DEPARTMENT OF ECONOMICS

Working Paper

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Working Paper No. 2001-3

ISSN 1396-2426

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Partial vs. Global Coordination of Capital Income Tax Policies*

Bo Sandemann Rasmussen†

March 9, 2001

Abstract

Coordination of tax policies among policy makers is an often considered remedy against inefficiently low taxes on mobile tax bases induced by tax competition. Tax coordination may, however, not be particularly successful if some countries do not take part in the coordination. The outcome of such "partial coordination" in capital income taxation is derived within a linear-quadratic tax competition model with imperfect capital mobility, and the results suggest that the critical mass of countries needed for partial coordination to matter significantly is likely to be a very large percentage of the economies of the world, with the main benefits accruing to countries not participating. This may call for implementation of a global capital income tax treaty administered along the lines of the WTO trade agreements.

Keywords: Capital income taxation, tax competition, tax coordination, partial coordination.

JEL: H21, H26, F21.

1. Introduction

The increasing international mobility of capital flows is well recognized to pose problems for policy makers aimed at raising tax revenue in the least distorting way. The inability of tax authorities to monitor foreign source capital income implies

*A previous version of this paper (entitled "Coordinating Capital Income Taxation among a Subset of Countries") was presented at the World Congress of the Econometric Society in Seattle, August 11-16, 2000. Comments from participants at the congress are gratefully acknowledged.

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that investors can effectively escape domestic taxation by investing abroad, ruling out effective application of the residence principle in capital income taxation. Instead, tax authorities can impose source-based capital income taxes. This, on the other hand, opens up for competition among tax authorities to attract capital income into their jurisdiction by offering favourable tax treatment. The implications hereof are well established in the theoretical literature on tax competition (see e.g. Bucovetsky and Wilson (1991), Gordon (1992), Wilson (1986, 1991) and Zodrow and Mieszkowski (1986) for the original contributions to the tax competition literature, or Wilson (1999) for an excellent recent survey), with capital income being taxed too lenient in a tax competition (Nash) equilibrium. As also noted in this literature one possible way out of this "under-taxation" of highly mobile capital is for the tax authorities to engage in some kind of international tax coordination, e.g. by exchanging information on foreign source capital income (Razin and Sadka (1991)). For such an arrangement to be fully effective, however, all countries in the world economy must participate in the sharing of information, since otherwise capital flight into the non-participating countries is still viable. In the extreme case with coordination only among two small economies taking the world rate of return to capital as given Razin and Sadka (1991) have shown that such policy coordination is useless since the investors in the two cooperating countries can still obtain the world rate of return by investing in some country not participating in the coordination. Sørensen (2000) analyses how regional coordination among a group of small countries (thought of as the EU-countries) affects equilibrium tax rates when the rest of the world (modelled to be Japan and the US) stays outside the coordination, and shows that the gains from regional coordination appear to be rather small. Given that regional coordination is unable to provide substantial gains, an interesting question is what kind of critical mass is needed for coordination on a more world wide basis to generate substantial benefits?[1]

In an attempt to shed light on that question we set up a static general equilibrium model of a N-country world economy. To capture the essence of capital being the mobile factor of production we take labour to be completely immobile between countries while capital is mobile at some cost. Varying the mobility cost

[1]In principle, partial coordination could even be harmful to the participating countries as shown by Beaudry *et al.* (2000). They discuss in general terms the issue of partial coordination and argue that it is the nature of the strategic spillovers that determines whether or not partial coordination is preferable to non-cooperation. In our model the nature of the spillovers implies that any kind of partial coordination is beneficial to the participating countries. Moreover Beaudry *et al.* (2000) limit the analysis to symmetric environments where partial coordination involves cooperation among players within groups of identical size (see also Sørensen (1996)). In the present paper we allow for asymmetries in the sense that some countries may cooperate among themselves while other countries act fully non-cooperatively.

of capital allows us to consider the importance of the degree of capital for the results. In each country the tax authorities use a source-based capital income tax to finance a country-specific public good.[2] Starting from the standard tax competition (Nash) equilibrium where the tax authorities in each country set their capital income taxes unilaterally, the notion of partial capital income tax coordination is introduced. In a partial coordination equilibrium a subset $M < N$ of the world economies cooperate on setting a common[3] capital income tax while the remaining $N-M$ countries act non-cooperatively. Then, for $M \in \{2, 3, ..., N-1\}$ it is possible to consider how the extent of coordination affects the equilibrium outcome. In particular, we are interested in establishing when a "critical mass" of coordinating countries is reached, i.e. when there is a "significant" gain to cooperating countries relative to non-cooperation.[4]

To facilitate explicit analytical solutions to the model we use linear-quadratic functional forms for preferences and technology. One advantage is that these specific functional forms ensure existence of (Nash) equilibrium. Secondly, it is also possible to derive an explicit analytical solution to the tax competition games, although we need to resort to numerical solutions in order to compare welfare levels under the various equilibria. The main drawback of this approach is, of course, the loss of generality of our results. Thus, with this caveat in mind our results seem to suggest that the critical mass in partial capital income tax coordination is a rather large fraction or the world economies. As should be expected, the countries not participating in the coordination obtain a larger welfare gain than those actually participating. This implies that capital income tax coordination should not only take place among the leading world economies, like the G7, but should include as many countries as possible. One possibility would be to implement an international capital income tax treaty along the lines of the trade agreements within the WTO, to secure exchange of information on foreign capital income, thereby allowing for the residence principle to be applied in capital income taxation in each country.

