The dilemma of international capital tax competition in the presence of public capital and endogenous growth

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The Dilemma of International Capital Tax Competition in the Presence of Public Capital and Endogenous Growth

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Abstract: Using an OLG-model with endogenous growth and public capital we show, that an international capital tax competition leads to inefficiently low tax rates, and as a consequence to lower welfare levels and growth rates. Each national government has an incentive to reduce the capital income tax rates in its effort to ensure that this policy measure increases the domestic private capital stock, domestic income and domestic economic growth. This effort is justified as long as only one country applies this policy. However, if all countries follow this path then all countries will be made worse off in the long run.

JEL: H21,H41, H54, O41

1 Introduction

The aim of this paper is to show in a simple OLG-model with endogenous growth and public capital that perfect international capital mobility creates an incentive for small economies to engage in an inefficient international tax competition. We assumethat public capital is a source of productivity. This paper is motivated by the following stylized facts.

1. Public capital plays the role of 'fuel' for economic growth.
2. The ratio between investments in public capital and GDP and hence the ratio between the stock of public capital to GDP have declined in the last 30 years in most developed countries.
3. In developed countries, the capital income and corporate tax rates have declined in the last 30 years.
4. The growth rates of the GDP per capita of developed countries have decreased in the last 30 years.

Romp and de Haan (2007) confirm the validity of the growth-enhancing effect of public capital investments, even that its positive effect is lower than estimated by Aschauer (1989). Just as well, the empirical study of Arslanalp et al. (2010) which included 48 countries confirms the first fact. Additionally, the authors surveyed empirical 61 studies on the relationship between public capital and growth and 50 studies confirmed the positive relationship between public capital, output and growth.

Moreover, the meta-analysis of Bom and Lighardt (2008) and the more recent studies of Gupta et al. (2011) or Bottasso et al. (2013) confirm the positive relationship between public capital and economic growth. Roughly, we can derive from all the studies that the production elasticity of public capital is probably between 0.05 and 0.2.

Regarding the validity of the second fact, we refer to Gupta et al. (2011), who state that in their 71 countries sample, the average public investment to GDP ratio has decreased from 4.7 percent in 1960ies to 4.4 percent in the last decade (2000-09) and that public capital stock growth has declined from 4.4% to 3.5% in the same period.[1]Gomes

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[1]See for example Bottasso et al. (2013). A survey about the empirical literature on public capital and growth is given by de Haan and Romp (2007). However, the measurement of public capital investments is

and Pouget (2008) come to similar results with respect to 21 OECD countries in the period 1960-2010. In addition, Allain-Dupre et al. (2012) confirm the second fact considering OECD member countries in the period 1995-2011. Arslanalp at al. (2010) find that public investment rate peaked in OECD countries in the beginning of the 1970ies and the public capital stock peaked in the beginning of the 1980ies. With respect to 26 non-OECD countries, the corresponding years were 1980 and 1984.

With regard to the third fact, we can only observe directly the statutory corporate tax rates and not the effective average and effective marginal tax rates which, according to Devereux and Griffith (2003) and Devereux and Lockwood (2006) are the relevant tax rates for private investment decisions. Although, Kawano and Slemrod (2012) note that the changes in the statutory corporate tax rates are mostly accompanied by a broadening of the tax base, Simmons (2006) states that not only the average statutory tax rate (ASTR) of OECD countries declined between 1982 and 2003, but also the effective marginal (EMTR) and effective average corporate (EATR) tax rates.

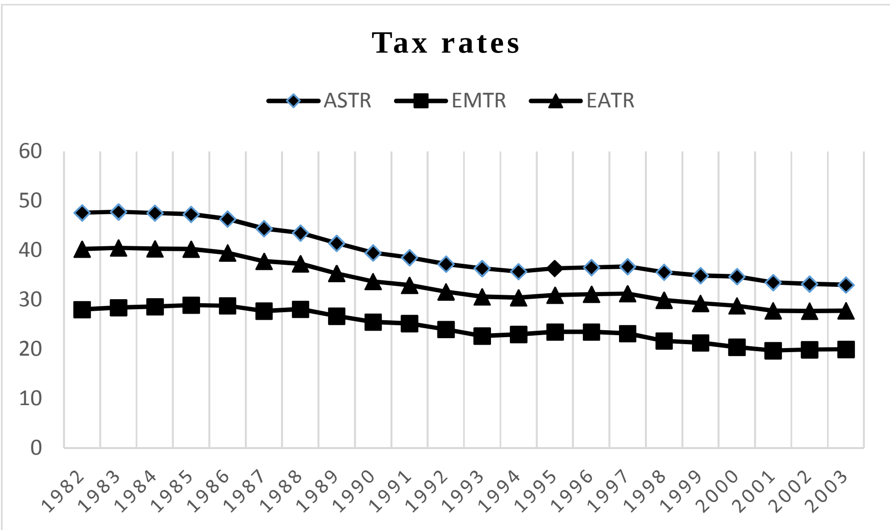

Figure 1 (Data taken from Simmons (2006))[2]

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not free from of accounting obstacles. For example, investments of private public partnerships are accounted as private investments.

