014). In kishore and Roy(2014), investors differ in their net return on capital outside the host country, which makes the dynamic inconsistency problem more severe (investors need to be compensated for future loss of returns up-front because of holdup problem) compared to our paper where investors differ in their cost of relocation which investors incur only once. In our model falling cost of capital relocation makes dynamic inconsistency problem more severe and at the same time offers incentive to the host country to wait as well. Although, there are many paper which argue that falling cost of capital relocation increases tax competition which can potentially reduce tax revenues of competing countries, as far as I know there has been no study to analyze this inter-temporal effect of decreasing cost of capital relocation. This scenario is not analyzed in Industrial Organization as well. It also highlights if a country's has incentives to change its polity choice depending on the economic environment outside the host country such as; falling cost of cap-

[1] Solution to this problem include self-enforcing agreements between individual investors and the host government through long term interaction (See, among many others Eaton and Gersovitz (1983), Thomas and Worrall (1994), Doyle and Van Wijinbergen (1994) and Schnitzer (1999)), as well as multilateral treaties between soverign nations.

[2] Kishore and Roy (2014) show that this dynamic inconsistency problem can be fully resolved if the host government can commit to non-preferential taxation of foreign capital.

ital relocation and changes in tax compliance cost. We find that when the host country can commit to future tax rates (and also when the government has no or only partial commitment ability), the tax rate decreases over time. Moreover, the government commit to future tax rates or not, its tax revenue increases if there is considerable reduction in cost of capital relocation. Richard and Davies (2004) argue that the rationale behind falling tax rates over time is reduced risk of expropriation when two countries send foreign direct investments to each other jurisdictions. Our paper suggests that another rationale for reduction in the tax rate is the cost of capital relocation.

2 Model

We consider a dynamic two-period economy ($t = 1,\ 2$) where the host government wishes to attract foreign investments. In order to focus on taxation of capital income and to compare the tax revenue implications of alternative structures, we assume that the government's objective is to maximize the total tax revenue over both periods. Further, we assume for simplicity that the host country has no domestic capital at the beginning of period 1. Outside the host country there is a continuum of investors of unit mass, each endowed with a unit of capital. Each unit of capital invested in the host country yields return equal to 1 in each period. An investor that does not invest in the economy will receive net return equal to zero. Further, there is cost of relocating capital to the host country which varies across investors and decreases over time. The cost of relocation is distributed uniformly over $[0,\ 1]$ and $[0,\ \rho]$ respectively, in period 1 and period 2, where $1 \geq \rho \geq 0$. An investor who has cost cost of relocation to the host country equal to r in period 1 will see his cost of relocation reduced to ρr in period 2. We assume that capital is sunk once invested in the host country. For simplicity, we also assume that neither the government nor investors discount future.

We study the rational expectations equilibrium of this model under various assumptions on the commitment ability of the government.

3 Outcome with full commitment

We begin with the benchmark case where the government can fully commit to future tax rates. The government problem is to incentivize investors not to wait for period 2 in order to make investments but at the same time also gain from low cost of relocation in period 2. Lemma 1 describes the equilibrium outcome when the cost of capital relocation in period 2 is considerably high, i.e. $\rho \geq \frac{1}{2}$.

Lemma 1 *When $\rho \geq \frac{1}{2}$, whether or not the government can extend preferential treatment to new investors, the optimal full commitment tax scheme is one where all investors invest in period 1 and there is no new investments in period 2. The optimal full commitment tax revenue is equal to $G_{FC} \equiv 1$. Moreover, the outcome is independent of relative fall in capital relocation in period 2.*

Proof. At the beginning of period 1, along with the tax rate on foreign capital in period 1 (t_1), the government also chooses the tax rates in period 2 on domestic capital $\left(t^N\right)$ and foreign capital (t_2). Suppose all investors with the cost capital relocation less than r_1 invest in the host country in period 1. The gain from making investment in period 1 is

$$1 - t_1 - r_1. \tag{1}$$

If the critical investor invests in period 2 its gain is

$$1 - t_2 - \rho r_1. \tag{2}$$

The critical investor is the one who is indifferent between making investment in period 1 and waiting until period 2, hence, from (1) and (2) ,for the critical investor following equality holds

$$\begin{aligned} 1 - t_1 - r_1 &= 1 - t_2 - \rho r_1 \\ &\Rightarrow \quad r_1 = \max\left\{\frac{t_2 - t_1}{1-\rho},\ 1\right\} \end{aligned} \tag{3}$$

