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Reforming an Asymmetric Union: On the Virtues of Dual Tier Capital Taxation*

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Abstract

We analyze the effects of introducing a two tier structure of capital taxation, where the asymmetric member states of a union choose a common, central tax rate in the first stage, and then non-cooperatively set local tax rates in the second stage. We show that this mechanism effectively reduces competition for mobile capital between the members of the union. Even without side payments, the gains from partial coordination are distributed across the heterogeneous members in a way that yields a strict Pareto improvement over a one tier system of purely local tax choices. Finally, we show that a dual structure of capital taxation has advantages even in a setting where costly side payments are feasible.

Keywords: capital tax competition, dual tier taxation, international unions

JEL Classification: H25, H73, H87

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1 Introduction

During the last decades, foreign direct investment (FDI) has increased rapidly in all parts of the world. Among the different regions, Europe is by far the most important source and destination of FDI, accounting for more than 54% of all FDI outflows and almost 48% of worldwide FDI inflows. Moreover the growth of FDI has also been stronger in Europe than elsewhere, as a result of deepening economic integration in the European Union (Barba Navaretti and Venables, 2004, pp. 5-8).¹ A large body of recent literature has furthermore emphasized that the location decisions of multinational firms are particularly sensitive to international tax differentials between the members of an economic unions, due to the otherwise similar location conditions that exist in an integrated market.² Hence, if the individual jurisdictions within an integrated union retain independent taxing powers, then the union is likely to face aggressive tax competition between its member states.

According to Table 1, tax competition appears indeed to be stronger between the members of the European Union, in comparison to other countries. The figure shows that the fall in statutory corporate tax rates has been significantly more pronounced, both in relative and in absolute terms, among the group of EU countries, as compared to the non-EU members of the OECD. Similar conclusions follow from direct empirical evidence towards strong strategic interactions in the setting of corporate taxes among EU countries (Devereux et al., 2008). This suggests that the *internal* tax competition between the members of the union is likely to be the binding constraint for the capital taxes set by each country, even if the union as a whole simultaneously competes for capital with other regions in the world.

In recent years the European Union has taken some measures of corporate tax coordination. In particular, its member states have signed a code of conduct in business taxation (European Communities, 1998) in which they committed to eliminate preferential tax

¹Of course, the importance of Europe vis-vis the United States is closely related to the definition of FDI, which classifies an enterprise that is present in two European countries as a multinational firm, whereas an enterprise that operates in several U.S. States is a domestic firm.

²For theoretical analyses see, e.g., Kind et al. (2005) and Haufler and Wooton (2006). There is also empirical evidence that foreign direct investment responds more sensitively to international tax differentials within a geographical area or an economic union (Devereux and Griffith, 1998; Grubert and Mutti, 2000).

Table 1: Corporate tax rates in EU and non-EU countries (1985-2010)

country	maximum tax rate	year	tax rate in 2010	absolute change ^a	relative change ^b
EU countries					
Austria	55.0	1985	25.0	-30.0	-0.55
Belgium	45.0	1985	34.0	-11.0	-0.24
Czech Republic	45.0	1993	19.0	-26.0	-0.58
Denmark	50.0	1985	25.0	-25.0	-0.50
Finland	61.8	1985	26.0	-35.8	-0.58
France	50.0	1985	34.4	-15.6	-0.31
Germany	60.0	1985	30.2	-29.8	-0.50
Greece	49.0	1985	24.0	-25.0	-0.51
Hungary	50.0	1989	19.0	-31.0	-0.62
Ireland	50.0	1985	12.5	-37.5	-0.75
Italy	53.2	1994	27.5	-25.7	-0.48
Luxembourg	40.0	1985	28.6	-11.4	-0.29
Netherlands	43.0	1985	25.5	-17.5	-0.41
Poland	40.0	1992	19.0	-21.0	-0.53
Portugal	55.1	1985	26.5	-28.6	-0.52
Slovak Republic	45.0	1993	19.0	-26.0	-0.58
Spain	35.0	1985	30.0	-5.0	-0.14
Sweden	60.1	1990	26.3	-33.8	-0.56
United Kingdom	40.0	1985	28.0	-12.0	-0.30
average ^c	48.8		25.2	-23.6	-0.48
non-EU countries					
Australia	49.0	1986	30.0	-19.0	-0.39
Canada	49.8	1986	29.5	-20.2	-0.41
Japan	50.0	1990	39.5	-10.4	-0.21
Korea	30.8	2000	24.2	-6.6	-0.21
Mexico	42.0	1985	30.0	-12.0	-0.29
New Zealand	48.0	1986	30.0	-18.0	-0.38
Norway	50.8	1985	28.0	-22.8	-0.45
Switzerland	31.9	1985	21.2	-10.7	-0.34
Turkey	33.0	2000	20.0	-13.0	-0.39
United States	49.8	1986	39.2	-10.6	-0.21
average ^c	43.5		29.2	-14.3	-0.33

^a in percentage points^b in per cent of highest tax rate^c unweighted average

Source: OECD (2010). Taxation of corporate and capital income 1981-2010.