[2] The following countries are included: USA, Japan, France, Germany, United Kingdom, Italy, Spain, Portugal, Ireland, Belgium, Greece, Sweden, The Netherlands, Austria, Finland, Norway, and Switzerland.

The same result is derived by Devereux and Sørensen (2006) for EU member countries for the period 1982-2004. Recently, Abbas and Klemm (2013) got some similar findings with respect to cooperate tax rates in low-income and developing countries.

Additionally, Simmons (2006) finds that the statutory, the average and the effective corporate tax rates of OECD countries converged. The fourth stylized fact states that the per capita growth rates have declined in the last 30 years. We take the average per capita growth rate of OECD countries exemplarily to confirm this stylized fact.

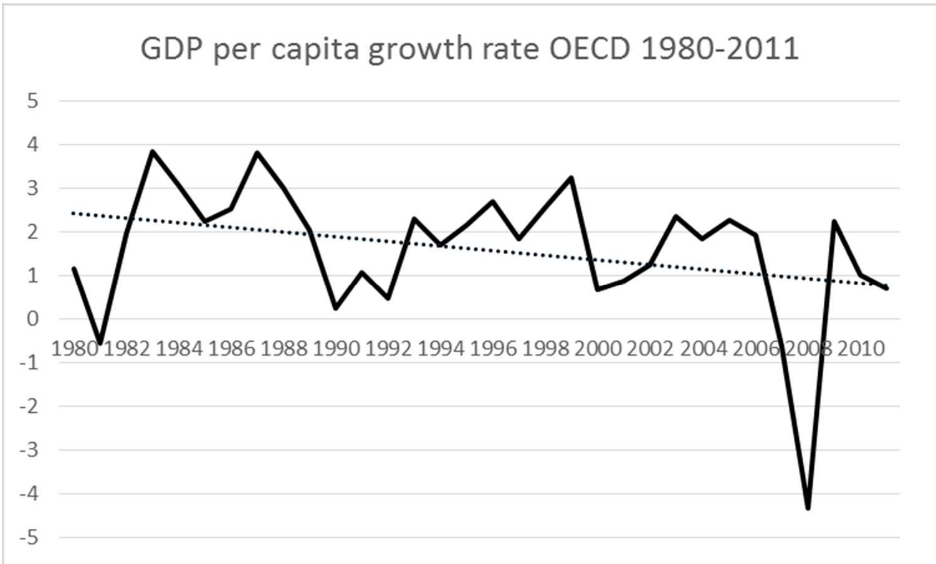

Figure 2 (Data taken from the OECD)

The aim of this paper is to rationalize the four stylized facts in a simple growth model, and to show that they were unavoidable. The intuition is that especially small countries have an incentive to lower the corporate and capital income tax rates to attract capital from abroad with the intention to increase their national income, their tax base and hence their tax revenues. This increased tax revenues can be used for public investments to raise the countries' attractiveness for foreign investment. If this intuition is true, and many countries follow this strategy, then we expect an international tax competition which leads to a reduction of tax rates and as a consequence to less growth. The dilemma is that all countries are compelled to engage in this competition to avoid more disadvantages for their economies.

The analysis of tax competition between countries or sub-national authorities is not new and goes back to Tiebout (1956), who concludes that tax competition leads to an efficient firm allocation. The discussion about tax competition was revived by Wilson (1986) and Zodrow and Mieszkowski (1986). It is beyond the scope of this paper to refer to all the work, which is done in the field of tax competition.[3] It should be remarked that the majority of the models in this field are static ones, and corporate or capital income taxation is motivated by the provision of public goods. However, according to a number of studies (Devereux et al., 2008; Heinemann et al., 2010; Simmons, 2006; Devereux and Sørensen, 2006; Slemrod, 2004; Keen and Simone, 2004) countries compete for private capital by lowering the corporate tax rates.[4]

Our approach differs from the existing literature in so far that we applya model of Stauvermann (1997), which merges a Diamond (1965) type OLG model with the production function introduced by Barro (1990), Barro and Sala-i-Martin (1992, 2004) and Carlberg (1988).[5]

The model here differs from the papers on tax competition and growth of Lejour and Verbon (1997), Wildasin (2003) and Becker and Rauscher (2013) in so far, that the authors allow for costs of investments and differentiate explicitly between a capitalist class owning all capital and workers. One difference to the paper of Gomes and Pouget (2008) is that the authors assume that public capital has the characteristics of a private good instead of a public good with congestion as proposed in this paper.

