DEPARTMENT OF ECONOMICS

Working Paper

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TAX COOPERATION AND
CAPITAL CONTROLS

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Working Paper No. 1997-9

ISSN 1396-2426

UNIVERSITY OF AARHUS • DENMARK

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International Tax Competition, Tax Cooperation and Capital Controls*

Bo Sandemann Rasmussen†

March 20, 1997

Abstract

Tax competition between independent authorities is known to lead to inefficient outcomes, implying there is scope for cooperation. In an international framework where the authorities are national governments, the undesirable features of tax competition may alternatively be mitigated by imposing restrictions on international capital ows. Using a two-country model it is shown that capital controls may fully remedy the adverse effects of tax competition and thereby render tax cooperation super uous. In more general cases, however, capital controls have some undesirable side-effects, leaving room for cooperative actions. Moreover, the mere option of imposing capital controls may promote the implementation of tax cooperation.

Keywords: International tax competition, capital controls, tax cooperation, endowments, efficiency.

JEL: H21, H26, F21.

1. Introduction

The theory of tax competition among jurisdictions within a country has shown that taxes on interjurisdictional mobile capital leads to inefficiently low levels of taxes and local public expenditures (cf. Wilson (1986, 1991), Zodrow and Mieszkowski (1986) and others). Increasing the tax on capital in one jurisdiction induces an out ow of capital to other jurisdictions yielding a positive externality.

*Comments form seminar participants at the University of Aarhus are gratefully acknowledged.

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Therefore, non-cooperative tax and expenditure policies will lead to inefficient outcomes, and there is scope for coordinating policies among jurisdictions. Interpreting jurisdictions as countries, the results are easily transformed into implications of having national tax authorities competing with each other. Indeed, the basic assumption embedded in this literature, that the source principle is used in capital income taxation, may be much easier to justify in an international framework where it is a stylized fact that national tax authorities encounter severe difficulties of enforcing taxes on foreign-source capital income of domestic residents (cf. Frenkel *et al.* (1991)). National tax authorities may, on the other hand, possess more policy instruments than local tax authorities, especially regarding the possibility of in uencing the ease with which capital moves across national borders. For a small open economy that is a capital net exporter Razin and Sadka (1991a) have shown that once foreign-source capital cannot be taxed, severe restrictions on capital ows should be imposed.[1] The small open economy framework of Razin and Sadka (1991a) has, however, a number of limitations since the state of the world economy is assumed to be independent of the actions of the small open economy. Thus, the world rate of interest is unaffected by domestic tax policies, and responses by foreign tax policies are left out, by assumption. Moreover, the direction of net capital ows should be endogenously determined, and what determines capital ows will presumably also in uence optimal tax policies, including optimal restrictions on capital ows. Finally, the small open economy framework prevents consideration of cooperative tax policies.

This is our point of departure. We set up a two-country model along the lines of Wilson (1991) and Zodrow and Mieszkowski (1986) to analyze the incentives of national tax authorities for restricting international capital ows, and to what extent capital controls may either substitute for or promote the implementation of cooperative tax policies. Three different versions of the basic model is considered. First, a fully symmetric model is speci ed where no net capital ows survive in equilibrium. Then, following Wilson (1991) and Bucovetsky (1991), the two countries are assumed to be identical except for the size of their populations, and nally differences in per capita endowments of capital are introduced. The last two versions of the model both incorporate equilibria with net capital ows when capital ows are unrestricted. The results reveal that in the symmetric country case capital controls are indeed a blessing, since their presence leads to a Pareto-improvement relative to the tax competition equilibrium. The optimal

[1] Bjerksund and Schjelderup (1995) have shown, however, that if the foreign earnings of rms can be costlessly monitored while foreign earnings of households are unobservable, the optimal policy should only disallow capital exports from households. Gordon (1992) argues that capital controls may be used to make capital income taxes feasible in small open economies, but he notes that few countries have in practice imposed capital controls. Our results may provide one explanation for why countries obviously choose not to impose capital controls (section 6).

restrictions on capital flows are quite severe as a complete ban on capital flows is required. Moreover, the presence of optimally chosen capital controls solves all the inefficiencies encountered in the tax competition equilibrium and therefore fully substitute for cooperative tax policies. Introducing heterogeneity makes matters more complicated. With a small and a large country, the large country has incentives to impose strict capital controls that may actually hurt the small country. Nevertheless, the outcome with strict capital controls is efficient and will generally differ from the cooperative outcome under perfect capital mobility. Heterogeneity at a more fundamental level is present when the two countries differ with respect to capital endowments. In that case net capital flows are needed for an efficient international allocation of capital, and it can be shown that no non-cooperative equilibrium, including those supported by optimally chosen capital controls, can be fully efficient. Hence, there is generally scope for cooperation. The mere option of imposing capital controls may, however, affect the scope for cooperation, since the incentives of the countries to engage in tax cooperation depend on the non-cooperative equilibrium prevailing in case cooperation does not take place.

The paper is organized as follows. In section 2 some general principles for optimum capital income taxation in the presence of a high degree of international mobility of capital are discussed while section 3 is devoted to setting up the basic model. The symmetric case where both countries are identical in all respects is analyzed in section 4, while section 5 is devoted to the first asymmetric case where we have one large and one small country. The other asymmetric case where the countries differ with respect to per capita endowments of capital is analyzed in section 6 while some concluding remarks are offered in section 7.

2. Principles of Optimum Capital Income Taxation

For a closed economy the taxation of capital income generally distorts the intertemporal allocation of consumption and production by driving a wedge between the intertemporal marginal rate of substitution and the intertemporal marginal rate of transformation (Razin and Sadka (1991b)). In an international context capital income taxation can lead to some additional sources of distortions. First, capital income taxes can lead to international differences in the intertemporal marginal rates of substitution once net returns to capital are not equalized among countries, implying that the international allocation of savings will be inefficient (Frenkel *et al.* (1991)). Second, capital income taxes can lead to international differences in the intertemporal marginal rates of transformation once gross returns to capital are not equalized among countries, implying that the allocation of investments across countries will be inefficient (Frenkel *et al.* (1991)). Third, capital

income taxes can lead to differences within a country between the marginal rate of substitution and the marginal rate of transformation between private and public goods, if taxes on international mobile capital are set inefficiently low (Zodrow and Mieszkowski (1986)). Finally, capital income taxes may lead to international differences in marginal rates of substitution between private and public goods if the incentives for taxing mobile capital differ among the countries, leading to an inefficient distribution of consumption goods among countries.[2] Having identi ed these various forms of distortionary effects of capital income taxation, it should be noted that due to savings being exogenously given in our model, we are left with only three of the above-mentioned distortionary effects, *viz.* a possible inefficient international allocation of capital (a production inefficiency), a possible inefficient allocation of nal output between private and public consumption within each country (an output mix inefficiency), and a possible inefficient international allocation of private and public goods (a consumption inefficiency).