<http://www.oecd.org/dataoecd/26/56/33717459.xls>

regimes, which had previously been used to discriminate in favor or internationally mobile tax bases. At the same time, however, member states remain completely free to set non-discriminatory corporate tax rates in a non-cooperative way. As shown in the theoretical literature, the effects of abandoning discriminatory taxation on the overall ‘aggressiveness’ of tax competition in the EU are fundamentally ambiguous; specifically, the measure may well reduce aggregate corporate tax collections in all countries (Keen, 2001; Janeba and Smart, 2003).³ A case in point is Ireland which employed a split corporate tax rate until 2002, providing preferential tax treatment to sectors in which multinational firms are prominent. When Ireland was forced by the code of conduct to terminate this discriminatory practice, it responded by setting a *general* corporate tax rate of only 12.5% on all corporate profits (see Table 1).

The most important obstacle to effectively constrain corporate tax competition within a union appears to be the fact that, in the presence of country asymmetries, competition for mobile capital creates winners as well as losers. Low-tax countries which benefit from an inflow of capital are unwilling to give up this advantage. In an institutional setting where measures of tax coordination require unanimity among all member states (as is the case in the EU), such conflicts of interest have the potential to block reforms of the status quo, unless side payments can be made to the low-tax countries in exchange for their consent to a reform measure. Making such side payments is difficult, however, because governments often face political resistance against monetary payments in exchange for political concessions from the other side. Moreover, negotiations that involve side payments are typically subject to strategic behavior on the part of the involved parties, resulting in substantial delays for policy reform (Harstad, 2007).⁴

Against this background the present paper analyzes a dual structure of capital taxation.

³Bucovetsky and Haufler (2008) extend this analysis to the case of asymmetric countries and show that both large and small countries may lose from eliminating preferential tax regimes.

⁴An example is the EU savings tax directive, which has introduced a system of information exchange among EU members to reduce the evasion of interest income tax. The directive was proposed in 1998 but it only came into effect in 2005. Some countries who objected to the coordination measure (Austria, Belgium and Luxembourg) were allowed to replace information exchange by a system of interest withholding taxes, phased in gradually over a period of 6 years. No definite time frame has been set for their eventual inclusion of these countries into the system of information exchange. As a monetary compensation, these countries are furthermore allowed to retain 25% of the interest income tax collected. See Nicodème (2009) for an account of these developments.

We propose a mechanism where asymmetric member states of a union agree on some uniform, central tax rate in the first stage, and then non-cooperatively set local tax rates in the second stage. Moreover, total (federal plus regional) tax rates are not allowed to exceed some limit as prescribed by constitutional restrictions, or by mutual agreement.⁵

We show that such a simple mechanism succeeds in reducing tax competition among the members of the union. At the same time, it succeeds in distributing the gains from partial coordination across members in a way that yields a strict Pareto improvement over a one tier system of purely local capital tax competition, without requiring an explicit compensation mechanism. To gain some understanding for these findings, note that the optimal federal tax set in the first stage constrains local tax rates in the second stage. In equilibrium of the second stage, larger countries (who act less aggressively and choose larger local taxes) reach an upper limit in the tax competition game. As a best response, small countries also respond by reducing their tax rate, but they do so by a lesser amount than their larger counterparts. Hence, the tax gap narrows and overall tax revenues rise as a result of introducing a capital tax at the central level. The mechanism works because intuitively, federal taxes help large countries to commit to regional tax rates that are more aggressive than in a one-tier situation, which induce small countries to act less aggressively. Notice that the central tax will never be chosen so large that there is no room for additional local taxes: for federal tax rates that exceed a certain size, the equilibrium tax differential across countries reduces to a level at which small countries would resist to participate in the mechanism. We also show that the basic argument for a two tier tax structure is maintained when costly side payments are allowed for.