The paper is organized as follows. In section 2 the model is set up. The implications of tax competition and of various degrees of tax coordination is analyzed analytically in section 3 while section 4 presents some numerical results allowing

[2] As usual in the tax competition literature the public good is assumed to be a rival good, e.g. health care, benefitting domestic residents only.

[3] Since countries are identical the coordinating countries will choose the same capital income tax level in equilibrium. If countries differ, e.g. in size, they may wish to set different capital income taxes in a partial coordination equilibrium. One way of modelling this would be to let the individual countries bargain over taxes taking the non-cooperative equilibrium as the fall-back position (see e.g. Rasmussen (1992) in a different setting).

[4] What "significant" means in this context is obviously somewhat arbitrary. However, the results will be presented in such a way that the reader can choose his own level of significance.

for welfare effects of tax coordination to be studied. Section 5 briefly discusses some of the policy implications of these results while some concluding remarks are offered in section 6.

2. The Model

Consider a one period model of N identical countries interacting through trade in goods and capital. A homogenous tradable good is produced by competitive firms in the N countries (the price of this tradable good is normalized at unity). Due to existence of positive "mobility costs" for international capital flows (see e.g. Persson and Tabellini (1992)) capital mobility is imperfect.[5] The static nature of the model implies that the total supply of capital is exogenously determined by the initial endowments of capital. To be able to analyze the consequences of "partial coordination" specific functional forms for preferences and technologies are employed. Following Bucovetsky (1991) and van Ypersele (1998) linear-quadratic functional forms are assumed such that an explicit analytical solution to the capital market equilibrium can be obtained.

Compared to Sørensen (2000) where the inefficiency of the non-cooperative equilibrium is a lack of income redistribution under non-cooperation (since the public good is financed through a lump sum tax on the margin), we follow the more traditional tax competition framework where the inefficiency of non-cooperation is an under-provision of the public good. Obviously, both kinds of inefficiency may prevail under real world tax competition, making the two analyses complementary rather than competing.

An implication of assuming imperfect capital mobility and asymmetric extents of coordination is that care must be taken to keep track of ownership of capital used in production in each country. As a general rule we let superscripts denote the residence of the owner of the capital while subscripts denote the location of the firm using the capital as an input in production. Hence, k_j^i denotes the amount of capital owned the representative household in country i used in production in country j.

2.1. Taxes

In open economies two separate principles for taxing capital income are usually distinguished (see e.g. Frenkel *et al.* (1991)): The source principle according to which capital income generated within a country is taxed at the same rate irrespective of the residence of the owner of the capital stock; and the residence

[5] Another way of restricting capital flows is to assume that governments impose capital controls on international capital movements. See Rasmussen (1999) for such an analysis.

principle where capital income of the residents of a country is tax at the same rate irrespective of the source of the capital income (home or foreign). However, the availability of these taxes depends on the institutional setting for tax policies where e.g. a pure residence tax on capital income requires a minimal amount of coordination among all the N countries to share information on capital income of non-residents. As shown by Bacchetta and Espinosa (1995) full information sharing and application of the residence principle in all countries is a cooperative equilibrium as long as countries are identical. However, if either not all countries participate in the information sharing or there are some fundamental asymmetries among the countries (e.g. with respect to size or initial endowments) the residence principle can no longer be applied effectively.[6] We therefore assume that source-based capital income taxes, t_i, are the only ones available. Furthermore, since labour supply will be assumed to be inelastic and we do not want to consider lump sum taxes, labour income is assumed to be untaxed.[7]

2.2. Firms

The representative firm in country i produces the homogenous tradable good in an amount y_i. The production function is assumed to be quadratic in the capital-labour ratio, k_i

$$y_i = (\alpha - \beta k_i)\, k_i,$$

with $\alpha > 0$, $\beta > 0$ and $\alpha - 2\beta k_i > 0$ for all possible values of k_i (implying a positive marginal product of capital). The demand for capital becomes

$$k_i = \frac{\alpha - (R_i + t_i)}{2\beta}, \tag{2.1}$$

where R_i is the return to capital and t_i is the unit tax on capital in country i. Notice that the rate of return to capital may differ among countries due to capital mobility being imperfect. The wage becomes

$$w_i = \beta\,(k_i)^2\,.$$

2.3. Households

Households are endowed with one unit of labour supplied inelastically to domestic firms and one unit of capital to be invested at home or abroad. The utility function

[6] In this case capital flight prevents effective use of the residence principle in capital income taxation, an assumption which is often used in this literature, see e.g. Wilson (1991).