In a second-best context the optimum capital income tax policy is one that minimizes these distortionary effects and for some special cases it is quite straightforward to characterize the optimal capital income tax policy. If the tax authorities encounter no difficulties taxing foreign source capital income the residence principle, according to which residents are taxed uniformly on their world wide income, will be optimal (cf. Frenkel *et al.* (1991)). The residence principle leads to international equalization of gross returns to capital, implying an efficient allocation of investments across countries. Net returns, however, need not be equalized across countries such that the international allocation of savings will be inefficient if tax rates differ across countries. The optimality of the residence principle in this case is, in fact, an application of the Diamond-Mirrlees aggregate production efficiency theorem (Diamond and Mirrlees (1971)): Provided an unrestricted set of tax instruments is available (i.e., foreign source capital income is taxable) optimal taxation should leave production decisions undistorted. In practice, however, tax authorities often encounter severe difficulties in attempting to tax foreign source capital income, implying that the residence principle cannot be enforced (cf. Razin and Sadka (1991a)). That leaves source-based taxation, according to which all capital income generated through activities within the country is taxed uniformly regardless of the residency of the income recipient, as the only available option. To what extent source-based taxes on internationally mobile capital should be part of an optimal tax policy depends on the size of the country relative

[2]If capital income accruing from private and public goods production are subject to different tax rates, international differences in the marginal rates of transformation between private and public goods can occur, introducing another distortion. Since our model only contains a single production sector supplying both private and public consumption goods (implying a uniform tax rate on capital income within each country) that distortion cannot occur in our model.

to the world economy. For a small country that takes the world interest rate as given there should be no source-based taxes on capital income, leaving the full tax burden on immobile factors like labour (Frenkel *et al.* (1991)). Then, investments will be allocated efficiently among countries while e.g. labour supply decisions will be distorted. A large country, however, that effectively in uences the world rate of interest will choose to employ both labour and capital income taxation thus striking a balance between the distortions to labour supply decisions and to the international allocation of capital (see Bucovetsky and Wilson (1991) and Wilson (1991)). However, capital income tax rates will be too low relative to tax rates on labour income (and if labour is not taxed at all capital income taxes will be too low compared to the efficient taxes as in Zodrow and Mieszkowski (1986)). As a consequence, non-cooperative equilibria will be inefficient, implying there is scope for international tax cooperation.

Tax cooperation between tax authorities of different countries can take various forms. The most simple form of cooperation, and yet in many cases a very powerful one, is for the tax authorities to exchange information on capital income accruing to foreign residents, implying that the residence principle can be applied in capital income taxation. As shown by Bucovetsky and Wilson (1991) and Razin and Sadka (1991b) use of the residence principle leads to a Pareto efficient outcome, making further attempts to cooperate super uous. However, even though information sharing generally leads to efficiency, we cannot be sure that all countries will want to participate in this kind of tax cooperation. It is possible that a single country will be better off under tax competition (e.g. due to asymmetries between the countries) than under the efficient outcome, implying that the country will not want to exchange information on residents foreign-source capital income (unless side-payments are possible). In that case other forms of tax cooperation, like joint determination of tax rates, may be relevant, but the associated cooperative equilibrium will generally not be efficient (again, unless side-payments are possible).

Another possibility for national tax authorities to mitigate some of the undesirable effects of tax competition is to impose restrictions on international capital ows. For a small open economy that is a net capital exporter Razin and Sadka (1991a) have shown that it is optimal to impose such restrictions once foreign source capital income cannot be taxed. To establish whether their result generalizes to a multi-country framework is part of the purpose of the present paper. Furthermore, how optimally chosen restrictions on capital ows interact with the incentives to cooperate international tax policies can only be studied properly in a multi-country set-up. An important difference between capital controls and cooperative tax policies is that while the former can be imposed unilaterally by a single country the latter requires mutual consent of all countries involved, im-

plying that the mere option of imposing capital controls may affect the scope for cooperation, if a threat of imposing capital controls, should the other country not want to cooperate, is credible.

3. The Model

Consider a world economy consisting of two independent countries producing a homogenous good using capital and labour (the model is essentially as in Wilson (1991) except that he considers regions within a country instead of different countries). Each country has a fixed amount of immobile labour, L_i , and there is a fixed endowment of capital per worker in each country, $\overline{k}_i$.[3] Technologies are identical in the two countries and exhibit constant returns to scale. Unless capital flows are restricted by government policies, capital flows freely between countries to equalize after-tax returns, R_i. Capital is taxed in each country using the source principle, reflecting the difficulties domestic authorities encounter in enforcing taxes on foreign-source capital income. However, since our economies are independent countries, and not regions as in Wilson (1991) and others, governments may possess an additional policy instrument, *viz.* restrictions on capital flows (as in Razin and Sadka (1991a)). Cooperative tax policies may imply that residence-based taxes become viable or that the tax authorities jointly determine tax rates in the two countries.[4]

3.1. Firms

The representative firm in each country operates in a competitive world market. The price of output is normalized at unity. Since the production function exhibits constant returns to scale we can express output in country i, y_i, as a function of the capital-labour ratio, k_i

$$y_i = f(k_i), \quad f(0) = 0, \quad f'(k_i) > 0, \quad f''(k_i) < 0, \quad i = 1, 2. \tag{3.1}$$

Capital is taxed in each country according to the source principle by a unit tax at a rate t_i. Profit maximization requires equalization of the marginal product of

[3] We thereby disregard the effects of taxation on savings. If savings were endogenous, as in e.g. Kehoe (1989), some further interesting aspects of taxation and capital controls could emerge. We leave that extension for future research. The exogeneity of savings basically implies that two of the distortionary effects of capital income taxation are not present in the analysis: The wedge between the intertemporal marginal rates of substitution and transformation becomes immaterial, and no inefficiencies in the international allocation of savings can prevail.