Our paper builds on the basic model of asymmetric tax competition in a one-tier setting by Bucovetsky (1991) and Wilson (1991), which we extend to allow for multiple small jurisdictions. It is also related to the literature on tax competition in federal states, but there are important differences. One often studied issue here is that different levels of government simultaneously impose taxes on the same tax base. This gives rise to vertical fiscal externalities and leads to the possibility of excessive taxation within a federation (Edwards and Keen (1996); Wrede, 2000; Keen and Kotsogiannis, 2002). In contrast, we focus on a setting where the taxing powers remains fundamentally in the

⁵This limit on total taxes is not binding at the symmetric, welfare maximizing solution.

hands of the individual members of the union, implying that horizontal externalities dominate in tax competition. Another important element of federations is the existence of fiscal equalization schemes. As the literature has shown, this may reduce tax competition by equalizing either tax revenues or tax bases among the lower levels of government (Köthenbürger, 2002, Hindriks et al., 2008). In our model, the dual tax structure also reduces effective tax competition whereas the underlying mechanism does not require explicit or implicit transfers within the federation.

Our paper can also be linked to the general literature on fiscal federalism (Oates, 1972, Besley and Coate, 2003), where a central issue is the choice between uniformity and differentiation of policies within a federation. Alesina et al. (2005) analyze the federal and local provision of public goods in the presence of interregional benefit spillovers. They find that dual provision of this sort raises welfare for a majority of regions and citizens. Regarding its focus on taxation issues, our paper is closer to Keen and Smith (2000), who propose a two-tier structure for the European value-added tax, with a harmonized central rate and differentiated local tax rates.⁶ Their case for a dual system of value-added taxation is primarily based on administrative concerns and the compatibility with the EU internal market.

This paper proceeds as follows. In Section 2 we set out the basic one tier model of capital tax competition as a benchmark. Section 3 analyzes the dual model of capital taxation, solving first for the non-cooperative local tax rates in the second stage and then for the cooperative choice of the central tax rate in the first stage of the game. Section 4 introduces the possibility of side payments and discusses different modifications of our basic model. Section 5 concludes.

2 One Tier Capital Taxation

We set up a workhorse model of capital tax competition within a union of asymmetric countries. Our model extends the framework of Bucovetsky (1991) and Wilson (1991) to allow for variation in the number of regions. There are two types of countries, large and small, which are indexed by L and S , respectively. The number of large countries is n_L and there are n_S identical small countries. Small and large countries have the same

⁶This resembles the system in some federal countries, such as Canada (see Bird and Gendron, 2000).

per-capita endowment of capital, but differ in their absolute size. The size parameter of the large country is α_L , whereas the size of each small country is α_S with $\alpha_L > \alpha_S$. We interpret the parameters α_i as the population size of country i .⁷ The total number of citizens in the federation, N , is therefore given as

$$n_S \alpha_S + n_L \alpha_L = N. \quad (1)$$

Each region of type $i = S, L$ produces output using a quadratic per-capita production function $f(k_i) = (a - bk_i/2)k_i$, with k_i being the per-capita capital in region i , and a, b being positive parameters. Under autarky, each worker in the union employs the per-capita capital endowment \bar{k} , and the (assumed positive) gross return to capital is $a - b\bar{k} > 0$. Total capital in the union is therefore $K = N\bar{k}$. Capital market clearing in the per-capita notation implies

$$\frac{n_S \alpha_S}{N} k_S + \frac{n_L \alpha_L}{N} k_L = \bar{k}, \quad (2)$$

where the weights $(n_i \alpha_i)/N$ sum to one from (1).

Governments in each country i can raise capital taxes t_i , up to an exogenous level $t^{max} > 0$. This exogenous maximum could be seen as enshrined in the constitution, and must remain below the expropriation level under autarky.⁸ It could also be interpreted as the maximum tax rate that is sustainable in the worldwide competition for mobile capital, which is taken as exogenous in our analysis. Capital is freely mobile across regions. Hence, the net return r is identical everywhere, and given by

$$r = a - bk_i - t_i \geq 0 \quad \forall \quad i. \quad (3)$$

We focus on symmetric equilibria in which all countries of the same type $i = S, L$ choose identical tax rates. From equation (1), we can then define the average tax rate in the union as

$$\bar{t} = \frac{n_S \alpha_S}{N} t_S + \frac{n_L \alpha_L}{N} t_L. \quad (4)$$

We also define the average tax rate in all countries other than country i as

$$\bar{t}_{-i} = \frac{(n_i - 1)\alpha_i t_i + n_j \alpha_j t_j}{N - \alpha_i} \quad \forall i, j \in \{L, S\}, i \neq j. \quad (5)$$

⁷Other interpretations are equally possible. For example, α_i could also stand for the number of production facilities in a respective country.

⁸In Germany, for example, the constitutional court has ruled that the aggregate tax rate on all types of income must not exceed 50%.

The Appendix then shows that capital allocations across countries satisfy

$$k_i^* = \bar{k} + \frac{\bar{t} - t_i}{b}. \quad (6)$$

The (per-capital) capital in each country i is linear in the difference between its own tax rate, and the union wide average rate. Notice that in particular, only the average tax rates but not the composition of taxes across other countries matters for the capital flows into region i .