The structure of the paper is as follows; in the next section, we introduce the basic model, and derive the optimal capital and labor income tax rates for a closed economy. In the third section, we analyze the consequences of opening the international capital market. We will consider only tax policies, which do not harm the currently living generations. This restriction guarantees that all citizens of a country are in favor of this tax policy. In the fourth section we summarize the results.

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[3] For a survey see for example Wilson and Wildasin (2004).

[4] Devereux and Loretz (2012) and Brueckner (2003) give overviews about the empirical literature about corporate tax competition. Wilson and Wildasin (2004) survey the theoretical literature about tax competition.

[5] For a survey of production functions with public capital see Irmen and Kuehnel (2009).

2 The model

We begin with a closed economy, where we apply a usual Diamond (1965) overlapping generation model to describe the consumption side of the economy. In each period live two generations: a young one and an old one. The members of the young generation supply their labor inelastically and save a part of their labor income. The members of the old generation do not work and live exclusively from the interest income which is a result of their savings from the previous period. The underlying utility function $U_t$is a log-linear one:[6]

$$U_t(c_t^1, c_{t+1}^2) = \ln c_t^1 + q \ln c_{t+1}^2. \qquad (1)$$

The variables $c_t^1$and c_{t+1}^2 reflect the consumption in the first and second period of life and the subscripts indicate the periods. The parameter $0 < q < 1$ is the subjective discount factor. The corresponding intertemporal budget constraint has the following form:

$$c_t^1 + \frac{c_{t+1}^2}{(1-\tau_R)R_{t+1}} = (1-\tau_w)w_t. \qquad (2)$$

The wage rate is given by w_t, the interest factor by R_{t+1}, where we assume without loss of generality that the depreciation rate of all capital goods is 100 per cent.

The government taxes the capital income with the rate τ_R and the wage income with the rate τ_w. Further, we assume without loss of generality, that the population is constant and normalized to one. The representative agent maximizes her utility with respect to her budget constraint. The resulting necessary optimality conditions are:

$$\frac{c_{t+1}^2}{c_t^1} = q(1-\tau_R)R_{t+1} \qquad (3)$$

and the budget constraint (2). Using these optimality conditions, we derive the indirect utility function of the representative individual, which depends on the factor prices and tax rates:

$$V_t((1-\tau_w)w_t, (1-\tau_R)R_{t+1}) = ln\left[\left(\frac{(1-\tau_w)w_t}{1+q}\right)^{1+q} ((1-\tau_R)R_{t+1})^q\right]. \qquad (4)$$

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[6] The results do not change qualitatively if we would use a quasi-concave and homothetic utility function, which is continuous, twice differentiable and if the consumption in the second period of life is a normal good. Additionally, the interest elasticity of savings must be non-negative.

The output in this economy $Y_t$depends on private capitalK_t, on the labor force L_t and public capital P_t. The output can be consumed or transformed into private or public capital. Its price is normalized to one. In the most general form the production function can be written according to Romp and de Haan (2007) or Sturm (1998) like:

$$Y_t = A(P_t)F(K_t, L_t, P_t). \tag{5}$$

Regarding how to interpret the public capital, we use a Cobb-Douglas function, because then we can omit the discussion if the public capital should be a pure public good in the sense of Samuelson or if it should be a common good, where the companies cannot be excluded from its use for some reasons. Especially, we use a form of production function which goes back to Barro (1990), Barro and Sala-i-Martin (1992), Carlberg (1988) and Stauvermann (1997).

The simplest interpretation of the public capital stock is to view it as a common good or a public good with congestion. Possible examples are all kind of networks, like roads, electricity supply, broadband, public administration and so on.