Note that, if $t_2 - t_1$ increases then for the equality to hold, an investor with higher cost of relocation will invest in period 1. Also, if $(t_2 - t_1)$ is held constant then as ρ increases there is more investments in period 1. This captures the idea "how dynamic inconsistency problem gets more severe as the cost of relocation falls". It gets more difficult for the government to induce investments in period 1. Assuming the tax rate in period 2 is low enough to induce new investments, investors with cost of relocations less than r_2 will invest, where

$$r_2 = 1 - t_2.$$

New investments in period 2 is equal to

$$\frac{r_2 - \rho r_1}{\rho} = \frac{1 - t_2 - \rho r_1}{\rho}$$

The tax revenue of the government from new investments in period 2 is equal to

$$\left(\frac{1 - t_2 - \rho r_1}{\rho}\right) t_2. \tag{4}$$

If the government sets a tax rate equal to t_1 in period one then the fraction of investors who invest in period one is equal to

$$\frac{t_2 - t_1}{(1-\rho)}$$

Hence, the tax revenue of the government from investments in period 1 is equal to

$$\max\left\{\frac{t_2 - t_1}{1-\rho},\ 1\right\} t_1 + \max\left\{\frac{t_2 - t_1}{1-\rho},\ 1\right\} \tag{5}$$

Where $\left(\frac{t_2-t_1}{(1-\rho)}\right)t_1$ is the tax revenue in period 1 and $\left(\frac{t_2-t_1}{(1-\rho)}\right)$ is the tax revenue from domestic capital in period 2. Hence, from (4) and (5) ,the total tax revenue of the government is equal to

$$\max\left\{\frac{t_2-t_1}{1-\rho},\ 1\right\}t_1+\max\left\{\frac{t_2-t_1}{1-\rho},\ 1\right\}+\left(\frac{1-t_2-\rho r_1}{\rho}\right)t_2. \tag{6}$$

The government will choose the tax pair $(t_1,\ t_2)$ simultaneously to maximize its total tax revenue. From (6) , the maximization problem of the government is

$$\max_{0\leq t_1\leq 1, t_1<t_2\leq 1}\left(\frac{t_2-t_1}{(1-\rho)}\right)t_1+\frac{t_2-t_1}{(1-\rho)}+\frac{1}{\rho(1-\rho)}(1+\rho t_1-t_2-\rho)t_2 \tag{7}$$

$$s.t.\ 0\leq\frac{t_2-t_1}{1-\rho}\leq 1 \tag{8}$$

Note that the function is strictly concave in both t_1 and t_2. The first order condition for the unconstrained version of above problem is

$$2t_1-2t_2+1 = 0 \tag{9}$$
$$2\rho t_1-2t_2+1 = 0 \tag{10}$$

The two first order conditions (9) and (10)can hold simultaneously only when $t_1=0$, in which case $t_2=\frac{1}{2}$. For $t_1=0$ and $t_2=\frac{1}{2}$, we have $\frac{t_2-t_1}{1-\rho}=\frac{0.5}{1-\rho}$, the minimum value of which is equal to 1 for $\rho=0.5$. Hence, all investors invest in period 1. The total tax revenue of the government is equal to 1. ■

Lemma 1 shows that when the fall in cost of relocation is not very large the government's tax revenue does not increase. If the government lowers the tax rate in period 2, due to lower cost of mobility, investors have more incentive to wait until period 2 in order to make investment. The gain to the government from its ability to set a higher tax rate in period 2 (and yet attract investments) due to lower mobility cost is less than the loss of tax revenue from investors delaying investments. Note that the marginal cost of increasing t_1 in period 1 is $\frac{1}{1-\rho}(2t_1-t_2+1)$, which at $t_1=0$ is equal to $\frac{1-t_2}{1-\rho}$. The marginal benefit of decreasing t_2 is $\frac{1+\rho t_1-\rho-2t_2}{\rho(1-\rho)}$ which at $t_1=0$ is equal to $\frac{1-\rho-2t_2}{\rho(1-\rho)}$. The marginal cost of increasing t_1 is greater than the marginal benefit of decreasing t_2 when $t_1=0$ when

$$1-t_2\geq\frac{1-\rho-2t_2}{\rho} \tag{11}$$

The right hand in (11) is decreasing in ρ, hence, the maximum value is obtained at $\rho=0.5$, which is equal to $1-4t_2$. Lemma 2, below described the equilibrium outcome when $\rho<1/2$. We saw that when $\rho\geq 1/2$, it is beneficial for the government to attract all investors in period 1 and commit not to set t_2 lower than 0.5. But when $\rho<1/2$, the government should wait to gain from falling cost of capital relocation. Although, lemma 1 and lemma 2 can be proved simultaneously, it is instructive to look at them separately.