[7] A labour income tax could be introduced without changing any of the results as long as the labour tax revenue remains smaller than the desired public spending, implying that the source-based capital income tax is the tax used on the margin.

is assumed to be linear with a constant marginal rate of substitution between private goods, c_i, and public goods, g_i

$$U_i = c_i + \theta g_i,$$

where $\theta > 1$.[8] Private consumption is constrained by the sum of wage income, w_i, and the return from investments of capital income at home and abroad. Following Persson and Tabellini (1992) imperfect capital mobility is modelled by assuming (strictly) convex mobility costs reducing the return to foreign investment. More specifically, quadratic mobility costs are assumed, implying that investing k_j^i units of capital in country j yields a net return of $\left(R_j k_j^i - \frac{\phi}{2}\left(k_j^i\right)^2\right)$,the second term being the "mobility costs".[9] The parameter $\phi > 0$ measures the degree of imperfect capital mobility. The budget constraint then reads

$$c_i = w_i + R_i k_i^i + \sum_{j \neq i}^{N} \left(R_j - \frac{\phi}{2} k_j^i\right) k_j^i,$$

where the second term on the RHS is domestic capital income while the last term is total capital income from foreign investments net of mobility costs. Obviously, the holdings of capital in different countries are constrained by the endowment of capital (equal to unity):

$$\sum_{j=1}^{N} k_j^i = 1.$$

Notice that k_j^i can be positive (reflecting investments abroad) or negative (reflecting borrowing abroad) and that the same kind of mobility costs applies to positive

[8] An interior solution with positive values of both private and public consumption generally exists with $\theta > 1$ since the public good is financed through a distortionary tax. With lump sum taxes a corner solution with $g_i = w_i + R_i$ and $c_i = 0$ follows. If $\theta \leq 1$ no public goods should be provided. In the calibrated version of the model we impose the restriction that consumption cannot fall below some lower threshold, $\underline{c}$, implying that with lump sum taxes $c_i = \underline{c}$ and $g_i = y_i - c_i$. This basically amounts to having a utility function of the form $U_i = \max\{c_i, \underline{c}\} + \theta g_i$, with the constraint $c_i \geq \underline{c}$ only binding under global coordination (where capital income taxes are lump sum due to the world capital stock being exogenously given by the sum of the endowments of capital).

[9] Notice that mobility costs relate to each specific foreign investment and not to aggregate foreign investment. Since marginal mobility costs are increasing this implies that the households have an incentive to diversify their investment portfolios. As in the installation cost theory of capital stock adjustment one may think that it is difficult to justify increasing marginal mobility costs. However, in our case with linear utility functions the convexity of mobility costs simply adds some risk aversion regarding investment decisions (as reflected in the diversification of investment portfolios). Therefore, the presence of convex mobility costs may be argued to add some realism to the model.

and negative values of k_j^i. The optimal investment policy of the representative household follows from

$$\begin{aligned} \max_{\{k_j^i\}_{j=1}^N} U_i &= c_i + \theta g_i \\ & s.t. \\ c_i &= w_i + R_i k_i^i + \sum_{j \neq i}^{N} \left(R_j - \frac{\phi}{2} k_j^i \right) k_j^i \\ \sum_{j=1}^{N} k_j^i &= 1. \end{aligned}$$

The first-order condition reads

$$\frac{\partial U_i}{\partial k_v^i} = -R_i + R_v - \phi k_v^i = 0, \quad v, i = 1, ..., N, \; v \neq i,$$

such that

$$R_i = R_v - \phi k_v^i,$$

implying that the return to capital invested abroad in equilibrium must exceed the return to domestically invested capital by the size of the marginal mobility cost.[10] Solving for the supply of capital to foreign firms by domestic households yields

$$k_v^i = \frac{1}{\phi} \left(R_v - R_i \right), \quad v, i = 1, ..., N, \; v \neq i,$$

which will be one of the key ingredients in determining the equilibrium returns to capital in the world economy.

2.4. Government

Since the source tax on capital income is the only tax available to the government the budget constraint of the government simply reads

$$g_i = t_i k_i.$$

2.5. Equilibrium

Equilibrium in the international capital market requires that the demand for capital by firms in each country equals the supply of capital from investors in the

[10] Of course, if the household borrows in country v, so $k_v^i < 0$, the cost of borrowing abroad must be less than the domestic cost of borrowing in equilibrium to cover the capital mobility costs.

world economy, i.e.

$$k_i = \sum_{j=1}^{N} k_i^j, \quad i = 1, ..., N. \tag{2.2}$$

The demand for capital is given by equation 2.1. To determine the supply of capital notice that

$$\sum_{j=1}^{N} k_i^j = \sum_{j \neq i}^{N} k_i^j + k_i^i = \sum_{j \neq i}^{N} k_i^j + 1 - \sum_{j \neq i}^{N} k_j^i.$$

By the symmetry of mobility costs follows that

$$k_i^j = -k_j^i,$$

implying that

$$\sum_{j=1}^{N} k_i^j = 1 + 2\sum_{j \neq i}^{N} k_i^j = 1 + \frac{2}{\phi}\sum_{j \neq i}^{N} (R_i - R_j), \quad i = 1, ..., N.$$

Thus, we have N conditions to determine the equilibrium world returns to capital:

$$\frac{\alpha - (R_i + t_i)}{2\beta} = 1 + \frac{2}{\phi}\sum_{j \neq i}^{N} (R_i - R_j), \quad i = 1, ..., N. \tag{2.3}$$