We assume that all markets are perfectly competitive. The production function of a firm i, where i=1,.,m, has the form:

$$Y_{t,i} = AK_{t,i}^{\alpha}\left(\bar{k}_t L_{t,i}\right)^{1-\alpha}\left(\frac{P_t}{K_t}\right)^{\sigma}, \tag{6}$$

where $A > 0$, $\bar{k}_t = \frac{K_t}{L_t}$, $L_t = \sum_{i=1}^{m} L_{t,i}$ and $K_t = \sum_{i=1}^{m} K_{t,i}$.Further, we assume in general that$0 < \alpha, \sigma < 1$.The parameters α and σ can be interpreted as the production elasticity of private capital at the firm's level and respectively the production elasticity of public capital. Empirical studies indicate that $\alpha > \sigma$.[7]

The firm takes the capital intensity $\bar{k}_t$, the public capital stock P_t, the aggregate private capital stock K_t, the wage rate w_t and the interest factor R_t as given. It maximizes its profits with respect to its capital stock $K_{t,i}$ and its labor input $L_{t,i}$. Calculating the first order conditions of all m firms, using the symmetry of all firms, taking into account that the labor force is normalized to one and aggregating the total output, we get the resulting factor prices:

[7] See for example Arslanalp et al. (2010) and especially the literature survey in their appendix.

$$w_t = (1-\alpha)AK_t\left(\frac{P_t}{K_t}\right)^{\sigma} \tag{7}$$

$$R_t = \alpha A\left(\frac{P_t}{K_t}\right)^{\sigma} \tag{8}$$

And the aggregate production function results to:

$$Y_t = AK_t^{1-\sigma}P_t^{\sigma}. \tag{9}$$

The provision of the public capital is financed by a labor and capital income tax, where the corresponding tax rates are τ_R and τ_w. The resulting tax revenue T_t becomes:

$$T_t = \tau_R\alpha AK_t\left(\frac{P_t}{K_t}\right)^{\sigma} + \tau_w(1-\alpha)AK_t\left(\frac{P_t}{K_t}\right)^{\sigma} = \big(\tau_R\alpha + \tau_w(1-\alpha)\big)AK_t\left(\frac{P_t}{K_t}\right)^{\sigma} \tag{10}$$

Assuming that the government budget is balanced, the public capital stock in period t+1 is equal to $P_{t+1} = T_t$.

Using the results (3), (7) and the identity $S_t = (1-\tau_w)w_t - c_t^1$we rewrite the savings function as:

$$S_t = s(1-\tau_w)(1-\alpha)AK_t\left(\frac{P_t}{K_t}\right)^{\sigma}, \tag{11}$$

where $s = \frac{q}{1+q}$. By using the capital market equilibrium condition $K_{t+1} = S_t$, and equations (9) and (11)we calculate the resulting growth factor of this closed economy:

$$G_t = \frac{Y_{t+1}}{Y_t} = As(1-\tau_w)(1-\alpha)\left(\frac{\big(\tau_R\alpha+\tau_w(1-\alpha)\big)}{s(1-\tau_w)(1-\alpha)}\right)^{\sigma}. \tag{12}$$

Obviously, both tax rates influence the growth factor. The corresponding derivatives with respect to the tax rates become:

$$\frac{\partial G_t}{\partial \tau_w} = \left[\frac{s(1-\alpha)A\left(\frac{\alpha\tau_R+(1-\alpha)\tau_w}{s(1-\tau_w)(1-\alpha)}\right)^{\sigma}}{\alpha\tau_R+(1-\alpha)\tau_w}\right]\left[1-(1-\tau_w)\sigma\left((1-\alpha)-\frac{\alpha\tau_R+(1-\alpha)\tau_w}{(1-\tau_w)}\right)\right] \gtreqless 0,$$

and

$$\frac{\partial G_t}{\partial \tau_R} = \frac{s(1-\alpha)\sigma\alpha(1-\tau_w)A\left(\frac{\alpha\tau_R+(1-\alpha)\tau_w}{s(1-\tau_w)(1-\alpha)}\right)^{\sigma}}{\alpha\tau_R+(1-\alpha)\tau_w} > 0.$$

An increase of the capital income tax rate leads undoubtedly to an increase of the growth factor, G_t. This positive effect is caused by the fact that the tax revenue will be invested in public capital instead of being consumed by the older generation. On the other hand, the effect of a rising labor income tax rate is unclear because it reduces the private savings and hence the private capital stock of the following period, and increases the public capital stock in the following period. Therefore the overall effect is unclear. If the wage tax rate is relatively low, then an increase will enhance the growth factor and if the wage tax rate is relatively high, it decreases the growth factor.