Lemma 2 *When $\rho < 1/2$, then under full commitment the tax revenue of the government is equal to $G_{FC} \equiv \frac{4\rho^2-8\rho+5}{4(1-\rho)}$. The tax revenue of the government increases as ρ decreases.*

Proof. Suppose the government sets the tax rate t_1 in period 1. In period 2 it sets t^N and t_2 on domestic and foreign capital, respectively. Because the government can fully commit to future tax rates only t_1+t^N matters for investors at the beginning of period 1. Hence, we fix $t^N = 1$. Suppose investors with cost of capital relocation less than r_1 invest in period 1. As before the critical investor should be indifferent between making investment in period 1 or period 2. The gain to the critical investor is $1 - t_1 - r_1$ and $1 - t_2 - \rho r_1$ respectively, if it chooses to invest in period 1 and period 2. For the critical investor following equality should hold:

$$\begin{aligned} 1 - t_1 - r_1 &= 1 - t_2 - \rho r_1 \\ &\Rightarrow \quad r_1 = \frac{t_2 - t_1}{1-\rho}. \end{aligned} \tag{12}$$

If a fraction r_1 of investors invest in period 1 then the government receives $r_1 t_1$ and r_1 respectively, from taxes on foreign capital in period 1 and domestic capital in period 2. In period 2, if the government sets $t_2 = 1 - \rho$, then all remaining investor will invest in period 2. Suppose the government sets t_2 such that $1 - \rho \leq t_2 \leq 1 - \rho r_1$. The critical investor in period 2 is the investor with the cost of capital relocation equal to $1 - t_2$. Hence, a fraction $\frac{1-t_2-\rho r_1}{\rho}$ of investors invest in period 2. The government receive $\left(\frac{1-t_2-r_1}{\rho}\right) t_2$ from taxes on new investments in period 2. The maximization problem of the government is:

$$\max \left(\frac{t_2 - t_1}{1-\rho}\right) t_1 + \left(\frac{t_2 - t_1}{1-\rho}\right) + \left(\frac{1 - t_2 - r_1}{\rho}\right) t_2 \tag{13}$$

$$s.t \; 0 \leq \frac{t_2 - t_1}{1-\rho} \leq 1, \; t_2 \geq 1 - \rho, \; t_1 \leq 1 \text{ and } t_2 \leq 1. \tag{14}$$

The function is strictly concave in t_1 and t_2. The first order condition for the unconstrained version of the above problem is

$$-\rho + t_2 - 2\rho t_1 + \rho t_2 = 0 \tag{15}$$

$$1 - 4t_2 + t_1 + 2\rho t_2 + \rho t_1 = 0 \tag{16}$$

Solving for t_1 and t_2 we obtain

$$\begin{aligned} t_1 &= \frac{1-2\rho}{5\rho - 1} \\ t_2 &= \frac{\rho}{5\rho - 1} \end{aligned}$$

$t_2 \equiv \frac{\rho}{5\rho-1}$ is equal to $1 - \rho$ when $\rho = \frac{1}{2} - \frac{1}{10}\sqrt{5}$. Also, when $\rho > \frac{1}{2} - \frac{1}{10}\sqrt{5}$, we have $t_2 < 1 - \rho$ and when $\rho < \frac{1}{2} - \frac{1}{10}\sqrt{5}$, we have $t_2 > 1 - \rho$. Hence, there is possibility of an interior solution only when $\rho < \frac{1}{2} - \frac{1}{10}\sqrt{5}$. For $\rho \geq \frac{1}{2} - \frac{1}{10}\sqrt{5}$, we have $t_2 = 1 - \rho$. Now $\frac{t_2 - t_1}{1-\rho} \equiv \frac{3\rho - 1}{(5\rho-1)(1-\rho)} > 0$ when $\rho > \frac{1}{3}$. Hence, when $\rho \leq \frac{1}{3}$, we can not have an interior solution. At the same time, we also saw that for an interior solution we should have $\rho < \frac{1}{2} - \frac{1}{10}\sqrt{5}$. But $\frac{1}{2} - \frac{1}{10}\sqrt{5} < \frac{1}{3}$, hence, we don't have an interior solution. Hence, the maximum tax revenue is achieved when $t_2 = 1 - \rho$ and the government attract all remaining investors in period 2. Given $t_2 = 1 - \rho$, the government's maximization problem is

$$\max \left(\frac{1-\rho-t_1}{1-\rho} \right) t_1 + \frac{1-\rho-t_1}{1-\rho} + \left(1 - \frac{1-\rho-t_1}{1-\rho} \right) (1-\rho) \qquad (17)$$

$$s.t.\ 0 \leq \frac{1-\rho-t_1}{1-\rho} \leq 1 \text{ and } t_1 \leq 1. \qquad (18)$$