Due to the linear-quadratic functional forms of the model the system of equilibrium conditions is linear and can be solved explicitly. Collecting terms we can express the N equations in 2.3 in matrix form:

$$\begin{bmatrix} \phi + 4\beta(N-1), & -4\beta, & \cdots & -4\beta \\ -4\beta, & \ddots & & -4\beta \\ \vdots & & \ddots & \vdots \\ -4\beta, & -4\beta, & \cdots & \phi + 4\beta(N-1) \end{bmatrix} \begin{bmatrix} R_1 \\ R_2 \\ \vdots \\ R_N \end{bmatrix} = \begin{bmatrix} \phi(\alpha - 2\beta - t_1) \\ \phi(\alpha - 2\beta - t_2) \\ \vdots \\ \phi(\alpha - 2\beta - t_N) \end{bmatrix}.$$

Solving for R_i yields

$$R_i = \alpha - 2\beta - \frac{\phi + 4\beta}{\phi + 4N\beta} t_i - \frac{4\beta}{\phi + 4N\beta} \sum_{j \neq i}^{N} t_j, \quad i = 1, ..., N. \tag{2.4}$$

Finally, we can use 2.4 to solve for the supply of capital to foreign firms by domestic households as a function of taxes:

$$k_v^i = \frac{t_i - t_v}{\phi + 4N\beta}, \quad v, i = 1, ..., N, \ v \neq i,$$

revealing that capital flows in this symmetric world economy are only caused by differences in capital income taxes. The supply of capital to domestic firms is then determined residually:

$$k_i^i = 1 - \frac{(N-1)\,t_i}{\phi + 4N\beta} + \frac{\sum_{j\neq i}^{N} t_j}{\phi + 4N\beta}, \quad i = 1, ..., N.$$

3. Tax Policies

An important aspect of tax policies is how governments interact strategically. At one extreme all governments act non-cooperatively, corresponding to the tax competition-case. At the other extreme all governments cooperate implying that the residence principle can be applied effectively. Since the aggregate capital stock is exogenously given by initial endowments such a residence-based capital income tax will be a lump-sum tax and the resulting cooperative equilibrium will achieve the first-best outcome.[11] In between these extremes governments of a subset of countries may coordinate their capital income tax policies with each other leading to "partial coordination" outcomes.

3.1. Tax Competition

The non-cooperative equilibrium taxes can be explicitly derived for this model.[12] Each country chooses its tax, t_i, to maximize utility of the representative consumer subject to the constraints imposed by the competitive equilibrium. For any country i the government solves

$$\begin{aligned}
\max_{t_i} V_i &= w_i + R_i k_i^i + \sum_{j\neq i}^{N} \left(R_j - \frac{\phi}{2} k_j^i \right) k_j^i + \theta t_i k_i \\
&\quad s.t. \\
R_j &= \alpha - 2\beta - \frac{\phi + 4\beta}{\phi + 4N\beta} t_j - \frac{4\beta}{\phi + 4N\beta} \sum_{v\neq j}^{N} t_v, \quad j = 1, ..., N, \\
k_v^i &= \frac{t_i - t_v}{\phi + 4N\beta}, \quad v = 1, ..., N,\ v \neq i
\end{aligned}$$

[11] Remember that we have constrained the first-best outcome by requiring that private consumption cannot fall below some threshold level, $\underline{c}$. This is done to avoid the cooperative outcome representing an unrealistically large gain over the non-cooperative outcome. However, compared to Sørensen (2000) our model still implies that there is a relatively large potential gain from global coordination (cf. section 4).

[12] Existence of a Nash equilibrium to such a game is guarateed if the utility functions are continuous and quasi-concave (in taxes) and the strategy sets are compact and convex (see Bucovetsky (1991) and van Ypersele (1998)). These conditions are fulfilled for our choice of functional forms.

$$\begin{aligned} k_i^i &= 1 - \frac{(N-1)\,t_i}{\phi + 4N\beta} + \frac{\sum_{j\neq i}^{N} t_j}{\phi + 4N\beta} \\ w_i &= \beta\,(k_i)^2 \\ k_i &= \frac{\alpha - (R_i + t_i)}{2\beta} \\ t_{-i} &\equiv (t_1, ..., t_{i-1}, t_{i+1}, ..., t_N) \ \textit{given.} \end{aligned}$$

After some manipulations the first-order condition reads

$$\begin{aligned} \phi + 4\beta &= -2\,(N-1)\,(\alpha + (\theta - 1)\,t_i) + (N-1)\,R_i \\ &\quad +\theta\,(\phi + 4N\beta)\,k_i + \sum_{j\neq i}^{N} R_j. \end{aligned}$$

In a symmetric equilibrium all governments choose the same taxes, $t_i = t,\ i = 1, ..., N$, eliminating capital flows, $k_j^i = 0$, making capital stocks equal to endowments $k_i = 1,\ i = 1, ..., N$. Equilibrium returns to capital are also equalized, $R_i = R = \alpha - 2\beta - t$. We can then solve for the non-cooperative equilibrium tax, t^{NC}:

$$t^{NC} = \frac{(\theta - 1)}{\theta}\frac{(\phi + 4N\beta)}{2\,(N-1)}.$$

While this non-cooperative equilibrium may not be that interesting in itself, it is a useful reference point to compare with when we now consider equilibria with partial coordination.

3.2. Partial Coordination

To analyze the effects of coordination among a subset of the N countries, we let $i = 2, ..., M < N$ denote the number of countries taking part in the coordination while $j = M + 1, ..., N$ denotes the non-cooperating countries. Since the cooperating countries are identical they will set a common tax, t_i.[13] The difference between a cooperating and a non-cooperating country is now that when t_i is changed that goes for all the M cooperating countries while a change in t_j is for a single country, only.