Obviously, the economic development depends strongly on the tax rates. However, the question is, how should the optimal tax rates be determined? We use the following approach, which differs from the concept of a social planner with a social discount factor. We are searching for the sustainable tax system, which is maximizing the utility of all generations. This means we are searching for a tax system which is accepted by all generations. The idea is that a representative individual who is behind a veil of ignorance and where she does not know when she will be born, has to choose a uniform labor income tax rate and a uniform capital income tax rate which will be applied to all generations. For this purpose we substitute the equilibrium factor prices, tax rates and growth factor in the indirect utility function.

$$V_t(\tau_w, \tau_R) = ln\left(\frac{\left[As(1-\tau_w)(1-\alpha)\left(\frac{(\tau_R\alpha+\tau_w(1-\alpha))}{s(1-\tau_w)(1-\alpha)}\right)^{\sigma}\right]^{t-1}(1-\tau_w)(1-\alpha)AK_0\left(\frac{P_0}{K_0}\right)^{\sigma}}{1+q}\right)^{1+q}$$

$$+ln\left((1-\tau_R)\alpha A\left(\frac{(\tau_R\alpha+\tau_w(1-\alpha))}{s(1-\tau_w)(1-\alpha)}\right)^{\sigma}\right)^{q} \qquad (13)$$

Now we maximize the indirect utility function of an individual born in period t with respect to both tax rates. We get the following results, after solving for both tax rates:

$$\tau_w^{opt}(t) = -\frac{q\big((\alpha-\sigma)(t+2)-1\big)+(1+t)(\alpha-\sigma)}{(1-\alpha)\big((t+2)q+1+t\big)},$$

$$\tau_R^{opt}(t) = \frac{q(\alpha(t+2)-1)+\alpha(1+t)}{\alpha(t(1+q)+1+2q)}.$$

Notably, both optimal tax rates are time-dependent and hence there exists no pair of tax rates which is sustainable if one calculates their optimal values independently of each other. Therefore, each generation prefers different tax rates. Please note, the later an individual is born, the higher is the preferred capital income tax rate and the lower is the preferred labor income tax rate which should be applied to all generations born earlier and her generation. However, when repeating the analysis with the assumption that an income tax should be applied, it follows that only one uniform tax rate $\tau = \tau_w = \tau_R$ has can be chosen by the individual behind the veil of ignorance. Substituting the income tax rate for the labor income tax rate and capital income tax rate in the indirect utility function, we obtain the optimal income tax rate. The indirect utility function becomes:

$$V_t(\tau) = ln\left(\frac{\left[As(1-\tau)(1-\alpha)\left(\frac{\tau}{s(1-\tau)(1-\alpha)}\right)^{\sigma}\right]^{t-1}(1-\tau)(1-\alpha)AK_0\left(\frac{P_0}{K_0}\right)^{\sigma}}{1+q}\right)^{1+q}.$$

$$+ln\left((1-\tau)\alpha A\left(\frac{\tau}{s(1-\tau_w)(1-\alpha)}\right)^{\sigma}\right)^{q} \tag{14}$$

Differentiating the indirect utility function (14) with respect to the income tax rate, τ, for all generations, we get:

$$\frac{\partial V_t(\tau)}{\partial \tau} = \frac{(\sigma-\tau)(tq+t+q)}{(1-\tau)\tau} = 0, \forall t, t > 0. \tag{15}$$

Solving the FOC leads to the following optimal income tax rate:

$$\tau^* = \sigma, \forall t, t > 0. \tag{16}$$

Proposition 1: *The optimal income tax rate which is supported by all individuals of all generations is $\tau^* = \tau_w^* = \tau_R^* = \sigma$. Additionally, this tax rate is Pareto-efficient.*

We suppose that most people would judge such a tax system, which taxes the income independently of its source equally as fair.

Coincidently, this income tax rate maximizes the growth factor of the economy as explicitly shown by Stauvermann (1997), implicitly by Neill (1996) and Lau (1995).[8] Barro and Sala-i-Martin (1992, 2004) also derived this result using a continuous growth model with an indefinitely long living individual and considering productive public services. However, they did not analyze the role of public capital.Unfortunately, all other capital income tax rates or income tax rates are unacceptable for at least some generations. We can characterize the resulting dynamic equilibrium if $\tau^* = \sigma$ as follows:

$$\frac{P_t}{K_t} = x^* = \frac{\sigma}{(1-\sigma)s(1-\alpha)} \tag{17}$$

The optimal ratio between public and private capital depends negatively on the production elasticity of private capital, positively on the production elasticity of public

[8] This statement is only true if we take uniform income tax rates into account. However, Stauvermann (1997) has shown that this tax system is Pareto-optimal. Lau (1997) and Neill (1996) consider additionally government consumption, so that their optimal tax rates differ a little bit from the result here.

capital and negatively on the savings rate. Given the tax rate, we can describe the growth equilibrium of this closed economy by the following equations.

$$w_t^* = (1-\alpha)AK_t\left(\frac{\sigma}{(1-\sigma)s(1-\alpha)}\right)^{\sigma} \tag{18}$$

$$R_t^* = \alpha A\left(\frac{\sigma}{(1-\sigma)s(1-\alpha)}\right)^{\sigma} \tag{19}$$

$$Y_t^* = AK_t\left(\frac{\sigma}{(1-\sigma)s(1-\alpha)}\right)^{\sigma} \tag{20}$$

$$G^* = A\big((1-\sigma)s(1-\alpha)\big)^{1-\sigma}\sigma^{\sigma}. \tag{21}$$

The interest factor $R_t^*$and the growth factor $G^*$of public capital, private capital, consumption, income and savings are constant.