[4] The precise form of cooperation depends on the institutional features of the bargaining process between the tax authorities. The form of cooperation actually materializing is beyond the scope of the present paper.

capital and the post-tax return to capital,

$$f'(k_i) = R_i + t_i, \quad i = 1, 2, \tag{3.2}$$

such that the demand for capital can be written as a function of its gross return, $r_i = R_i + t_i$,

$$k_i = k(R_i + t_i) = k(r_i), \quad 1 = 1, 2. \tag{3.3}$$

Due to the assumption of constant returns to scale, implying zero pure pro ts, wages are given by

$$w_i = f(k_i) - (R_i + t_i)\, k_i, \quad i = 1, 2. \tag{3.4}$$

3.2. Households

Households derive utility from consumption of the private good, c_i, and from the provision of the public good, g_i

$$U_i = U(c_i, g_i), \quad i = 1, 2, \tag{3.5}$$

where the utility function is assumed to be twice continuously differentiable and strictly quasi concave.[5] Households are endowed with one unit of labour and $\overline{k}_i$ units of capital. The households themselves are immobile whereas their endowment of capital may be invested either at home or abroad. Let k_j^i denote the amount of capital invested in country j by households that are residents in country i, such that $\overline{k}_i = k_i^i + k_j^i$. Since there is no uncertainty households maximize utility from investments by maximizing total wealth. Thus, households invest in the country with the highest after-tax return. Without restrictions on capital ows, arbitrage implies equalization of after-tax returns, $R_1 = R_2 = R$ and the households will be indifferent between investing at home and abroad. If, however, capital ows are restricted, either fully or partially, after-tax return differentials may exist, and the representative household will invest as much as possible of its capital endowment in the country with the higher after-tax return.

With respect to consumption, households simply consume their net income,

$$c_i = w_i + R_i k_i^i + R_j k_j^i, \quad i, j = 1, 2, \quad i \neq j, \tag{3.6}$$

where the last two terms are capital income from domestic and foreign sources, respectively. In case no capital controls are imposed, equalization of after-tax returns implies that the household budget constraint reduces to $c_i = w_i + R\overline{k}_i$.

[5] If the two countries differ in size, it will obviously be cheaper per capita for the larger country to nance a given level of a proper public good. To avoid such trivial differences we basically assume that government consumption is a publicly provided private good (e.g. medical care).

3.3. Governments

The government in each country collects source-based taxes on capital[6] to nance the provision of the public good. The government budget constraint reads

$$g_i = t_i k(R_i + t_i), \quad i = 1, 2. \tag{3.7}$$

Even tough, for a given domestic capital stock, there is a one-to-one relation between the tax rate and the public expenditure level, it generally matters for Nash equilibria whether taxes or expenditure levels are the strategic variables of governments (see Wildasin (1988)). We follow the major part of the literature by assuming that tax rates are strategic variables (which is also the choice suggested by the analysis in Wildasin (1991)). Since our economies are national entities, the policy-makers may also be able to restrict the movements of capital across borders. In that case, k_j^i effectively becomes a policy variable of the government in country i.

When a government considers the revenue effects of increasing the tax rate on capital, we assume the effect is positive i.e., we disregard the possibility of Laffer-effects. More precisely, this implies that

$$\frac{\partial \left(t_i k(R_i + t_i)\right)}{\partial t_i} = k_i \left(1 - \varepsilon_{k,t}^i\right) > 0, \quad i = 1, 2, \tag{3.8}$$

where

$$\varepsilon_{k,t}^i \equiv -\frac{\partial \left(k(R_i + t_i)\right)}{\partial t_i} \frac{t_i}{k_i} > 0, \quad i = 1, 2, \tag{3.9}$$

is the elasticity of the capital stock with respect to the tax rate in country i. To avoid Laffer-effects, this elasticity must fall short of unity.

3.4. Equilibrium

Equilibrium in the international capital market requires, in the absence of capital controls, that the demand for capital equals the supply of capital, i.e.

$$\sum_{i=1}^{2} \left(L_i k(R + t_i)\right) = \sum_{i=1}^{2} \left(L_i \overline{k}_i\right), \tag{3.10}$$

[6]Since labour is xed in supply both nationally and internationally a tax on labour would simply be a lump sum tax whereas the potential mobility of capital makes the tax on capital a distortionary tax. If an unrestricted tax on labour could be levied the optimal tax problem would be trivial and the rst best outcome would follow (provided the revenue requirement does not exceed total wage income).

which determines an equilibrium after-tax return, $R = R(t_1, t_2) = R(\tau)$, where $\tau = (t_1, t_2)$ is the vector of tax rates.[7] Then, we can write equilibrium capital stocks and wages as functions of the tax vector, $k_i = k(\tau)$ and $w_i = w(\tau)$. To clarify the discussion of how capital controls affect the adverse effects of tax competition, it is useful to distinguish between two types of equilibria, depending on the policy variables available to the authorities. If taxes are the only policy variables available, we de ne a T-equilibrium.

De nition 3.1. ***(T-equilibrium)*** *A vector* $\widehat{\tau} = \left(\widehat{t}_1, \widehat{t}_2\right)$ *is a T-equilibrium if, for all* i, $\widehat{t}_i$ *maximizes* $U(c_i, g_i)$ *subject to*

$$\begin{aligned} c_i &= w_i(\tau) + R(\tau)\overline{k}_i \\ g_i &= t_i k(R(\tau) + t_i) \\ t_j &= \widehat{t}_j, \quad j \neq i. \end{aligned}$$

This is the standard tax competition equilibrium concept. If, however, the authorities are able to restrict capital ows we de ne a (T,K)-equilibrium as follows.

De nition 3.2. ***((T,K)-equilibrium)*** *Two vectors* $\widetilde{\tau} = \left(\widetilde{t}_1, \widetilde{t}_2\right)$ *and* $\widetilde{\kappa} = \left(\widetilde{k}_2^1, \widetilde{k}_1^2\right)$ *constitute a (T,K)-equilibrium if, for all* i, $\left(\widetilde{t}_i, \widetilde{k}_j^i\right)$ *maximizes* $U(c_i, g_i)$ *subject to*

$$\begin{aligned} c_i &= w_i(\tau, \kappa) + R_i(\tau, \kappa)k_i^i + R_j(\tau, \kappa)k_j^i \\ g_i &= t_i k(R(\tau, \kappa) + t_i) \\ t_j &= \widetilde{t}_j \text{ and } k_i^j = \widetilde{k}_i^j, \quad j \neq i. \end{aligned}$$

Notice, that we have included the levels of the capital controls, $\kappa = (k_2^1, k_1^2)$, as arguments in the equilibrium expressions for wages, capital stocks and after-tax returns since the capital controls affect the capital market equilibrium (and in particular makes after-tax return differentials possible). An allocation can only be a (T,K)-equilibrium if none of the authorities can make a unilateral deviation to their own bene t possibly changing taxes and capital controls simultaneously. Notice, that both T-equilibria and (T,K)-equilibria are non-cooperative equilibrium concepts.