For investors in a non-cooperating country there are three options to consider: Investing at home; investing in another non-cooperating country paying the mobility costs; or investing in the cooperating countries again paying the mobility

[13] In principle, the coordinating countries could use the residence principle for capital income generated within the group of coordinating countries, but due to mobility costs there will be no capital flows among the coordinating countries as long as they choose the same tax levels. It is therefore without loss of generality to maintain the assumption that only source taxes are levied.

costs.[14] Investors in a cooperating country have effectively only two options: Investing at home or investing in the non-cooperating countries, since investing in another cooperating country will be unprofitable due to the mobility costs.

For each of the non-cooperating countries, $j = M+1, M+2, ..., N$, the optimal tax problem reads

$$\begin{aligned}
\max_{t_j} V_j &= w_j + R_j k_j^j + M\left(R_i - \frac{\phi}{2}k_i^j\right)k_i^j + \sum_{\substack{v=M+1 \\ v\neq j}}^{N}\left(R_v - \frac{\phi}{2}k_v^j\right)k_v^j + \theta t_j k_j \\
&\quad s.t. \\
R_j &= \alpha - 2\beta - \frac{\phi+4\beta}{\phi+4N\beta}t_j - \frac{4M\beta}{\phi+4N\beta}t_i - \frac{4\beta}{\phi+4N\beta}\sum_{\substack{v=M+1 \\ v\neq j}}^{N} t_v \\
R_i &= \alpha - 2\beta - \frac{\phi+4M\beta}{\phi+4N\beta}t_i - \frac{4\beta}{\phi+4N\beta}\sum_{v=M+1}^{N} t_v \\
k_v^j &= \frac{t_j - t_v}{\phi+4N\beta}, \quad v = 1, ..., N, \ v \neq j \\
k_j^j &= 1 - \frac{(N-1)\,t_j}{\phi+4N\beta} + \frac{Mt_i}{\phi+4N\beta} + \frac{1}{\phi+4N\beta}\sum_{\substack{v=M+1 \\ v\neq j}}^{N} t_v \\
w_j &= \beta\left(k_j\right)^2 \\
k_j &= \frac{\alpha - (R_j + t_j)}{2\beta} \\
t_{-j} &\equiv (t_1, ..., t_M, ..., t_{j-1}, t_{j+1}, ..., t_N) \quad given.
\end{aligned}$$

The first-order condition for a non-cooperating country can be simplified somewhat by imposing the "symmetric" equilibrium condition that all non-cooperating countries choose the same tax, $t_j = t, \ j = M+1, M+2, ..., N$. After extensive manipulations we obtain

$$\left(\frac{\left[\phi + 8\left(N-1\right)\beta\right]M}{\phi+4N\beta} - 2M\theta\right)(t_i - t) = -2\left(N-1\right)\theta t + \left(\theta - 1\right)\left(\phi + 4N\beta\right). \tag{3.1}$$

For a cooperating country, $i = 1, ..., M$, the optimal tax problem looks like[15]

$$\max_{t_i} V_i = w_i + R_i k_i^i + (N-M)\left(R - \frac{\phi}{2}k_j^i\right)k_j^i + \theta t_i k_i$$

[14] Due to mobility costs being convex an investment in the group of coordinating countries will be spread evenly among all the coordinating countries to minimize mobility costs.

[15] For simplicity, we have already imposed the equilibrium condition for the non-cooperating countries that $t_j = t$, and $R_j = R, \ \ j = M+1, ..., N$.

$$
\begin{aligned}
& s.t. \\
R_i &= \alpha - 2\beta - \frac{\phi + 4M\beta}{\phi + 4N\beta} t_i - \frac{4\beta (N - M)}{\phi + 4N\beta} t \\
R &= \alpha - 2\beta - \frac{\phi + 4 (N - M) \beta}{\phi + 4N\beta} t - \frac{4M\beta}{\phi + 4N\beta} t_i \\
k_j^i &= \frac{t_i - t}{\phi + 4N\beta}, \quad j = M + 1, ..., N, \\
k_i^i &= 1 + \frac{(N - M)(t - t_i)}{\phi + 4N\beta} \\
w_i &= \beta (k_i)^2 \\
k_i &= \frac{\alpha - (R_i + t_i)}{2\beta} \\
t_{-i} &\equiv (t_{M+1}, ..., t_N) \ \textit{given.}
\end{aligned}
$$

Rewriting the first-order condition extensively leads to

$$
\frac{4 (N - M) \beta (2M - 1)(t - t_i)}{\phi + 4N\beta} = -2 (N - M) \theta t_i + (\theta - 1)(\phi + 4N\beta). \quad (3.2)
$$

Although it is possible to obtain an analytical solution for the two taxes by solving equations 3.1 and 3.2 simultaneously, the expressions are so complex that they are not very helpful for characterizing equilibrium. Moreover, what we basically are interested in are the welfare levels in the various countries in the different equilibria, and although it is possible to obtain explicit analytical expressions for the equilibrium welfare levels, the complexity of these expressions prevents any interesting information from being extracted. Instead, we illustrate the results through some numerical examples allowing us to focus on the importance of the number of countries participating in the coordination, M.