3. Small Open Economy

Let us assume that the domestic country opens its borders and allows for the free flow of capital and let us assume that labor is immobile. Additionally, we assume that the domestic country cannot influence the world interest rate and henceit is taken as given. Without loss of generality and to keep the analysis simple, we assume that all other countries use the same technology and have identical preferences like the individuals in the domestic economy.

Without any change of policy or behavior, no country will import or export capital. With respect to taxation, we assume that the taxes are source-based taxes. That means the incomes of residents and non-residents are taxed equally in each country. Because of the fact that the savers in the domestic country can invest abroad and foreigners can invest in the domestic economy, we must take into account an international non-arbitrage condition for the allocation of capital, which is:

$$(1-\tau_R)R_t = (1-\tau_R)\alpha A\left(\frac{P_t}{K_t}\right)^{\sigma} = R^W, \tag{22}$$

where R^W is the world market after tax interest factor. The domestic government recognizes that the domestic private capital stock depends on the capital income tax rate and the domestic public capital and no longer on the national savings. We solve the non-arbitrage condition for the domestic capital stock:

$$K_t = P_t\left(\frac{(1-\tau_R)\alpha A}{R^W}\right)^{\frac{1}{\sigma}}. \tag{23}$$

Equation (23) tells us that the private capital stock is negatively dependent on the capital income tax rate and increasing linearly in the public capital stock. Thus, the national income depends then on the capital income tax rate:

$$Y_t = AP_t^{\sigma}\left(P_t\left(\frac{(1-\tau_R)\alpha A}{R^W}\right)^{\frac{1}{\sigma}}\right)^{1-\sigma} = AP_t\left(\frac{(1-\tau_R)\alpha A}{R^W}\right)^{\frac{1-\sigma}{\sigma}}. \quad (24)$$

Now we allow national governments to change the tax rates if the living generations are not harmed by the change. Therefore, the domestic government considers a reduction of the capital income tax rate to increase the current national income. Reducing the capital income tax rate leads to two opposite effects in the domestic economy. Firstly, it reduces the tax revenue because of the lower tax rate, and secondly, the higher after-tax interest rate attracts foreign capital, which increases the tax base. In general, the overall effect on the tax revenue is unclear. Therefore, we analyze the effect of a capital income tax rate change on the tax revenue. This is important because if the tax revenue declines, the public capital stock will be lower in the future compared with the situation without the tax rate change. The tax revenue is given by:

$$T_t = \left(\tau_R\alpha + \tau_w^*(1-\alpha)\right)AP_t\left(\frac{(1-\tau_R)\alpha A}{R^W}\right)^{\frac{1-\sigma}{\sigma}}. \quad (25)$$

Because of the fact that the world interest rate will remain unchanged by assumption, we can argue that an increase in income corresponds to an increase in welfare. Taking into account that the public capital stock in *t*+1 equals the tax revenue in *t*, we get the following formula for the growth factor of a small open economy:

$$G_t = A\left(\tau_R\alpha + \tau_w^*(1-\alpha)\right)\left(\frac{(1-\tau_R)\alpha A}{R^W}\right)^{\frac{1-\sigma}{\sigma}}. \quad (26)$$

The reason why the growth of the domestic country does not depend on the domestic savings is that its savings are relatively small compared to the aggregate world capital stock.

Maximizing the growth factor with respect to the capital income tax, and assuming that the labor income tax remains constant, we get:

$$\frac{\partial G_t}{\partial \tau_R} = \frac{\left(\tau_w^*(1-\alpha)(1-\sigma)+(\sigma-\tau_R)\alpha\right)A\left(\frac{(1-\tau_R)\alpha A}{R^W}\right)^{\frac{1-\sigma}{\sigma}}}{(1-\tau_R)\sigma} = 0. \quad (27)$$

Solving (27) for τ_R leads to the optimal capital income tax rate:

$$\tau_R^* = \frac{\alpha\sigma - \tau_w^*(1-\sigma)(1-\alpha)}{\alpha} = \frac{\sigma(2\alpha+\sigma-1-\alpha\sigma)}{\alpha}. \tag{28}$$