Existence and uniqueness of T-equilibria have been extensively discussed in the literature on tax competition. Existence of equilibrium basically requires that reaction functions are continuous (cf. Wilson (1991)). Multiple equilibria may, of course, exist as long as no restrictions are imposed on utility functions and technologies (Bucovetsky (1991) shows that even with quadratic production functions multiple equilibria cannot be ruled out in the asymmetric case with one

[7] The equilibrium after-tax return to capital depends, of course, also on the endowments of capital. These are suppressed, for simplicity.

small and one large country). To clarify the discussion, however, we will assume that a unique T-equilibrium exists, but our analysis could easily be extended to deal with multiple T-equilibria. Furthermore, we assume, as Wilson (1991) does, a positive equilibrium after-tax return, $R > 0$ (see also Bucovetsky (1991) for a discussion of this point).

3.5. Efficiency

Given the atemporal set-up of the model equilibria may fail to be efficient on three accounts. First, if taxes lead to international differences in gross returns to capital, investments will be allocated inefficiently across countries (cf. equation 3.2). Second, if the marginal rate of substitution differs from the marginal rate of transformation between private and public goods (equal to unity since nal output serves as both private and public good), the allocation of output between private and public goods within a country will be inefficient. Finally, if the marginal rates of substitution between private and public goods differ between countries, the allocation of consumption of goods between countries will be inefficient. An efficient allocation will therefore require that

$$f'(k_1) = f'(k_2), \tag{3.11}$$

for production efficiency to prevail, while

$$MRS^1 = MRS^2 = MRT = 1, \tag{3.12}$$

must hold for consumption and output mix efficiency to prevail, MRS^i being the marginal rate of substitution of private for public goods in country i, and MRT being the marginal rate of transformation between private and public goods.

It is straightforward to show that application of the residence principle in both countries (together with unrestricted capital ows) leads to efficiency. With free capital movements and residence-based taxes instead of source-based taxes the constraints for the optimum tax problem read:

$$f'(k_i) = R, \quad i = 1, 2 \tag{3.13}$$

$$c_i = f(k_i) - f'(k_i)k_i + (R - T_i)\,\overline{k}_i, \quad i = 1, 2 \tag{3.14}$$

$$g_i = T_i\overline{k}_i, \quad i = 1, 2, \tag{3.15}$$

where T_i is the residence-based tax on capital income. It follows immediately from 3.13 that perfect capital mobility and no source-based taxation leads to production efficiency. Maximizing utility with respect to T_i subject to the constraints 3.13-3.15 reveals that

$$\frac{\partial U(c_i, g_i)}{\partial T_i} = U_c^i \left[-\overline{k}_i\right] + U_g^i \overline{k}_i = 0, \quad i = 1, 2, \tag{3.16}$$

where $U_c^i \equiv \frac{\partial U(c_i, g_i)}{\partial c_i}$ and $U_g^i \equiv \frac{\partial U(c_i, g_i)}{\partial g_i}$ are the marginal utilities of private and public consumption, respectively, such that

$$MRS^i \equiv \frac{U_g^i}{U_c^i} = 1, \quad i = 1, 2, \tag{3.17}$$

and since $MRT = 1$ follows from the single good assumption, consumption and output mix efficiency holds and no further gains from cooperation can be reaped. That the first-best outcome can be achieved using the residence principle in capital income taxation follows from the assumption of exogenously given capital stocks (savings), implying that the residence-based capital income tax is a lump-sum tax. With savings determined endogenously (e.g. in a two-period framework) the equilibrium could at most be second-best optimal due to the tax wedge between the intertemporal marginal rate of substitution and the intertemporal marginal rate of transformation. Still, the equilibrium could not be improved upon by further cooperation since there are no spill-over effects from domestic tax policies on foreign residents (see Bucovetsky and Wilson (1991) and Razin and Sadka (1991b)).

Residence-based taxes are, however, not available unless both countries choose to cooperate through exchanging information on the capital income accruing to foreign residents. Therefore, non-cooperative tax policies can only include source-based capital income taxes, possibly supplemented by restrictions on capital flows.

4. Symmetric Countries

When the two countries are identical in all respects, the symmetric T-equilibrium corresponds to the tax competition equilibrium studied in Zodrow and Mieszkowski (1986). To characterize this T-equilibrium, simple manipulations of the first-order condition for the optimal choice of taxes for country i leads to

$$MRS^i = \frac{1 + \frac{\partial R}{\partial t_i}\left(1 - \frac{\overline{k}_i}{k_i}\right)}{1 - \varepsilon_{k,t}^i}, \quad i = 1, 2. \tag{4.1}$$

Evaluated in symmetric equilibrium, where $k_i = \overline{k}_i = \overline{k}$ and $\frac{\partial R}{\partial t_i} = -\frac{1}{2}$, we obtain,

$$MRS = \frac{1}{1 - \varepsilon_{k,t}} > 1, \tag{4.2}$$

and since the marginal rate of transformation is unity, $MRT = 1$, tax competition leads to inefficiently low levels of public goods (i.e., output mix inefficiency prevails). Notice, that by the symmetry of the equilibrium the international allocations of investments and consumptions goods are efficient (i.e., production efficiency and consumption efficiency prevail). Let $\widehat{t}_i$ denote the equilibrium tax rate in the T-equilibrium. The efficient equilibrium, characterized by $MRS = MRT = 1$, requires higher levels of public goods and hence larger tax rates, denoted $t_i^* > \widehat{t}_i$.