The function described in (17) is strictly concave in t_1. From the first order condition we obtain

$$t_1 = \frac{1-2\rho}{2}. \qquad (19)$$

Note that t_1 described by (19) satisfies both conditions described by (18). Hence, in equilibrium, the tax revenue of the government is equal to

$$G_{FC} = \frac{4\rho^2 - 8\rho + 5}{4\,(1-\rho)}. \qquad (20)$$

Hence proved. ■

We can see that if the cost of capital relocation falls considerably the government does obtain a higher tax revenue. Note that the average tax faced by investors who invest in period 1 is $\frac{t_1+t_N}{2} = \frac{3}{4} - \frac{1}{2}\rho$ which is strictly greater than $1-\rho$ when $\rho < \frac{1}{2}$. Hence, the tax rate on foreign investments decreases over time. Most foreign investments are done through bilateral treaty between two countries and it is observed that the tax rate decreases over time. Richard and Davies (2004) argue that the rationale behind the same is reduced risk of expropriation when two countries send foreign direct investments to each other jurisdictions. Lemma 2 suggests that another rationale for reduction in the tax rates is falling of capital relocation.

4 Outcome with no commitment

Consider the situation where the government can not make any credible commitment at the beginning of period 1 about the taxes it intends to levy in period 2. In particular, the government can discriminate between sunk capital (from investments in period 1) and new investments in period 2. This leads to two different problems. First, there is a hold up problem; in period 2 the government has every incentive to fully expropriate the returns on existing investments made by investors in period 1, as it can do so without affecting its ability to tax new investments. Anticipating this expropriation of future returns, foreign investors will invest in period 1 only if the government lower its tax sufficiently (possibly offers a large subsidy) in period 1. However, as the government wants to engage in inter-temporal tax discrimination (reducing taxes over time), the initial tax can not be too low and this distorts the size of investment in period 1. Second, there is a Coasian problem; investors understand that the government has every incentive to offer reduced preferential taxes in the future to attract investors who do not make investment in period 1, and so investors with moderately good outside options prefer to wait until period 2. This again may lead to loss of total tax revenue (compared to the full commitment solution). Moreover, the dynamic inconsistency problem is more severe here; reduced cost of capital relocation provides more incentives to wait until period 2. But, the loss of tax revenue from falling cost of relocation may be somewhat compensated because the government has to offer less tax rebates to investors when cost of relocation falls. Proposition 1 describes the equilibrium outcome when the government resort to preferential taxation scheme.

Preposition 1: *If the government resort to preferential taxation and $\rho < \frac{1}{2}$, the tax revenue of the government is equal to $G_{NC} \equiv \frac{1}{4(1-\rho)}\left(4\rho^2 - 8\rho + 5\right)$. In this case the tax revenue of the government increases monotonically as ρ decreases. When $\rho \geq \frac{1}{2}$, the tax revenue of the government is equal to 1. The tax revenue under a preferential taxation scheme is equal to the tax revenue under full commitment, e.g., $G_{NC} = G_{FC}$.*

Proof. Suppose investors with cost of relocation less than r_1 invested in period 1. In period 2, the government is free to set different tax rates for domestic (investments from period 1) and foreign capital. The optimal taxation scheme is to set the maximum tax rate for domestic capital and provide tax rebates to less willing investors. The tax revenue in period 2 from taxes on domestic capital is r_1. The cost of relocation of marginal investor who didn't invest in period 1 is $r_1' = \rho r_1$. If the government set a tax rate t_2 such that $1 - \rho < t_2 < 1 - \rho r_1$, investors with cost of relocation lower than r_2 will invest in period 2, where r_2 satisfies following equality; $1 - r_2 = t_2$. New investments in period 2 for the tax rate t_2 is $\left(\frac{1-t_2-\rho r_1}{\rho}\right)$. The maximization problem of the government in period 2 is

$$G_{NC}^2 = \max \left(\frac{1 - t_2 - \rho r_1}{t_2}\right) t_2 \tag{21}$$

$$s.t.\ t_2 \geq 1 - \rho \tag{22}$$

G_{NC}^2 is strictly concave in t_2, hence, from the first order condition of the unconstrained version of the above problem we obtain

$$t_2 = \frac{1 - \rho r_1}{2}. \tag{23}$$

In this case it is always beneficial for the government to attract more investments in period 2. For an interior solution we must have $t_2 \geq 1 - \rho$, which is true when

$$\begin{aligned} \frac{1-\rho r_1}{2} &\geq 1-\rho \\ &\Rightarrow r_1 \leq 2-\frac{1}{\rho} \end{aligned} \tag{24}$$