4. Numerical Examples

In our first numerical example we choose the following parameter values:

$$
N = 100, \ \alpha = 12, \ \beta = .1, \ \theta = 1.2, \ \phi = 10
$$

while we let M vary between 1 and 99.[16] In Table 1 the equilibrium outcomes under partial coordination are presented.[17] The welfare effects of partial coordi-

[16] Of course, $M = 1$ is just the non-cooperative Nash equilibrium.

[17] The calculations were performed using the Maple facility in Scientific Workplace 3.0. In the tables U is welfare, t is the tax on capital income, and k is the capital stock. Superscript

nation are measured relative to the first best outcome.[18]

*** * * Table 1 about here * * ***

Figure 1 illustrates the welfare of the cooperating countries (the solid line) and the welfare of the non-cooperating countries (the dashed line) for the different levels of coordination. The figure shows first of all, that the cooperating countries must be a significant part of the world economy for the coordination to matter quantitatively. E.g. when 90% of the countries cooperate their welfare gain is less than 0.2% compared to the non-cooperative welfare level. This extends the result in Razin and Sadka (1991), that two small economies taking the world rate of return as given have no incentive to engage in tax coordination with each other, by showing that even a lot of small countries may not be able to benefit significantly by engaging in (partial) coordination. However, even though there may be a limited welfare gain under partial coordination there seems to be no risk of partial coordination being outright detrimental to the participating countries.

*** * * Figure 1 about here * * ***

For the non-participating countries there are no significant effects of partial coordination as long as the participating countries are not a significant part of the world economy. However, for every $M > 1$ the welfare of a non-participating country exceeds the welfare level of the participating countries. This basically generalizes a result in the asymmetric two-country model in Wilson (1991) who shows that the agents in the small country are better off than the agents in the large country under tax competition. In our model the group of coordinating countries can be considered the "large country" in which the citizens are worse off

"pc" denotes a country participating in partial coordination while superscript "nc" denotes a country not participating. Welfare is measured relative to the welfare obtained under global tax coordination (normalized at 100). The model is calibrated such that the total potential gain from coordination is $4-5\%$ (approximately in units of consumption). This is somewhat larger than in Sørensen (2000) where the maximum gain is around 1%. In this sense the results are biased by overstating the potential gains from coordination compared to Sørensen (2000).

[18] In principle, all output is used for public consumption at the first best allocation since $\theta > 1$. However, to add some realism the model is callibrated such that public consumption is approximately 25% of total production at the first best outcome. This basically implies that the utility function can be written as $U_i = \max\{c_i, \underline{c}\} + \theta g_i$, requiring private consumption not to fall short of some minimum level, $\underline{c}$, where in our case $\underline{c} \approx 0.75 \cdot y$. In the calibrated model the restriction $c_i \geq \underline{c}$ is only binding under global coordination.

than in any of the small non-cooperating countries. Hence, for a marginal country there is no incentive to participate in coordination (rather, there are incentives not to participate). Moreover, when only a few countries do not participate these countries are better off than at global coordination allocation - e.g. for $M = 97$ there are 3 countries not cooperating and these countries have a welfare level exceeding the welfare level under global coordination by 8% - due to heavy imports of foreign capital. This is actually a generalization of another finding in the two country model in Wilson (1991) where a sufficiently small country will be better off under tax competition than at the cooperative equilibrium. Our analysis shows that this may also be the case for a (small) group of non-cooperating countries.

To analyze the importance of capital market imperfections for these results we reduce the mobility costs (by a factor 100) while keeping the remaining parameters unchanged. Hence, the parameter values are: $N = 100,\ \alpha = 12,\ \beta = .1,\ \theta = 1.2,\ \phi = .1$.

*** * * Table 2 about here * * ***

It should be rather obvious from comparing Table 1 and 2 that the degree of capital market imperfection is not particularly important for our results. Taxes tend to be lower when capital mobility is increased, but the international allocation of capital is practically unaffected by the increase in capital mobility due to the optimal response of policy makers when choosing taxes. The gains from coordination are marginally larger with a higher degree of capital mobility, as are the gains to the non-cooperating countries. Intuitively, with a high degree of capital mobility tax competition is more fierce, making the gains from alleviating tax competition larger.

5. Policy Implications

The most important feature of our results is the need for establishing a critical mass of cooperating countries for capital income tax coordination to be beneficial to the participating countries. The level of critical mass is in our examples a very high percentage of the world economies. If, e.g., 90% of the countries in the world economy initiate a common capital income tax policy the relative gain from doing so compared to establishing an all-encompassing global cooperative capital income tax policy is rather modest, with less than 4% of the potential gain from global coordination being reaped under partial coordination. Hence, it is not sufficient to establish policy coordination among the leading world economies, like the G7-countries. Instead, a much more encompassing tax coordination is

needed, suggesting that an international organization akin to the WTO could play a prominent role here by enforcing a capital income tax treaty on a world wide basis.[19] The essence of such a capital income tax treaty could be to secure exchange of information on foreign source capital income among the member countries, allowing the residence principle to be applied effectively. As shown in Sørensen (2000) exchange of information among policy makers is usually sufficient for most of the gains from global tax coordination to be reaped, even in the case where policy makers can use spending on productive public goods strategically as a substitute for offering lenient capital income taxation. Of course, establishing a global capital income tax treaty is not an easy task given that current tax havens are likely to be hurt by accepting such a treaty, implying that introduction of compensatory measures could be necessary for the whole project to take off.