In this symmetric T-equilibrium no net capital flows survive. If, however, the perfect capital mobility assumption is to be taken seriously, some gross capital flows survive in equilibrium, i.e. $k_i^j > 0$. Let $\widehat{k}_i^j$ denote the level of foreign investments in a T-equilibrium (notice that by symmetry $\widehat{k}_i^j = \widehat{k}_j^i$).[8] It therefore makes sense to ask the following question: Does $\tau = \widehat{\tau}$ and κ unrestricted constitute a (T,K)-equilibrium? If not, a country will have an incentive to deviate unilaterally from the tax competition equilibrium if it can impose capital controls. Consider first a marginal deviation by country i from an allocation with $\tau = \widehat{\tau}$ and κ unrestricted. Any deviation from this potential equilibrium must involve some restrictions on k_j^i. Therefore, let k_j^i be restricted slightly below $\widehat{k}_j^i$, $dk_j^i < 0$. Since the aggregate capital stock is fixed, this restriction reallocates capital from country j to country i, $dk_i = -dk_j = -\,dk_j^i > 0$. Now, if investors in country j are not to withdraw investments from country i, $R_i = R_j$ must still be satisfied. Hence, the tax in country i, t_i, must be changed such that $dR_i = dR_j$. Notice, that

$$dR_i = f''(\overline{k})dk_i - dt_i \tag{4.3}$$

$$dR_j = f''(\overline{k})dk_j, \tag{4.4}$$

such that $dR_i = dR_j$ requires that

$$dt_i = 2f''(\overline{k})dk_i. \tag{4.5}$$

Government budget balance in country i requires that public consumption is changed according to

$$dg_i = k_i dt_i + t_i dk_i = \frac{t_i}{\varepsilon_{k,t}}\left(\varepsilon_{k,t} - 1\right) dk_i < 0, \tag{4.6}$$

where

$$\varepsilon_{k,t} = -\frac{t}{2f''(\overline{k})\overline{k}}, \tag{4.7}$$

[8] Of course, the size of $\widehat{k}_i^j$ is generally indeterminate.

is the elasticity of the capital stock with respect to the domestic tax rate when evaluated in symmetric equilibrium. Thus, public consumption is reduced by the introduction of capital controls. Private consumption is also affected, however. From the household budget constraint it is straightforward to show that

$$dc_i = -2\overline{k}f''(\overline{k})dk_i = \frac{t_i}{\varepsilon_{k,t}}dk_i > 0, \tag{4.8}$$

such that the marginal rate of transformation of private for public consumption induced by this marginal deviation from unrestricted capital ows is

$$MRT^i = 1 - \varepsilon_{k,t} < 1. \tag{4.9}$$

Since the marginal rate of substitution of private for public consumption at the symmetric equilibrium exceeds unity (cf. equation 4.2) this deviation from the symmetric T-equilibrium reduces welfare. Hence, no small deviations from the symmetric T-equilibrium are sufficiently strong to rule out $\tau = \widehat{\tau}$ and κ unrestricted as a (T,K)-equilibrium.

Another possibility is for the tax authorities in country i to impose severe capital controls, e.g. by banning capital exports altogether. In that case the domestic capital stock is bounded below by $\overline{k}$, and it follows straightforwardly that the efficient tax rate, t_i^* ($= t_j^* = t^*$ by symmetry), is the optimal choice for country i, given that domestic residents cannot invest abroad (and given $t_j = \widehat{t}_j$). Since $t_i = t^*$ and $k_i = \overline{k}$ trivially leads to a better outcome for country i than the tax competition equilibrium, we have shown that $\tau = \widehat{\tau}$ and κ unrestricted does not constitute a (T,K)-equilibrium. A natural alternative candidate for a (T,K)-equilibrium is then $\widetilde{\tau} = (t^*, t^*)$ and $\widetilde{\kappa} = (0, 0)$. Any deviation from this equilibrium without net or gross capital ows must involve a relaxation of capital controls. Let country i relax its capital controls slightly, $dk_j^i > 0$, making it possible for the domestic investors to invest abroad. Since after-tax returns are equalized initially, $R_i = R_j$, the capital exports from country i to country j lead to an after-tax return differential in favour of country i, $R_i > R_j$, implying that no investors will nd it pro table to invest abroad. Similarly, there is no incentive for the domestic tax authorities to change tax rates since foreign investors cannot be attracted (due to their ban on capital exports). Hence, $\widetilde{\tau} = (t^*, t^*)$ and $\widetilde{\kappa} = (0, 0)$ does constitute a (T,K)-equilibrium.[9] Thus, with symmetric countries each country will have an incentive to impose strict capital controls that will solve all the

[9]In fact, two other (T,K)-equilibria exist, *viz.* $\widetilde{\tau} = (t^*, t^*)$ and $\widetilde{\kappa} = \left(0, k_1^2 \textit{ unrestricted}\right)$, and $\widetilde{\tau} = (t^*, t^*)$ and $\widetilde{\kappa} = \left(k_2^1 \textit{ unrestricted}, 0\right)$ where only one of the countries imposes capital controls. In those cases the country that does impose capital controls can attract foreign investments by lowering its tax rate, but such a deviation will not bene t the deviator for the same reasons as a single country will not bene t from introducing small capital controls.

inefficiencies associated with non-cooperative tax policies in a world with highly mobile capital. Given the symmetric set-up, the introduction of capital controls represents a Pareto improvement, since the welfare gain is shared (equally) between the two countries. Furthermore, since the (T,K)-equilibrium also equals the cooperative equilibrium the countries will have no incentives to cooperate on tax policies.[10]

That full capital controls lead to an efficient outcome in the symmetric model can be illustrated by referring to conditions 3.11 and 3.12. Without capital flows symmetry implies that $k_1 = k_2 = \overline{k}$, implying an efficient international allocation of capital (condition 3.11). At the same time the absence of capital flows implies that the elasticity of the capital stock with respect to the tax rate, $\varepsilon^i_{k,t}$, is zero, and since $k_i = \overline{k}_i$, it follows from 4.1 that $MRS^1 = MRS^2 = MRT = 1$, and output mix and consumption efficiency prevail (condition 3.12).

5. Differences in Size: A Large and a Small Country

One obvious criticism of the symmetric country case is that no net capital flows survive in equilibrium. If countries differ in size, however, Bucovetsky (1991) and Wilson (1991) have proved the existence of an asymmetric T-equilibrium where the small country imposes a smaller tax rate on capital than the large country does, implying net capital flows from the large to the small country. The question is then: What are the incentives for introducing capital controls in such an asymmetric setting?