When $\rho \leq \frac{1}{2}$, we have $2-\frac{1}{\rho} \leq 0$, hence, irrespective of investments in period 1, the government sets the tax rate equal to $1-\rho$ in period 2 and attract all remaining investors. Hence

$$t_2 = 1-\rho \text{ if } \rho \leq \frac{1}{2}.$$

When $\rho > \frac{1}{2}$ and $r_1 < 2-\frac{1}{\rho}$, the government sets $t_2 = \frac{1-\rho r_1}{2}$, else it sets $t_2 = 1-\rho$. For $\rho = 1$, the government does not attract all investors in period 2 as long as $r_1 < 1$. Hence

$$G_{NC}^2 = \frac{1}{4\rho}\left(1-\rho r_1\right)^2 \; if \; \rho > \frac{1}{2} and \; r_1 < 2-\frac{1}{\rho}$$

When $r_1 \geq 2-\frac{1}{\rho}$, we have a corner solution where the government sets the tax rate equal to $1-\rho$ and attract all remaining foreign investors in period 2. In this case the tax revenue of the government is

$$G_{NC}^2 = \left(1-r_1\right)\left(1-\rho\right) \; if \; r_1 \geq 2-\frac{1}{\rho}$$

Hence, the total tax revenue of the host government in period 2 is equal to

$$G_{NC}^2 = \begin{cases} \frac{1}{4\rho}\left(1-\rho r_1\right)^2 + r_1 \;\; if \; r_1 < 2-\frac{1}{\rho} \\ \left(1-r_1\right)\left(1-\rho\right) + r_1 \;\; if \; r_1 \geq 2-\frac{1}{\rho} \; or \; \rho \leq \frac{1}{2} \end{cases} \tag{25}$$

Case 1 $\left(r_1 < 2-\frac{1}{\rho}\right)$: If the government sets the tax rate t_1 in period 1, then the critical investor should be indifferent between making investment in period 1 and waiting until period 2. If the critical investor invests in period 1 its revenue gain is equal to $1-t_1-r_1$. The investor knows that in period 2 the government will set the tax rate equal to $\frac{1-\rho r_1}{2}$, hence, its revenue gain from making investment in period 2 is $1-t_2-\rho r_1$ which for $t_2 = \frac{1-\rho r_1}{2}$ is equal to $\frac{1-\rho r_1}{2}$. The critical investor is the one who is indifferent between making an investment in period 1 and in period 2, hence, following equality holds

$$1-t_1-r_1 = \frac{1-\rho r_1}{2} \tag{26}$$

If the host government wants to attract all investors with the cost of relocation less than r_1 then from eq(26)

$$t_1 = \frac{1+\rho r_1 - 2r_1}{2}. \tag{27}$$

The tax revenue of the host government in period 1 is equal to $t_1 r_1$, which using eq(27) is equal to $\left(\frac{1-2r_1+\rho r_1}{2}\right) r_1$. In period 1, the government maximizes the sum of tax revenue from period 1 and period 2. Hence, using eq(25) the optimization problem of the government can be represented as

$$\max_{r_1<2-\frac{1}{\rho}} \frac{1}{4\rho}\left(1-\rho r_1\right)^2 + r_1 \;+ \left(\frac{1-2r_1+\rho r_1}{2}\right) r_1. \tag{28}$$

From the first first order condition of the unconstrained version of the above problem we obtain

$$r_1 = \frac{2}{4-3\rho} \tag{29}$$

But note that when $\frac{1}{2} \leq \rho \leq 1$, we have $\frac{2}{4-3\rho} \geq 2 - \frac{1}{\rho}$, hence, we have a corner solution where the government chooses $r_1 = \; 2 - \frac{1}{\rho}$. From eq(27) the tax rate in period 1 is equal to $\frac{1}{\rho}\left(1-\rho\right)^2$. The tax rate in period 1 increases as ρ decreases and is equal to 0 for $\rho = 1$. Substituting $r_1 = 2 - \frac{1}{\rho}$ in eq(28) , we obtain the total tax revenue of the government G_{NC} which is equal to

$$G_{NC} = \frac{1}{\rho^2}\left(3\rho^3 - 5\rho^2 + 4\rho - 1\right) \tag{30}$$

Case 2 $\left(r_1 \geq 2 - \frac{1}{\rho}\right)$: In this case the government sets the tax rate $1-\rho$ in period 2 and attract all remaining investors. The critical investor is the one who is indifferent between making investment in period 1 and waiting until period 2. If the host government sets t_1 in period 1, then the gain from making investment in period 1 is equal to $1 - t_1 - r_1$. Similarly, the gain from waiting until period 2 is $1 - t_2 - \rho r_1$, which is equal to $\rho - \rho r_1$ for $t_2 = 1 - \rho$. For the critical investor following equality holds:

$$1 - t_1 - r_1 = \rho - \rho r_1. \tag{31}$$

Hence, if the host government wants to attract all investors with the cost of capital relocation less than r_1, then from eq(31) , we have

$$t_1 = 1 + \rho r_1 - r_1 - \rho \tag{32}$$

The tax revenue of the host government in period 1 is equal to $t_1 r_1$ which using eq(32) is equal to

$$G^1_{NC} = \left(1 + \rho r_1 - r_1 - \rho\right) r_1 \tag{33}$$

Using eq(25) and eq(33), the optimization problem of the government can be represented as:

$$\max_{r_1 \geq \frac{1}{\rho}(2\rho-1)} \left(1-r_1\right)\left(1-\rho\right) + r_1 \;+ \left(1 + \rho r_1 - r_1 - \rho\right) r_1 \tag{34}$$