Note that the federation wide average tax rate in (4) can be written as

$$\bar{t} = \left[\bar{t}_{-i} + \frac{\alpha_i t_i}{N - \alpha_i} \right] \frac{N - \alpha_i}{N} = \beta_i t_i + (1 - \beta_i) \bar{t}_{-i} \quad (7)$$

with $\beta_i = \alpha_i/N \in (0, 1)$. With this notation, region i 's capital as a function of its own tax rate t_i , and the average tax rate of all other regions becomes

$$k_i^*(t_i, \bar{t}_{-i}) = \bar{k} + \frac{(1 - \beta_i)(\bar{t}_{-i} - t_i)}{b}. \quad (8)$$

This representation immediately reveals that k_i^* decreases in t_i , and increases in the average tax rate of all other regions. Also, and since β_i increases in α_i , country i 's per-capita capital endowment varies more strongly in tax differences, the smaller is the population in this country. Intuitively, a rise in country i 's tax rate above the average leads to an outflow of capital that is more substantial when it can be absorbed by a larger population abroad.

Governments in every region i maximize local per-capita tax revenues.⁹ These are

$$R_i(t_i, \bar{t}_{-i}) = t_i k_i^* = t_i \left[\bar{k} + \frac{(1 - \beta_i)(\bar{t}_{-i} - t_i)}{b} \right] \quad \forall i. \quad (9)$$

We are now prepared to explore the optimal regional tax policies. Taxes t_i are set non-cooperatively in order to maximize R_i . For given \bar{t}_{-i} , the first order condition to (9) yields region i 's reaction function

$$t_i^*(\bar{t}_{-i}) = \frac{n\bar{k}}{2(1 - \beta_i)} + \frac{\bar{t}_{-i}}{2} = \frac{b\bar{k}N + n_j\alpha_j t_j}{2N - \alpha_i(n_i + 1)} \quad \forall i, j, i \neq j, \quad (10)$$

⁹Equivalently, each region could maximize its total capital. Tax revenue maximization not only helps to simplify the exposition, but there are different arguments to motivate this objective. Governments may be of a Leviathan type and therefore mostly interested in tax revenue. In a political economy context, the capital poor majority could force government to maximize revenue from the corporate income tax. Whatever its underpinnings, revenue maximization is a frequent assumption in the tax competition literature (see, e.g. Kanbur and Keen, 1993).

where the second step has used (5). Equilibrium taxes are now easily computed as

$$t_i^* = \frac{b\bar{k}N(2N - \alpha_j)}{\rho} \quad \forall i, j \ i \neq j, \quad (11)$$

where

$$\rho = [2N - \alpha_i(n_i + 1)][2N - \alpha_j(n_j + 1)] - n_i n_j \alpha_i \alpha_j \quad i \neq j. \quad (12)$$

Notice that an interior equilibrium requires

Assumption 1: $t^{max} \geq t_L^*$

because otherwise, (at least) the high-tax large region would face a constraint in the choice of its tax rate.¹⁰ We can now state our first result.

Proposition 1: *Consider the one-tier model of asymmetric capital tax competition.*

- a) *For any $(\alpha_L, \alpha_S, n_S, n_L)$, small countries choose taxes more aggressively than large countries, $t_S^* < t_L^*$.*
- b) *The tax ratio $\Delta \equiv t_S/t_L$ is increasing in the size of each small country, α_S , and decreasing in the size of each large country, α_L .*
- c) *The tax ratio $\Delta \equiv t_S/t_L$ is increasing in the number of small countries n_S and it is increasing in the number of large countries n_L .*

Proof: Part a) of the proposition follows directly from the comparison of tax rates in (11) and $\alpha_S < \alpha_L$.

The comparative statics results for $\Delta \equiv t_S/t_L = (2N - \alpha_L)/(2N - \alpha_S)$ show

$$\frac{d\Delta}{d\alpha_S} = \frac{2n_S(\alpha_L - \alpha_S) + (2N - \alpha_L)}{(2N - \alpha_S)^2} > 0, \quad \frac{d\Delta}{d\alpha_L} = \frac{-\alpha_S(2n_L + 2n_S - 1)}{(2N - \alpha_S)^2} < 0.$$

This proves part b) of the Proposition. Finally, part c) is shown by

$$\frac{d\Delta}{dn_S} = \frac{2(\alpha_L - \alpha_S)}{(2N - \alpha_S)^2} > 0, \quad \frac{d\Delta}{dn_L} = \frac{2\alpha_L(\alpha_L - \alpha_S)}{(2N - \alpha_S)^2} > 0. \quad \square$$