Let country 1 be the large country, $L_1 > L_2$. Otherwise, the two countries are identical in all respects. To prove formally the existence of an asymmetric T-equilibrium where the small country chooses the lower tax rate is quite involved, and we simply refer to e.g. Wilson (1991) for the formal proof. Intuitively, starting from autarky the capital stocks measured in units of capital (and not per capita) are proportional to the size of the country. Therefore, the small country can attract a relatively large amount of foreign capital by reducing its tax rate,[11] which can be seen from

$$\varepsilon^i_{k,t} = -\frac{t_i}{f''(\overline{k}_i)\overline{k}_i}\frac{1}{\left(1+\frac{L_i}{L_j}\right)}, \tag{5.1}$$

[10] Similarly, if the two countries are able to implement the cooperative solution there will be no need for restricting capital flows.

[11] For a given reduction in the tax rate of a single country the size of the inflow of foreign capital measured in per capita units is the same for the small and the large country, implying that in absolute amounts the small country will experience a larger inflow of capital than the large country.

since that implies that

$$\left|\varepsilon_{k,t}^{1}\right| < \left|\varepsilon_{k,t}^{2}\right|, \quad for \;\; L_1 > L_2, \tag{5.2}$$

where $\varepsilon_{k,t}^{i}$ is the elasticity of the capital stock with respect to the tax in country i when evaluated in autarky. Expressed differently, the small country faces a relatively elastic supply of capital, and as a consequence it prefers a relatively low tax rate on capital. Let again $\widehat{\tau} = \left(\widehat{t}_1, \widehat{t}_2\right)$ denote the equilibrium tax rates in the T-equilibrium with $\widehat{t}_1 > \widehat{t}_2$. In this equilibrium there is a net capital ow from the large to the small country since capital market arbitrage implies that

$$R = f'(k_1) - \widehat{t}_1 = f'(k_2) - \widehat{t}_2, \tag{5.3}$$

such that $\widehat{k}_2 > \widehat{k}_1$ follows and $\widehat{k}_2 - \overline{k}_2 = -\left(\widehat{k}_1 - \overline{k}_1\right) > 0$ is the net capital ow from country 1 to country 2 in the T-equilibrium. An interesting feature of this equilibrium is that the residents of the small country are unambiguously better off than the residents of the large country, the reason being that the lower tax rate attracts foreign capital allowing a larger consumption of both the private and the public good.[12] Both countries may, however, be better off if both tax rates were raised to the common efficient level t^*.

Notice, that the asymmetry of the T-equilibrium implies that all three inefficiencies prevail: The differences in tax rates imply overinvestment in the small country and underinvestment in the large country (production inefficiency). A further consequence of the net capital ows is that consumption goods become inefficiently distributed between the two countries, since the marginal rates of substitution of private for public goods differ between countries (cf. equation 4.1) when evaluated at the asymmetric equilibrium). Finally, the provision of public goods is not efficient since the marginal rates of substitution of private for public goods generally differ from the marginal rate of transformation.[13]

Starting from this T-equilibrium, what are the incentives for the two countries to impose capital controls? Consider the large country rst. In this asymmetric equilibrium capital is owing out of the large country, implying that the large

[12] Wilson (1991) shows that the consumption bundle of the representative consumer in the large country lies within the consumption possibility set of the representative consumer in the small country such that the higher welfare level of the representative consumer in the small country follows from a revealed preference argument.

[13] In the large country the public good will generally be underprovided since $MRS > 1$ always holds in the asymmetric equilibrium. In the small country we may have either under- or overprovision of the public good since MRS may be either larger or smaller than unity ($k_2 > \overline{k}_2$ implies that the numerator in 4.1 is less than one and therefore may be smaller than the denominator).

country can gain by restricting its capital exports, even by very small amounts.[14] As in the symmetric country case a small restriction on the capital exports from country 1 to country 2 simply reallocates capital from country 2 to country 1, $dk_1 = -dk_2 = -\ dk_2^1 > 0$. But with restricted access to the world capital market the net return to capital in country 1 need not equal the foreign net return, such that t_1 can stay unchanged. The increase in the domestic capital stock enhances the domestic consumption possibility set and the deviation leads to higher domestic welfare. Hence, the large country clearly has incentives for restricting capital exports. The small country cannot bene t from imposing small capital controls (for the same reasons as no country could bene t from doing so in the symmetric country case), and if the small country is better off at the T-equilibrium than at the efficient allocation, it cannot bene t from imposing strict capital controls and raise its tax rate to the efficient level t^* either. Only in the case where the small country is better off at the efficient allocation than at the asymmetric T-equilibrium, it can bene t from imposing strict capital control and raise its tax rate to the efficient level.

Since autarky still implies a symmetric allocation, the set of (T,K)-equilibria is basically the same as in the fully symmetric country case, i.e., $\widetilde{\tau} = (t^*, t^*)$ and a complete ban on capital exports in at least one of the countries constitute (T,K)-equilibria.[15] The small country may be hurt by the introduction of capital controls, but since it is only the large country that has incentives for imposing capital controls in that case, the small country can do little about this.

As in the symmetric country case there is no need for cooperation once complete capital controls have been installed. Unlike the symmetric country case, however, cooperation may not substitute for capital controls. Assume that the small country is very small indeed such that the welfare of its residents is higher under tax competition than at the efficient allocation. Then, assuming capital controls are not available policy instruments, cooperation between the two coun-

[14] Since there are net capital ows in this T-equilibrium there need not be any gross capital ows in excess of the net capital ows, even if the perfect capital mobility assumption is to be taken seriously. Therefore, we assume that no residents in the small country invest in the large country in equilibrium. If gross capital ows in excess of the net capital ows existed, the incentives for introducing capital controls would be rather similar to those in the symmetric country case, but the (T,K)-equilibrium would be unaffected.

[15] One disclaimer may be relevant here. We have generally assumed away Laffer-effects by restricting the elasticity of the capital stock with respect to the tax rate to fall short of unity, $\varepsilon^i_{k,t} < 1$. The crucial difference between the small and the large country is, however, the size of this elasticity. Thus, it may well be that the Laffer-condition holds in the large country but not in the small country in autarky, implying that a lowering of the tax rate in the small country leads to an expansion of the consumption possibility set if the large country does not impose strict capital controls. In that case we have only two (T,K)-equilibria, *viz.* $\widetilde{\tau} = (t^*, t^*)$ and $\widetilde{\kappa} = (0, 0)$ and $\widetilde{\tau} = (t^*, t^*)$ and $\widetilde{\kappa} = \left(0, k_1^2 \ unrestricted\right)$.

tries is unlikely to lead to the efficient allocation since that would imply a welfare loss for the residents of the small country. Instead, one could imagine that the two countries would cooperate through bargaining over taxes with the tax competition outcome as a fall back position in case no agreement was reached.[16] In that case cooperation would not yield efficiency (simply because the small country would reject an offer that reduced its welfare below what it could obtain under tax competition) unless side-payments between the two countries were assumed possible. If, on the other hand capital controls are available as policy instruments, the large country can implement the efficient allocation simply by imposing strict capital controls. Hence, even if capital controls imply efficiency there need not be equivalence between cooperation and capital controls.