From the first order condition of the unconstrained version of the above problem we obtain

$$r_1 = \frac{1}{2\left(1-\rho\right)} \tag{35}$$

We have interior solution because $\frac{1}{2(1-\rho)} > 2 - \frac{1}{\rho}$. Using eq(33) and eq(35), the tax revenue of the government is equal to

$$G_{NC} = \frac{1}{4\,(1-\rho)}\left(4\rho^2 - 8\rho + 5\right) \tag{36}$$

Hence, when $r_1 \geq 2 - \frac{1}{\rho}$ the tax revenue of the government is equal to $\frac{1}{4(1-\rho)}\left(4\rho^2 - 8\rho + 5\right)$. Note that when $\rho < \frac{1}{2}$, we always have $r_1 \geq 2 - \frac{1}{\rho}$. Hence, when $\rho < \frac{1}{2}$, the tax revenue of the government is given by eq(36) . From eq(35) , it is clear that when $\frac{1}{2} \leq \rho \leq 1$, we have $r_1 = 1$. Substituting $r_1 = 1$ in eq(34) , we obtain $G_{NC} = 1$. From eq(30), when $\frac{1}{2} \leq \rho \leq 1$ and $r_1 < 2 - \frac{1}{\rho}$, the tax revenue of the government is equal to $\frac{1}{\rho^2}\left(3\rho^3 - 5\rho^2 + 4\rho - 1\right)$, which is strictly less than 1. Hence, proved. ■

We can see that the tax revenue of the government is same under "full commitment" and "no commitment". The full commitment outcome requires that the government offers a lower tax rate in period 2 to attract less willing investors and preferential taxation scheme without any commitment also offers same flexibility (to lower the tax rate over time). Hence, in tax treaties the government has incentive to resort to preferential taxation if they can not commit to future tax rates.

5 Outcome under partial commitment

In this section we analyze the situation where the government is committed to set an equal tax rate on both, domestic and foreign capital, i.e., it can not discriminate based on different vintages of capital. When investments in period 1 is large, it is more costly for the government to lower the tax rate in period 2 in order to attract more investments. The government has incentive to lower the tax rate in period 2 if investments in period 1 is small or the cost of relocation has decreased significantly. Proposition 2 explains the equilibrium outcome under a non-preferential taxation scheme.

Proposition 2. *Under a non-preferential taxation scheme when $\rho \leq \frac{1}{4}$, the tax revenue of the government is equal to $\frac{5}{4}(1-\rho)$. The government gains from a lower cost of capital relocation and attracts all investors in period 2. When $\rho > \frac{1}{4}$, the tax revenue of the government is equal to 1. When $0 < \rho < \frac{1}{2}$* and *, the tax revenue under non-preferential taxation scheme generates lower tax revenues compared to full commitment outcome (outcome with no commitment) , i.e. $G_{PC} \leq G_{FC} = G_{NC}$. For $\rho = 0$, the tax revenue of the government is equal under each taxation scheme.*

Proof. Suppose investors with cost of relocation less than r_1 invest in period 1. If the government does not wants to attract more investors in period 2, it will set the maximum tax rate on investments in period 2 and receive taxes from domestic capital only. If t_2 is the tax rate in period 2, investors with cost of relocation less than r_2 will relocate to the host country, where r_2 satisfy the following equality $r_2 = 1 - t_2$.The total tax revenue of the government in period

2 is equal to $r_2 t_2$. The optimization problem of the government is

$$\max \left(\frac{1-t_2}{\rho}\right) t_2 \tag{37}$$
$$s.t.\ 1-\rho \quad \leq \quad t_2 \leq 1 \text{ and } \frac{1-t_2}{\rho} \geq r_1$$

The function described in (37) is strictly concave in t_2. From the first order condition of the unconstrained version of the above problem we get

$$t_2 = \frac{1}{2} \tag{38}$$

Substituting for t_2 in (37) from (38), we obtain the tax revenue of the government in period 2, which is equal to

$$\frac{1}{4\rho}. \tag{39}$$

When $\rho \leq 1/2$, in period 2 the government will set the tax rate equal to $1-\rho$ and attract all investors. In this case the tax revenue of the government is equal to $1-\rho$. If the government decides not to lower the tax rate to attract more investments in period 2, it will set the maximum tax rate and expropriate entire returns on invested capital. The tax revenue of the government in this case is equal to r_1. Hence, if the investment in period 1 is large, i.e. $r_1 > \frac{1}{4\rho}$, it is not profitable for the government not to lower the tax rate to attract more investors in the period 2.