The optimal capital income tax rate is lower than the labor income tax rate $\tau_w^* = \sigma$. It cannot be excluded that the optimal capital income tax rate becomes negative. Therefore, the optimal capital income tax rate (28) is only positive, if

$$\alpha > \frac{\tau_w^*(1-\sigma)}{\tau_w^*(1-\sigma)+\sigma} = \frac{1-\sigma}{2-\sigma}. \tag{29}$$

If inequality (29) does not hold, the optimal capital income rate should be set to zero. If we take into account the estimations of the literature about the production elasticity of public capital, it is reasonable to assume a value close to 0.1. Therefore, according to this model the probability that the optimal capital income tax will be zero is high.

Consequently, lowering the capital income tax rate increases immediately the national income and also the growth factor and hence raises the welfare of the domestic economy in the long run. Additionally, the reduction of the capital income tax rate leads to a Pareto improvement because in the period of the introduction of a lower capital income tax rate, the old generation has to pay less capital income taxes, and the working generation will gain, because the wage rates increase as a result of the inflow of private capital and also because of a lower tax rate on their capital income in the future. All future generations are better off because of a higher growth rate and income. In Figure 3 the two graphs represent the possible relationship between growth factor and capital income tax rate.

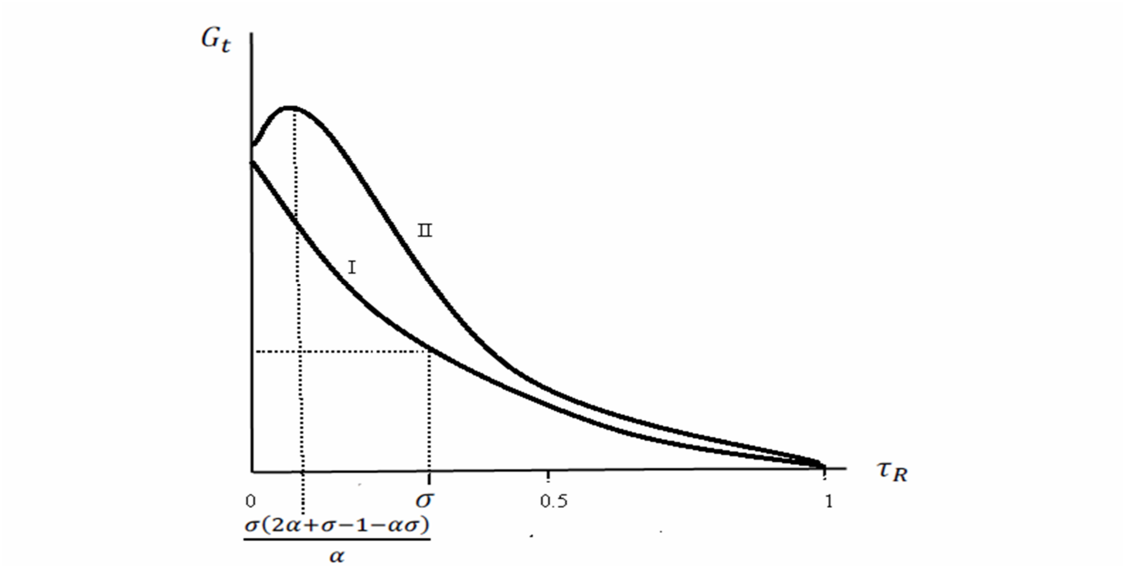

Figure 3: Possible relationships between capital income tax rate and growth factor

Proposition 2: *If a small open economy lowers its capital income tax rate, a Pareto improvement will be realized as long as no other country changes its capital income tax rate.*

Consequently, for the optimal capital income tax rate, we get the following condition:

$$\tau_R^* = \begin{cases} \frac{\alpha\sigma - \tau_W^*(1-\sigma)(1-\alpha)}{\alpha}, \text{ if } \alpha > \frac{\tau_W^*(1-\sigma)}{\tau_W^*(1-\sigma)+\sigma} \\ 0, \text{ if } \alpha \leq \frac{\tau_W^*(1-\sigma)}{\tau_W^*(1-\sigma)+\sigma} \end{cases}. \tag{30}$$

Proposition 3: *The domestic economy can increase its income and growth rate if it reduces the capital income tax rate and if other countries do not react on this change.*

At the first look, it seems to be that an economic policy which leads to a lower capital income tax rate than labor income tax rate is desirable, but the positive effects are caused by the inflow of foreign capital and hence this policy of the domestic country results in income losses of foreign countries and decreases their growth rates. If this situation would remain unchanged forever, the domestic economy would become the strongest economy and in the very long run, the incomes of all other countries will decrease. Even if this tax rate effect is negligibly small in the earlier periods, the other countries observe the income increase of the domestic economy, which creates an incentive for them to emulate the policy of the domestic economy. Therefore, the domestic economy must expect that all foreign countries will follow its policy measuresimmediately. If the foreign countries do so, the meltdown of the growth rates worldwide begins. This competition of undercutting capital income tax rates of other countries will endif the capital income tax rate as described in (30) is realized in all countries. Additionally, all countries are confronted with the non-arbitrage condition (23).