The results in Proposition 1 extend previous findings in the literature on asymmetric tax competition (Bucovetsky, 1991; Wilson, 1991). Proposition 1a) shows that the result that small countries underbid their larger neighbours carries over to a setting with a variable number of small and large countries. Proposition 1b) shows that this

¹⁰We assume that net returns to capital remain positive in all countries even when the tax rate t^{max} is imposed.

underbidding by small countries is the more pronounced the larger is the size difference between a typical large and a typical small country, irrespective of the number of jurisdictions of each type. A novel result to the literature is Proposition 1c). It states that any increase in the number of either large or small jurisdictions increases the tax ratio t_S/t_L and hence narrows the tax gap between a large and a small country. Intuitively, when n_S increases underbidding the fixed number of large countries becomes less attractive for each of the small countries, as the resulting capital flows are divided between more small countries. When n_L rises instead, increased tax competition between large countries reduces the tax rate in each of the large countries. The tax rate of small countries will also fall as a result of the positively sloped reaction function (10), but t_S falls by less than t_L in equilibrium.

Using the equilibrium taxes $t_S^* < t_L^*$ in (8) implies $k_S^* > \bar{k} > k_L^*$. On a per-capita basis, capital tax competition makes small countries become more capital rich than large countries. The reduced-form expression for the capital tax bases in both types of countries are

$$k_i^* = \bar{k} \left[1 + \frac{n_j \alpha_j (\alpha_j - \alpha_i)}{\rho} \right] \quad \forall i., i \neq j, \quad (13)$$

where ρ is given in (12). Using this and (11) yields per-capita tax revenues in the non-cooperative tax equilibrium:

$$R_S^* = \frac{b\bar{k}^2 N (2N - \alpha_L)^2 (N - \alpha_S)}{\rho^2}, \quad R_L^* = \frac{b\bar{k}^2 N (2N - \alpha_S)^2 (N - \alpha_L)}{\rho^2}. \quad (14)$$

Analyzing the equilibrium outcome, we can then state:

Proposition 2: *Consider the one-tier model of asymmetric capital tax competition. In equilibrium, per-capita tax revenues in each small country, R_S^* , exceed those in the large country.*

Proof: From (14) the difference in per-capita tax revenues can be transformed to

$$R_S^* - R_L^* = \frac{b\bar{k}^2 N}{\rho^2} (\alpha_L - \alpha_S) [(N - \alpha_S)\alpha_L + N\alpha_S] > 0. \quad \square$$

By choosing a lower tax rate than their larger neighbours, each of the small countries attracts a larger per-capita share of mobile capital in equilibrium. As a result, equilibrium tax revenues are also higher in each small country.

Since equilibrium taxes are below the revenue maximizing level, regional government might have incentives to introduce measures of tax harmonization.¹¹ In fact, aggregate tax revenue in the union would be maximized, if each region chooses the tax rate t^{max} . On the other hand, coordinated action in the absence of side payments does not necessarily constitute a Pareto improvement. This is true in particular for the small countries who take advantage of their minor size to undercut the large region's capital taxes, in order to attract a larger share of total capital. In a cooperative solution in which regions agree to harmonize taxes at any level t , small regions would suffer from a reduction in per-capita capital supply, and a corresponding decrease in government revenues that might well offset the positive effect of a larger common tax rate.

To make this argument precise, let $R_i(t)$ be region i 's tax revenue under a cooperative solution with tax rate t . Comparing this with each region's revenue under decentralized tax competition, as given in eq. (14), a coordinated outcome *cannot* be achieved under a one tier structure of capital taxation iff the following condition holds:

$$R_S^* > R_S(t^{max}) = t^{max} \bar{k}. \quad (15)$$

To understand this condition, notice first that the large country is always in favor of tax coordination: tax harmonization not only helps it to raise its tax rate, but it also gains from a larger (per-capita) capital tax base, relative to the non-cooperative equilibrium. Hence, $R_L^* > R_L(t^{max})$ will never be binding and it is the small regions who decide whether cooperation by all countries is accomplished or not. Second, notice that for each region, the cooperative revenue $R_i(t)$ increases in t . Hence, the case for harmonization is most compelling when regions agree on the maximum tax t^{max} .