$$G_{PC}^2 = \begin{cases} \frac{1}{4\rho}\ if \ \ \rho > \frac{1}{2} \text{ and } r_1 \leq \frac{1}{4\rho} \\ 1-\rho\ if\ \rho \leq \frac{1}{2} \text{ and } r_1 \leq 1-\rho \\ r_1\ if\ r_1 \geq \frac{1}{4\rho} \text{ when } \rho > \frac{1}{2} \text{ and } r_1 \geq 1-\rho \text{ when } \rho \leq \frac{1}{2} \end{cases} \tag{40}$$

Given the outcome of period 2, now we look at the outcome in period 1. In period 1, the government maximize the sum of tax revenues from period 1 and period 2.

Case $1\left(\rho > \frac{1}{2} \text{ and } r_1 \leq \frac{1}{4\rho}\right)$: In this case the tax rate in period 2 is equal to 1/2. The critical investor in period 1 should be indifferent between making investment in period 1 and waiting until period 2. Taking note of the fact that the tax rate in period 2 is equal to $\frac{1}{2}$ when $\rho > \frac{1}{2}$ and $r_1 \leq \frac{1}{4\rho}$, for a tax pair $(t_1,\ t_2)$ the gain to an investor with the cost of relocation r_1 is $1-t_1-r_1$ and $1-\frac{1}{2}-\rho r_1$ respectively, from making investment in period 1 and period 2. The critical investor should be indifferent between making investment in period 1 and waiting until period 2, hence, the following equality should hold

$$1-t_1-r_1 = 1-\frac{1}{2}-\rho r_1$$

From (**??**), we observe that if the government wish to attract all investors with the cost of capital relocation less than r_1 then the tax rate in period 1 is

$$t_1 = \frac{1}{2} + \rho r_1 - r_1. \tag{41}$$

The tax revenue of the government in period 1 is equal to $t_1 r_1$ which after substituting for t_1 from (41) is equal to

$$r_1\left(\frac{1}{2}+\rho r_1-r_1\right) \tag{42}$$

In period 1 the government maximizes the sum of tax revenues from period 1 and period 2, hence, using (40) and (42), the maximization problem of the government is:

$$\max_{r_1} r_1\left(\frac{1}{2}+\rho r_1-r_1\right)+\frac{1}{4\rho}\ s.t\ \rho>\frac{1}{2},\, 0\leq r_1\leq\frac{1}{4\rho} \tag{43}$$

The function described above is strictly concave in r_1. From the first order condition of the unconstrained version of above problem we obtain

$$r_1=\frac{1}{4\left(1-\rho\right)}$$

Note that $\frac{1}{4(1-\rho)}>\frac{1}{4\rho}$when $\rho>1/2$, hence, we have a corner solution and the government chose

$$r_1=\frac{1}{4\rho}. \tag{44}$$

Using (41) and (41) we obtain the tax rate in period 1 which is equal to

$$t_1=\frac{3}{4}-\frac{1}{4\rho}. \tag{45}$$

Substituting for r_1 in (43) from (44), we obtain the equilibrium tax revenue of the government which is equal to

$$G_{PC}=\frac{1}{16\rho^2}\left(7\rho-1\right) \tag{46}$$

Case 2 $\left(\rho\leq\frac{1}{2}\text{ and } r_1\leq 1-\rho\right)$: In this case the government attract all remaining investors in period 2 by setting the tax rate in period 2 equal to $1-\rho$. The gain to an investor with the cost of capital relocation r_1 is equal to $1-t_1-r_1$ and $1-(1-\rho)-\rho r_1$ respectively, from making investment in period 1 and period 2. For the critical investor following equality described below holds, because he is indifferent between making investment in period 1 and waiting until period 2

$$1-t_1-r_1=1-(1-\rho)-\rho r_1 \tag{47}$$

From (47), we observe that if the government wish to attract all investors in period 1 then it sets

$$t_1=\left(1-\rho\right)\left(1-r_1\right) \tag{48}$$

The tax revenue of the government in period 1 is $r_1 t_1$, which after substituting for t_1 using (48) is equal to

$$G_{PC}^1=\left(1-\rho\right)\left(1-r_1\right)r_1. \tag{49}$$

In period 1, the government maximizes the sum of tax revenue from period 1 and period 2, hence, using (40) and (49) can be represented as

$$\max_{r_1} (1-\rho)(1-r_1) r_1 + 1 - \rho \; s.t. \; 0 \leq \rho \leq \frac{1}{2} and \; 0 \leq r_1 \leq 1-\rho \tag{50}$$