6. Differences in Endowments: A Rich and a Poor Country

A common characteristic of the models in the previous two sections was that the international allocations of investments were efficient in autarky. Hence, imposing capital controls did not lead to distortions in the international allocation of capital. At the same time capital controls solved the problem of underprovision of public goods due to tax competition. Thus, by imposing capital controls the production inefficiency and the consumption and output mix inefficiency problems could be solved simultaneously. Such characteristics are, of course, rather special and yet of outmost importance for the welfare consequences of capital controls. In more general settings capital flows will be needed to equalize marginal productivities of capital across countries. One way to model such a need is to assume differences in the per capita capital endowments i.e., by assuming the existence of a rich and a poor country. In that case the optimal tax-*cum*-capital controls policy must weigh the production inefficiencies against the consumption and output mix inefficiencies associated with the optimal policy, since consumption and output mix efficiency on the one hand and production efficiency on the other hand cannot be obtained simultaneously.

Let country 1 be the rich country, $\overline{k}_1 > \overline{k}_2$, implying that capital flows from country 1 to country 2 are needed for investments to be allocated efficiently across countries. Unfortunately, it turns out that it is very difficult to fully characterize T- and (T,K)-equilibria in this model with respect to the relative size of tax rates and the directions of net capital flows, basically because that even when the two countries choose the same tax rates the resulting allocation will be asymmetric.[17] Instead, we try to establish the welfare implications of capital controls, and

[16] See Rasmussen (1992) for a similar set up for a bargaining process between two trade unions.

[17] That identical tax rates lead to a symmetric allocation is a feature that is useful in the characterization of equilibria in the model with a small and a large country, cf. Wilson (1991).

whether capital controls may substitute for cooperative tax policies.

An important result of the previous two sections was that a complete ban on capital exports was a necessary and sufficient condition for a non-cooperative equilibrium allocation to be efficient. With differences in endowments, however, it follows straightforwardly that production efficiency requires some net capital ows to equalize marginal products of capital among countries. Therefore, a complete ban on capital ows cannot lead to full efficiency. More generally, however, it can be shown that no non-cooperative equilibria, including (T,K)-equilibria, can be fully efficient. The proof goes as follows.

Consider rst a T-equilibrium which is characterized by the conditions

$$f'(k_1) - \widehat{t}_1 = f'(k_2) - \widehat{t}_2 \tag{6.1}$$

$$MRS^i = \frac{1 + \frac{\partial R}{\partial t_i}\left(1 - \frac{\overline{k}_i}{k_i}\right)}{1 - \varepsilon^i_{k,t}}, \quad i = 1, 2. \tag{6.2}$$

Production efficiency requires that tax rates are equalized, $\widehat{t}_1 = \widehat{t}_2$, since that implies equalization of capital stocks leading to an efficient international allocation of capital. With equalized capital stocks, $k_1 = k_2 = \frac{(\overline{k}_1 + \overline{k}_2)}{2}$ consumption and output mix efficiency cannot be satis ed since

$$\frac{MRS^1}{MRS^2} = \frac{3\overline{k}_1 + \overline{k}_2}{\overline{k}_1 + 3\overline{k}_2} > 1. \tag{6.3}$$

This, of course, just corresponds to the earlier results on the inefficiencies of T-equilibria.

For (T,K)-equilibria it should be noted that whenever capital controls are binding a marginal change in the tax rate of a country will not affect its capital stock. As a consequence, the elasticity of the capital stock with respect to the tax rate is zero, $\varepsilon^i_{k,t} = 0$. Furthermore, a xed capital stock due to binding capital controls implies that tax changes are fully backward shifted onto the net return to capital, $\frac{\partial R}{\partial t_i} = -1$. Hence, according to 3.12 and 4.1 output mix and consumption efficiency can only hold for $k_i = \overline{k}_i$, i.e. when capital ows are fully restricted. But without capital ows production efficiency, according to 3.11, cannot hold, implying non-existence of a fully efficient (T,K)-equilibrium when factor endowments differ. Therefore, unlike the earlier cases there may now be scope for cooperation even in the presence of capital controls.

To establish the scope for cooperation properly, one needs to characterize the non-cooperative equilibrium. Since we are not able to provide such a characterization, we have to aim a bit lower and simply consider the scope for cooperation assuming that the non-cooperative equilibrium is a (T,K)-equilibrium with fully

restricted capital ows.[18] A necessary (but not sufficient) condition for the two countries to be interested in engaging in tax cooperation is that both countries prefer the cooperative outcome to the non-cooperative outcome. Let tax cooperation consist of exchange of information on the capital income accruing to foreign residents such that the residence principle can be applied. We can then compare the economy-wide resource constraints under source-based taxation and strict capital controls (non-cooperation) on the one hand and residence-based taxation and unrestricted capital ows (cooperation) on the other hand. Under source-based taxes and strict capital controls the aggregate resource constraints read

$$c_i + g_i = f(\overline{k}_i), \quad i = 1, 2, \tag{6.4}$$

while residence-based taxation and free capital movements imply that

$$c_i + g_i = f\left[\frac{\overline{k}_i + \overline{k}_j}{2}\right] + f'\left[\frac{\overline{k}_i + \overline{k}_j}{2}\right]\left(\frac{\overline{k}_i - \overline{k}_j}{2}\right) \quad i = 1, 2, \quad i \neq j. \tag{6.5}$$