Since per-capita tax revenues under tax coordination are exogenously given for each country by the tax rate t^{max} and the per-capita capital endowment \bar{k} (which is equal for all residents in the union), whether or not condition (15) holds depends only on the effects of the exogenous parameters α_i and n_i . These results are summarized in

¹¹Our paper adopts a strict view of tax harmonization, requiring that tax rates are equalized in all countries. An alternative sometimes analyzed in the literature is the setting of a minimum tax rate. As the literature has shown, however, minimum tax rates do not eliminate strategic interactions between countries and results depend strongly on whether tax competition is analyzed in a Nash or a Stackelberg model, and whether minimum tax rates are binding or not. See Kanbur and Keen (1993), Wang (1999) and Konrad (2009). In the present analysis we want to avoid these complications, in order to have a clear reference point for the dual tier structure analyzed below.

Proposition 3: *Tax harmonization fails if (and only if) small countries oppose it. Specifically, harmonization is more likely to fail, when:*

- a) the size of each small region α_S is reduced or the size of each large region α_L is increased;*
- b) the number of small countries n_S or the number of large countries n_L is reduced.*

Proof: See the Appendix. (Still to be done.)

In a symmetric situation where $\alpha_S = \alpha_L$, all countries find tax coordination beneficial. Since the non-cooperative taxes and capital allocations are then symmetric, cooperation in form of harmonizing the maximum tax rate at t^{max} boosts each region's tax revenues. However, the larger is the size differential between the large and a representative small country, the larger is the strategic advantage that each small country has vis-a-vis the large country. Moreover, the gains from tax competition are reduced for each small country, if there is either a larger number of small countries or a larger number of large countries who all compete for mobile capital within the union. Hence each small country prefers tax competition over tax harmonization only if the number of small and the number of large countries is low enough. The interesting implication of Proposition 3b) is that admitting additional members to the union will make it *easier* from an economic perspective to sustain tax coordination between all members, because the expansion reduces the gains from non-cooperation.

The remainder of the paper focuses on an economic scenario where condition (15) is fulfilled and hence tax coordination cannot be achieved under a one-tier structure of capital taxation. The next section introduces a dual-tier system and shows that in such an institutional setting at least partial cooperation is always feasible, even if side payments are ruled out.

3 Dual Tier Capital Taxation

We now explore a scenario that combines capital taxation at the federal level with subsequent taxation at the decentralized level of government.

Suppose that in a *stage 1*, all countries can agree on a uniform federal capital tax T that is refunded to all regions on a symmetric per capita basis.¹² In one possible interpre-

¹²Given that all countries have the same per capita endowment of capital in the present model,

tation, federal tax revenues finance projects that benefit each region in proportion to its size, thus allowing each region to reduce their local expenditures on these projects. An alternative that is particularly relevant in a EU context is that the own resources of the central government are used to reduce the contributions of member states, again in proportion to their size. In our basic model we exclude side payments so that any successful agreement on T must raise the (net) tax revenues of each member state. We assume that the outcome of negotiations is such that regions split the negotiation surplus over the non-cooperative tax equilibrium in a Nash bargaining fashion. Specifically, small countries are characterized by a collective bargaining parameter $\gamma \in [0, 1]$, whereas the bargaining power of the large country is $(1 - \gamma)$.

Subsequently, in a *stage 2*, each country j sets an additional local capital tax t_j . As in the one-tier workhorse model of Section 2, these taxes are chosen in a non-cooperative way. For consistency with the previous model, we also assume that total taxes $T + t_j$ per unit in region j cannot exceed the exogenous level T^{max} , with $T^{max} = t^{max}$ identical to the maximum (local) tax rate in Section 2. Again, we focus on symmetric equilibria.

Using subgame perfection as the appropriate equilibrium concept, the analysis starts with the second stage of the game. Notice that any federal tax T implemented in stage 1 does not bias the inter-regional distribution of capital. Hence, federal taxes do not alter regional incentives to chase the mobile factor, and T affects stage-2 decision making only through its impact on feasible local tax rates. In particular, when setting its local tax rate, each region must satisfy the constraint $t_j \leq T^{max} - T$, a constraint which becomes tighter the larger T is. For the same reason as in the one-tier model, investor gross returns are always positive under Assumption 1 so that no investor will be tempted to withdraw capital from the market.

3.1 Stage 2: Local tax equilibrium

The analysis starts with the stage 2 tax decisions of local governments for varying levels of the federal tax T , as agreed upon in stage 1. To do so, it is convenient to divide the entire range of federal taxes $[0, T^{max}]$ into various regions.

this rule corresponds to the distribution of federal tax revenues according to capital endowments. See Section 4 for further discussion.

Let us begin with Regime I where $T \in [0, T_1]$, and an upper boundary defined by

$$T_1 = T^{max} - t_L^*. \quad (16)$$

Over this range of federal taxes, the equilibrium local tax rates (t_L^*, t_S^*) in the standard model remain feasible.¹³ Federal taxes generate regional lump sum revenues and thus, leave each region's reaction function in the relevant range $t_j \leq t_j^*$ unaltered. As a consequence, the equilibrium in regional taxes does not change and (t_L^*, t_S^*) remains the unique equilibrium.¹⁴ Within Regime I, the only impact of federal capital taxes is thus to raise each region j 's revenues by a per-capita amount TK , which is certainly welcomed by all local governments.