The function is strictly concave in r_1. From the first order condition of the unconstrained version of the above problem we get

$$r_1 = \frac{1}{2}. \tag{51}$$

$1-\rho \geq \frac{1}{2}$ when $\rho \leq \frac{1}{2}$, hence, we have interior solution and we can obtain the tax revenue of the government by substituting $r_1 = \frac{1}{2}$ in (50) which is equal to

$$G_{PC} = \frac{5}{4}(1-\rho). \tag{52}$$

Case 3 $\left(r_1 \geq \frac{1}{4\rho} \text{ when} \rho > \frac{1}{2} \text{ and } r_1 \geq 1-\rho \text{ when } \rho \leq \frac{1}{2}\right)$: In this case in period 2, the government does not attract more investments and sets the tax rate equal to 1 in period 2. An investor has no incentive to wait until period 2. An investor with the cost of capital relocation r_1 will invest as long as $1 - t_1 - r_1 \geq 0$, where t_1 is the tax rate in period 1. Hence, if the government wish ti attract all investors with cost of capital relocation less than r_1, it sets

$$t_1 = 1 - r_1 \tag{53}$$

The tax revenue of the government is $r_1 t_1$, and after substituting for t_1 using (53) we obtain

$$G^1_{PC} = (1-r_1) r_1. \tag{54}$$

The government maximizes the sum of tax revenue from period 1 and period 2, hence, using (40) and (54) the maximization problem of the government can be represented as

$$\begin{aligned} & \max (1-r_1) r_1 + r_1 & (55) \\ s.t. \; r_1 \; \geq \; & \frac{1}{4\rho} \text{ when } 0 \geq \rho > \frac{1}{2} \text{ and } r_1 \geq 1-\rho \text{ when } 0 \leq \rho \leq \frac{1}{2} \end{aligned}$$

The function described by (54) is strictly concave in r_1. From the first order condition of the unconstrained version of above problem we obtain

$$r_1 = 1. \tag{56}$$

$1 > \frac{1}{4\rho}$ when $\rho > \frac{1}{2}$ and $1 > 1-\rho$, hence, we have an interior solution and we obtain the tax revenue of the government by substituting $r_1 = 1$ in (55).

$$G_{PC} = 1. \tag{57}$$

To find the equilibrium tax revenue of the government we compare outcomes described by (46), (52) and (57). Note that $\frac{5}{4}(1-\rho) > 1$ when $1-\rho > \frac{4}{5} \Rightarrow \rho < \frac{1}{4}$. Also, $\frac{1}{16\rho^2}(7\rho-1) < 1$ when $\rho > \frac{1}{2}$. For $\frac{1}{4} \leq \rho \leq 1$, we have[3]

$$\frac{1}{4(1-\rho)}\left(4\rho^2 - 8\rho + 5\right) \geq \frac{5}{4}(1-\rho).$$

Hence proved. ■

When $0 < \rho < \frac{1}{2}$, under non-preferential taxation scheme the government is not able to gain as much from falling cost of capital relocation compared to preferential taxation scheme. The government has to reduce the tax rate on initial investments as well to attract more investments in later periods which results in loss of tax revenues. When $\rho = 0$, tax revenue under non-preferential taxation scheme is equal to outcome with full commitment because when the cost of capital relocation 0, the government does not have to offer tax rebate to attract investors in later period.

6 Conclusion

When the cost of capital relocation falls over time, it not only makes dynamic inconsistency more severe but the government can also gain from lower cost of capital relocation because it has to offer a relatively lower tax rebate to attract investors. The full commitment tax scheme involves lowering the tax rate over time to gain from lower cost of capital relocation as well as dissuade investors to wait for the future period, which can also be implemented under preferential taxation scheme because it offers the government flexibility to lower the tax rates over the time. When the cost of capital relocation falls considerably over time, the tax revenue of the government under full commitment outcome is higher than what he can obtain under a non-preferential taxation scheme. Even under non-preferential taxation scheme, the tax rate falls over time if the cost of capital relocation falls considerably. This offers another explanation for fall in tax rates in tax treaties. In this paper investors are small and do not act strategically. A future research should consider the case when investors are strategic.

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[3] $\frac{\partial}{\partial\rho}\left(\frac{1}{4(1-\rho)}\left(4\rho^2-8\rho+5\right)-\frac{5}{4}(1-\rho)\right) = \frac{1}{4(\rho-1)^2}\left((1-\rho)^2+1\right) > 0$. Hence, the minimum is attained at $\rho = 0$. For $\rho = 0$, the left hand side and the right hand side are equal.

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