Thus, by comparing equations 6.4 and 6.5 we can verify whether the countries have incentives to cooperate (in the sense that if the consumption possibility set de ned by 6.5 strictly dominates the set de ned by 6.4 for both countries, they will have an incentive to cooperate). Consider rst the rich country (i.e., $i = 1$) and let the poor country be very poor indeed ($\overline{k}_2 \to 0$). Then, under residence-based taxation and free capital movements (cooperation)

$$\lim_{\overline{k}_2 \to 0} (c_1 + g_1) = f\left[\frac{\overline{k}_1}{2}\right] + f'\left[\frac{\overline{k}_1}{2}\right]\frac{\overline{k}_1}{2} > f\left(\overline{k}_1\right), \tag{6.6}$$

where the inequality follows from the (strict) concavity of the production function. Under source-based taxation and strict capital controls (non-cooperation) the resource constraint of the rich country is independent of the endowments of the poor country (and given by $f\left(\overline{k}_1\right)$). Hence, when the poor country is very poor, the rich country will (strictly) prefer cooperation to non-cooperation. At the other extreme where the two countries become equally rich ($\overline{k}_2 \to \overline{k}_1$) the resource constraints become identical under the two tax regimes:

[18] One could argue that only two qualitatively different non-cooperative equilibria exists, *viz.* T-equilibria (with unrestricted capital ows) and (T,K)-equilibria with fully restricted capital ows, thereby disregarding the notion of partial capital controls. The problem with partial capital controls is that in a proper intertemporal framework the national tax authorities cannot control the total stock of foreign capital owned by domestic residents, since the current value of the foreign capital stock owned by domestic residents depends on the return on foreign capital in all previous periods, and it is exactly the absence of knowledge of these returns that creates the inefficiencies of non-cooperative tax policies. Therefore, partial controls will become very imprecise quantitative restrictions as time proceeds.

$$\lim_{\overline{k}_2 \to \overline{k}_1} (c_1 + g_1) = f(\overline{k}_1) \tag{6.7}$$

and since the aggregate resources of the rich country are declining monotonically in the endowment of the poor country when the residence principle is applied,

$$\frac{\partial (c_1 + g_1)}{\partial \overline{k}_2} = f'' \left[\frac{\overline{k}_1 + \overline{k}_2}{2} \right] \left(\frac{\overline{k}_1 - \overline{k}_2}{4} \right) < 0, \tag{6.8}$$

the rich country prefers cooperation to non-cooperation. For the poor country matters are a bit more complicated. Let again the poor country be very poor ($\overline{k}_2 \to 0$). Then, under residence-based taxation and unrestricted capital ows (cooperation)

$$\lim_{\overline{k}_2 \to 0} (c_2 + g_2) = f \left[\frac{\overline{k}_1}{2} \right] - f' \left[\frac{\overline{k}_1}{2} \right] \frac{\overline{k}_1}{2} > 0, \tag{6.9}$$

(again, the inequality follows from the (strict) concavity of the production function) whereas, of course, no resources are available for the residents of the poor country if the rich country imposes strict capital controls.[19] Increasing the endowments of the poor country expands the amount of resources available in the poor country in both tax regimes, since

$$\frac{\partial (c_2 + g_2)}{\partial \overline{k}_2} = f' \left[\frac{\overline{k}_1 + \overline{k}_2}{2} \right] - f'' \left[\frac{\overline{k}_1 + \overline{k}_2}{2} \right] \left(\frac{\overline{k}_1 - \overline{k}_2}{4} \right) > 0, \tag{6.10}$$

under residence-based taxation and free capital movements (cooperation), and

$$\frac{\partial (c_2 + g_2)}{\partial \overline{k}_2} = f'(\overline{k}_2) > 0, \tag{6.11}$$

under source-based taxation and strict capital controls (non-cooperation). At the other extreme where the two countries become equally rich, the two resource constraints again become identical. From the strict inequality in 6.9 we can conclude that for small values of $\overline{k}_2$, the poor country will always prefer cooperation to non-cooperation. For larger values of $\overline{k}_2$, however, we cannot rule out that cooperation will leave the poor country worse off, unless the production function satis es the following condition

$$f'(\overline{k}_2) > f' \left[\frac{\overline{k}_1 + \overline{k}_2}{2} \right] - f'' \left[\frac{\overline{k}_1 + \overline{k}_2}{2} \right] \left(\frac{\overline{k}_1 - \overline{k}_2}{4} \right) > 0, \quad \forall\, \overline{k}_2 \in \left[0, \overline{k}_1 \right[, \tag{6.12}$$

[19] Notice, that since cooperation implies net capital ows from the rich to the poor country, it is the capital controls of the rich country that are important for the comparisons of resources.

which basically involves restrictions on the third derivative of the production function. If condition 6.12 is satis ed we can conclude that both countries will prefer cooperation to non-cooperation. Otherwise, cooperation will only be preferred for sure by both countries when the poor country is sufficiently poor.

Thus, we have provided some (partial) arguments for the existence of scope for international tax cooperation even when the involved countries may choose to isolate themselves by imposing restrictions on capital ows. The basic assumption needed for this result is to have sufficiently important asymmetries among the countries, such that net capital ows play a vital role for establishing efficient outcomes.

7. Concluding Remarks

The bene cial properties of restrictions on international capital ows with respect to alleviating the inefficiencies induced by taxing internationally mobile capital depend critical on the assumptions regarding the role played by capital ows. As long as capital ows are not important for an efficient international allocation of capital to materialize, restrictions on capital ows are powerful instruments for mitigating the undesirable effects of tax competition, and there is little scope for cooperative actions. When net capital ows play a fundamental role in establishing an efficient international allocation of capital, however, capital controls lose part of their desirable effects, and there is generally scope for cooperative policies. Equally important is that the mere option of imposing capital controls may in uence whether cooperation will actually take place. Take as an example a case where country 1 ranks the equilibria as follows: The T-equilibrium is preferred to the efficient allocation which is preferred to the (T,K)-equilibrium, whereas country 2 prefers the efficient allocation to the (T,K)-equilibrium which is preferred to the T-equilibrium (assume that the efficient allocation will follow if the countries agree on tax cooperation). Then, if capital controls are not considered an available option, the outcome is unlikely to be efficient, since country 1 would prefer to act non-cooperatively. With capital controls as an option, country 2 will choose to impose restrictions on capital ows if country 2 will not take part in tax cooperation, and since such a threat is credible, country 2 will agree to cooperate.

Extensions of the model are certainly possible. One interesting extension would be to endogenize the saving decisions, e.g. by turning the model into a two-period model. Then, as shown by Kehoe (1989), tax competition may become preferable to tax cooperation, possibly leaving capital controls as a less desirable option. Another extension would be to consider a three country model with cooperation taking place only between two of the involved countries. In that case, capital controls could possibly be used by the cooperating countries against

the third country to avoid capital ight from the cooperating countries to the third country, thereby making capital controls and tax cooperation work together.

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