Consider now Regime II, characterized by the interval of tax rates $T \in [T_1, T_2]$. Defining $t_L^{**} = T^{max} - T$, $t_S^{**}(T) = t_S^*(t_L^{**})$ is region S 's best response when L chooses the largest admissible tax. The upper boundary of Regime II is now defined as¹⁵

$$T_2 = T^{max} - t_S^{**}(T_2). \quad (17)$$

For federal taxes larger than T_1 , the constraint not to exceed T^{max} becomes binding for region L , which imposes the higher tax rate under the one tier structure of capital taxation (as well as in Regime I). A local rate t_L^* ceases to be feasible because for any $T > T_1$, total taxes would satisfy $T + t_L^* > T^{max}$. Conversely, provided L opts for t_L^{**} , region S 's maximum-tax constraint is slack until T hits the interval's upper boundary, T_2 . To understand this, notice that $t_S^{**}(T)$ is the small region's unconstrained best response to the large region's boundary tax choice t_L^{**} . This best response is decreasing in T because the reaction function is upward sloping and a larger T reduces t_L^{**} . As long as $t_S^{**} + T \leq T^{max}$, that is, as long as $T < T_2$, the maximum-tax constraint does not bind for region S .

Notice that for any federal tax rate in the interval $T \in [T_1, T_2]$, the free disposal constraint of investors is non-binding.¹⁶ Specifically, the net returns of investors remain positive in all regions, and identical across regions due to the arbitrage condition.

¹³Recall $t_S^* < t_L^*$ and notice that for any $T < T_1$, combined taxes $T + t_L^*$ are less than T^{max} .

¹⁴One can easily check that in the alternate range $t_j > t_j^*$ for $j = S, L$ where the maximum-tax constraint can bind, reaction functions $t_j(t_i)$ become vertical in t_i and cannot cross each other. Intuitively, at a (large) local tax rate where the constraint becomes binding for region j , region i itself would like to lower its own tax rate in a way that no intersection of reaction functions is possible.

¹⁵Note that $T_2 < T^{max}$ because t_S^{**} is decreasing in T and $t_S^{**}(T^{max}) = t_S^*(t_L = 0) > 0$; see below.

¹⁶This is true not only under Assumption 1 but also under the weaker assumption $a > bK + T^{max}$.

What are the equilibrium local tax rates in Regime II? Suppose first that region S does not adjust its tax rate and still sets $t_S = t_S^*$. Then, region L in response adopts $t_L^{**} = T^{max} - T$: region L 's revenues are increasing for any $t_L < t_L^*$ so that its best response is the largest admissible tax rate. At the same time, the best response of region S to t_L^{**} is some t_S^{**} strictly *smaller* than t_S^* because its own reaction function is upward sloping in t_L . Using (11), one can now easily characterize the unique equilibrium $[t_S^{**}(T), t_L^{**}(T)]$ as

$$t_S^{**}(T) = \frac{Kb}{2 - \alpha_S(n+1)} + \frac{(1 - n\alpha_S)}{2 - \alpha_S(n+1)} [T^{max} - T]. \quad (18)$$

$$t_L^{**}(T) = T^{max} - T, \quad (19)$$

with t_S^{**} strictly decreasing in T at a rate less than $1/2$.¹⁷ Hence, an increase in T is matched by an equal reduction in country L 's local tax rate, whereas the local tax rate in each country S falls by less. Therefore, the higher is T the smaller is the tax gap $t_L^{**} - t_S^{**}$ and hence the smaller is the difference in the equilibrium levels of per-capita capital [eq. (8)].

We can also show that the upper boundary of Regime II is *always* smaller than the maximum tax, $T_2 < T^{max}$. Since t_L^{**} is decreasing in T at a rate of one and $t_S^{**}(T^{max}) = t_S^*(t_L = 0) > 0$, $t_S^{**}(T)$ and $t_L^{**}(T)$ must intersect at positive local tax rates in each country.¹⁸ Hence, there must exist a non-empty range of high federal taxes for which the maximum tax constraints of both types of countries are binding at the same time.¹⁹

This final region is Regime *III*, which is comprised of federal taxes in the range $[T_2, T^{max}]$. For any $T \geq T_2$, the local-tax constraint becomes binding for region S as well. Local equilibrium tax rates in all regions are then identical at the level $t_L^{***} = t_S^{***} = T^{max} - T$, and so is the capital endowment in each country. At the maximum federal tax T^{max} , local taxes disappear altogether and all tax revenues are generated at the federal level. Our results are summarized in:

Since $t_L^* > t_S^*$, we have $k_L^* < k_S^*$ and therefore, a net return of $a - bk_L^* - T^{max}$ ($> a - bK - T^{max} > 0$) in region L .