6. Concluding Remarks

We have proposed a model that might shed light on some of the aspects concerning international coordination in capital income taxation in general. The main conclusion to be derived from the analyses is that we need a substantial proportion of the world economies to take part in capital income tax coordination for significant gains to be reaped. This could call for capital income tax coordination to be undertaken on a world wide basis, possibly administered by an international organization akin to WTO. Of course, the problems facing the trade agreements within the WTO are likely to be present in the context of international agreements on capital income taxation, as well. One of the main problems of implementing a world wide agreement on capital income taxation is that due to asymmetries among countries the starting positions of these countries will be very different, implying that the gains from a world wide agreement may be rather unevenly distributed. Realistically, some countries may even become worse off by such an agreement, making the prospects for a successful implementation even more dim.[20]

[19] In some sense there are increasing returns to tax coordination: In our examples the gain from getting the first 99 countries to cooperate is of the same order of magnitude as the gain from getting the last country to give up its "tax haven-status". Thus, it is very important to avoid having a few countries staying outside the tax coordination.

[20] Even with respect to the regional coordination within the EU the opposition of Luxembourg to participate in a common EU capital income tax policy creates a major problem for the implementation of such a policy, and the presence of another tax haven just outside the EU (Switzerland) is not making the project any easier.

References

[1] Bacchetta, P. and M.P. Espinosa (1995), "Information Sharing and Tax Competition among Governments", *Journal of International Economics*, **39**, 103-121.

[2] Beaudry, P., P. Cahuc and H. Kemp (2000), "Is it harmful to Allow Partial Cooperation?", *Scandinavian Journal of Economics*, **102**, 1-21.

[3] Bucovetsky, S. (1991), "Asymmetric Tax Competition", *Journal of Urban Economics*, **30**, 167-181.

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

[5] Frenkel, J.A., A. Razin and E. Sadka (1991), "*International Taxation in an Integrated World*", MIT Press, Cambridge, Mass.

[6] Gordon, R.H. (1992), "Can Capital Income Taxes Survive in Open Economies", *Journal of Finance*, **47**, 1159-1180.

[7] Persson, T. and G. Tabellini (1992), "The Politics of 1992: Fiscal Policy and European Integration", *Review of Economic Studies*, **59**, 689-701.

[8] Rasmussen, B.S. (1992), "Union Cooperation and Nontraded Goods in General Equilibrium", *Scandinavian Journal of Economics*, **94**, 561-579.

[9] Rasmussen, B.S. (1999), "On the Scope for International Tax Cooperation: The Role of Capital Controls", *Open Economies Review*, **10**, 395-414.

[10] Razin, A. and E. Sadka (1991), "International Tax Competition and Gains from Tax Harmonization", *Economics Letters*, **37**, 69-76.

[11] Sørensen, J.R. (1996), "Coordination of Fiscal Policy among a Subset of Countries", *Scandinavian Journal of Economics*, **98**, 111-118.

[12] Sørensen, P.B. (2000), "The Case for International Tax Coordination Reconsidered", *Economic Policy*, **31**, 431-472.

[13] van Ypersele, T. (1998), "Cooperation of Capital Taxation among a Large Number of Asymmetric Countries", Center for Economic Research Working Paper No. 98137, Tilburg.

[14] Wildasin, D.E. (2000), "Factor Mobility and Fiscal Policy in the EU: Policy Issues and Analytical Approaches", *Economic Policy,* **31**, 339-378.

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

[16] Wilson, J.D. (1991), "Tax Competition with Interregional Differences in Factor Endowments", *Regional Science and Urban Economics*, **21**, 423-451.

[17] Wilson, J.D. (1999), "Theories of Tax Competition", *National Tax Journal*, **52**, 269-304.

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

Table 1. Outcomes under Partial Coordination

Parameter values: $N = 100,\ \alpha = 12,\ \beta = .1,\ \theta = 1.2,\ \phi = 10.$

M	U^{pc}	U^{nc}	t^{pc}	t^{nc}	k^{pc}	k^{nc}
1	95.4	95.4	.0421	.0421	1.00	1.00
5	95.4	95.4	.0438	.0421	.994	1.00
8	95.4	95.4	.0451	.0421	.989	1.00
10	95.4	95.4	.0461	.0422	.986	1.00
15	95.4	95.4	.0484	.0423	.979	1.00
20	95.4	95.4	.0510	.0425	.973	1.01
25	95.4	95.4	.0538	.0428	.967	1.01
30	95.4	95.4	.0568	.0432	.962	1.02
35	95.4	95.4	.0603	.0436	.957	1.02
40	95.4	95.4	.0642	.0442	.952	1.03
45	95.4	95.4	.0687	.0449	.948	1.04
50	95.4	95.5	.0740	.0458	.943	1.06
55	95.4	95.5	.0804	.0469	.940	1.07
60	95.4	95.5	.0883	.0483	.936	1.10
65	95.5	95.5	.0983	.0502	.933	1.13
70	95.5	95.5	.111	.0528	.929	1.16
75	95.5	95.6	.130	.0564	.926	1.22
80	95.5	95.7	.158	.0619	.923	1.31
85	95.5	95.9	.203	.0712	.921	1.45
90	95.6	96.6	.295	.0898	.918	1.74
93	95.7	97.9	.411	.114	.917	2.11
95	95.8	100	.568	.146	.916	2.60
96	95.9	103	.704	.174	.915	3.04
97	96.1	108	.931	.221	.915	3.76
98	96.5	125	1.39	.314	.914	5.20
99	97.6	211	2.75	.595	.914	9.54