To calculate the long-run equilibrium values resulting from the international tax competition we assume for simplicity, that all countries are identical regarding population size, the intertemporal preferences and the production technology. Because of the missing arbitrage opportunities, the situation is like in the closed economy, except that the capital tax rate is lower. Hence the equilibrium growth factor is:

$$G_t = \begin{cases} As(1-\tau_w)(1-\alpha)\left(\frac{\sigma\left((1-\tau_w)\alpha+\tau_w\right)}{s(1-\tau_w)(1-\alpha)}\right)^{\sigma}, \text{if } \tau_w > \frac{\alpha\sigma}{(1-\sigma)(1-\alpha)} \\ As(1-\tau_w)(1-\alpha)\left(\frac{\tau_w}{s(1-\tau_w)}\right)^{\sigma}, \text{if } \tau_w \leq \frac{\alpha\sigma}{(1-\sigma)(1-\alpha)} \end{cases}. \quad (30)$$

Dependent on the values of α and σ, the equilibrium growth factor can take two different levels corresponding with no capital income taxation or a relatively low capital income tax rate.

If we compare the resulting growth factor with the onein autarky, it becomes obvious that the growth rate of a small open economy with capital income tax competition is lower than the growth rate of a closed economy. Therefore, all countries are better off if they avoid a tax competition.

Proposition 4: *A global tax competition leads to lower capital income tax rates, growth rates and a lower public capital to income ratio compared to the corresponding variables in autarky.*

Obviously, the results derived from this simple model fits the stylized facts noted in the introduction. One main driver of economic growth in this model is the public capital stock. The opening of the international capital market leads in this model to lower capital income taxes and to lower growth rates. However, the ratio between public capital and national income is in autarky equal to the production elasticity of public capital,σ. After the opening of the international capital market, the ratio between public capital and national income decreased either to $\sigma\left(\alpha+\tau_w(1-\alpha)\right)$or to $\tau_w(1-\alpha)$. In both cases, the public capital stock is lower than its optimal level.

4 Conclusions

In this paper, we analyze the role of public capital in open economy. Without any coordination of tax policy at the international level, a tax competition with respect to the capital income tax rate is unavoidable because each government has the option to reduce the capital income tax rate or to retain it as it was determined in a closed economy. The problem is that all governments have this choice and in the short run, the country which reduces the tax rate at first will undoubtedly realize a welfare improvement because in the period of the decline of the domestic capital tax rate, private capital will flow into the domestic economy until the world market interest rate is reached. The results are an increase of the domestic wages, an increase of the domestic tax revenue and an increase of the growth rate. Consequently, all other countries experience a welfare loss caused by the outflow of private capital. The rationale reaction is that all other countries will also reduce their capital income tax rates. However, the point is that not any country has an incentive to wait with the tax reduction and therefore all countries will reduce the capital income tax rates directly after opening of the international capital market. The long-run consequence of the capital income tax rate reduction is a reduction of worldwide welfare compared with the situation in autarky because the equilibrium growth rates are lower than in autarky. Obviously, the world is in a dilemma which is analogous to the Prisoner's dilemma and hence, in the absence of any coordination measures, the realization of the worse Nash equilibrium is unavoidable. To some extent, the stylized facts noted above confirm this conclusion. Not surprisingly Abbas and Klemm (2013, p.613) note in their conclusion, "Countries seem to be under pressure to reduce tax rates; and lowering tax rates has a negative impact on revenues,…"

Restrictively it must be stated that the theoretical results were derived in a world with only small countries where no country can influence the world capital market interest rate. However, if we assume (as in the real world) that one or two countries can influence the world market interest rate, then the incentive to reduce the tax rate is weaker because the effect of a reduction of the domestic capital income tax rate leads to relatively less inflow of foreign private capital compared to the relative capital inflow of a small country. Nevertheless, if all small countries lower their tax rates, the huge economy must follow or accept a permanent outflow of domestic capital. Therefore, within conditions, the way out of such a situation would be to establish a kind of supranational institution which effectively manages the taxes that influence the allocation of factors on international markets.

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