Figure 1. Welfare under Partial Coordination

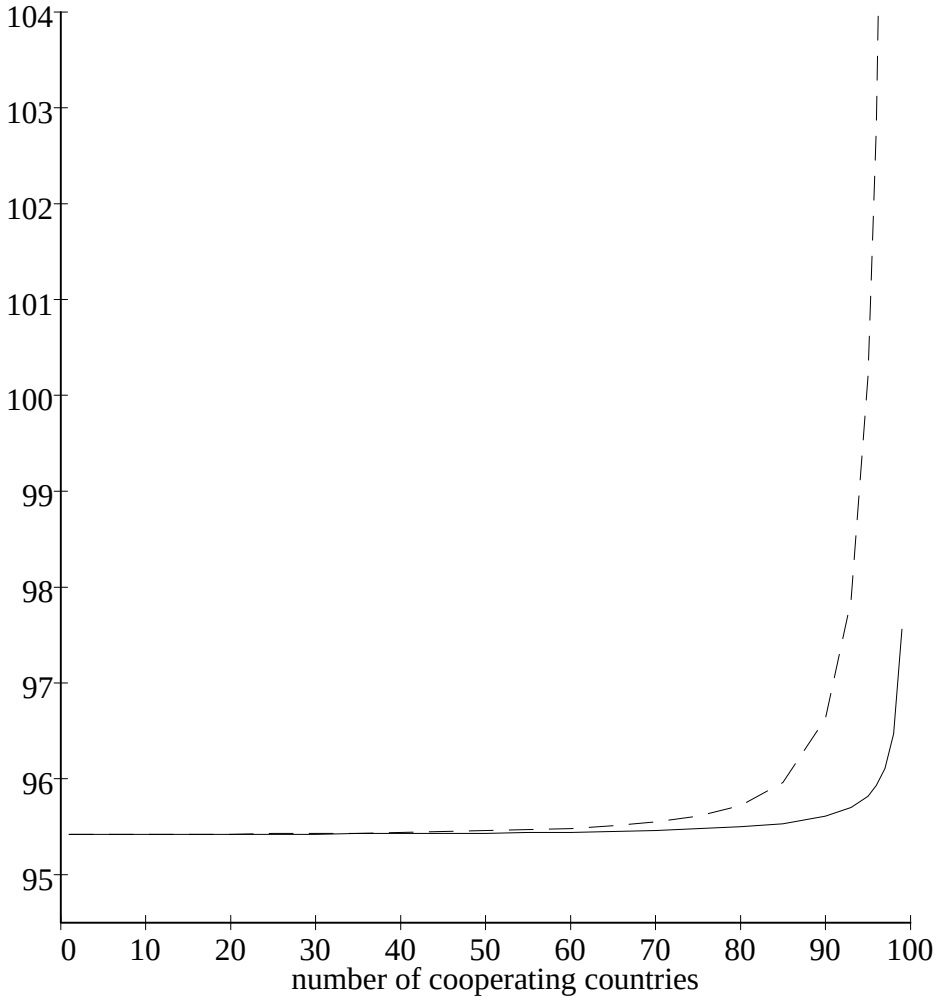

Table 2. Outcomes under Partial Coordination

Parameter values: $N = 100,\ \alpha = 12,\ \beta = .1,\ \theta = 1.2,\ \phi = .1.$

M	U^{pc}	U^{nc}	t^{pc}	t^{nc}	k^{pc}	k^{nc}
1	95.4	95.4	.0338	.0338	1.00	1.00
5	95.4	95.4	.0351	.0338	.994	1.00
8	95.4	95.4	.0362	.0338	.989	1.00
10	95.4	95.4	.0369	.0338	.986	1.00
15	95.4	95.4	.0387	.0339	.979	1.00
20	95.4	95.4	.0407	.0340	.973	1.01
25	95.4	95.4	.0428	.0341	.968	1.01
30	95.4	95.4	.0451	.0343	.962	1.02
35	95.4	95.4	.0477	.0346	.958	1.02
40	95.4	95.4	.0505	.0349	.953	1.03
45	95.4	95.4	.0539	.0352	.949	1.04
50	95.4	95.4	.0578	.0357	.945	1.06
55	95.4	95.4	.0624	.0363	.941	1.07
60	95.4	95.5	.0682	.0371	.938	1.09
65	95.4	95.5	.0754	.0381	.935	1.12
70	95.4	95.5	.0850	.0394	.932	1.16
75	95.4	95.5	.0984	.0414	.929	1.21
80	95.5	95.6	.118	.0443	.926	1.30
85	95.5	95.8	.151	.0492	.924	1.43
90	95.5	96.3	.217	.0590	.921	1.71
93	95.6	97.1	.301	.0717	.920	2.06
95	95.7	98.7	.413	.0886	.919	2.54
96	95.8	101	.511	.103	.919	2.95
97	95.9	104	.675	.128	.918	3.65
98	96.2	116	1.00	.177	.918	5.03
99	97.0	175	1.98	.326	.917	9.19

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