¹⁷For n , the slope of the small country's best response function (18) would be equal to $1/2$. With $n > 1$ the slope is reduced in absolute value, as a result of competition between several small countries.

¹⁸Note that $t_S^{**}(T_2) = t_L^{**}(T_2)$ by the definition of T_2 . When local tax rates are positive at this point of intersection, we have $T_2 < T^{max}$ because $t_L^{**}(T^{max}) = 0$.

¹⁹Intuitively, this must also be true because otherwise, $t_S = T^{max} - T$ would be the best response of small countries to $t_L = T^{max} - T$.

Lemma 1: *The equilibrium local taxes in each region, as a function of the federal tax rate, are characterized as follows:*

$T \in (0, T_1)$ (Regime I): *Tax rates are (t_S^*, t_L^*) , with interior solutions in countries L and S . Tax rates in all regions are the same as in the one-tier model of capital taxation.*

$T \in (T_1, T_2)$ (Regime II): *Tax rates are $[t_S^{**} = t_S^*(T^{\max} - T), t_L^{**} = T^{\max} - T]$, with a boundary solution in L and interior solutions in S . The tax difference $t_L^{**} - t_S^{**}$ is falling in T .*

$T \in (T_2, T^{\max})$ (Regime III): *Tax rates are $[t_S^{**} = t_S^*(T^{\max} - T), t_L^{**} = T^{\max} - T]$, with boundary solutions in L and S . Local tax rates in all regions are identical.*

3.2 Stage 1: Choosing the federal tax rate

We can now analyze which level of the centralized tax rate T will be chosen by the large and the small regions. For this we need to explore each region's total revenues for varying levels of the federal tax.

The analysis of Regime I is straightforward. Since local equilibrium taxes remain unchanged over this range, the capital allocation must remain the same as in the standard model. Hence, for each region j , the effect of increasing T on its overall per-capita tax revenue $R_j^I \equiv TK + t_j^* k_j^*(t_i, t_j)$ is simply

$$\frac{dR_j^I}{dT} = K > 0 \quad \forall j. \quad (20)$$

Hence all regions unambiguously welcome an increase in T towards the interval boundary, T_1 .

The analysis of Regime II is more challenging. Now, the maximum-tax constraint binds for the large region so that this country responds to an increase in T with a one-to-one reduction of its own tax t_L . Conversely, the small regions S remain unconstrained in this range. By responding aggressively and reducing t_S in T at a rate of one, those countries could make sure that the capital allocation remains the same as in Regime I. However, as we have seen above, this is not in their best interest: each region S will opt to reduce t_S at a significantly smaller rate [see eq. (18)] and as a consequence, an

increase in T causes regions S to lose capital to the large country. Formally, per capita tax revenues respond by²⁰

$$\frac{dR_j^{II}}{dT} = K + \left[t_j \frac{dk_j^*}{dt_j} + k_j^* \right] \frac{dt_j^{**}}{dT} + t_j \frac{dk_j^*}{dt_i} \frac{dt_i^{**}}{dT} \quad \forall j, i, j \neq i. \quad (21)$$

For the large region $j = L$, this change in revenue is certainly positive. Not only does the region benefit directly from the increase in federal tax revenues, but it also gains from the softened tax policy of the smaller regions. Denoting the slope of the small countries' best response functions in this region by $dt_S^{**}/dt_L = c < 1$, using $dt_L^{**}/dT = -1$ from (19), and $dk_L^*/dt_S = n\alpha_S/b = -dk_L^*/dt_L = -n\alpha_S/b$, we obtain

$$\frac{dR_L^{II}}{dT} = K - k_L^* + \frac{t_L n\alpha_S}{b}(1 - c) > 0, \quad (22a)$$

which is positive because $k_L^* < K$ and $c < 1$.

For a small country, there are two countervailing effects at work. On the one hand, a larger T raises the region's federal tax revenue. At the same time, region j not only lowers its regional tax rate but loses part of its capital to its larger rival. Observing that for this country the envelope theorem can be applied in (21) and using $dt_L^{**}/dT = -1$ and $dk_S^*/dt_S = -dk_S^*/dt_L$ we obtain

$$\frac{dR_S^{II}}{dT} = K + t_S^{**} \frac{dk_S^*}{dt_S} = K - k_S^* < 0, \quad (22b)$$

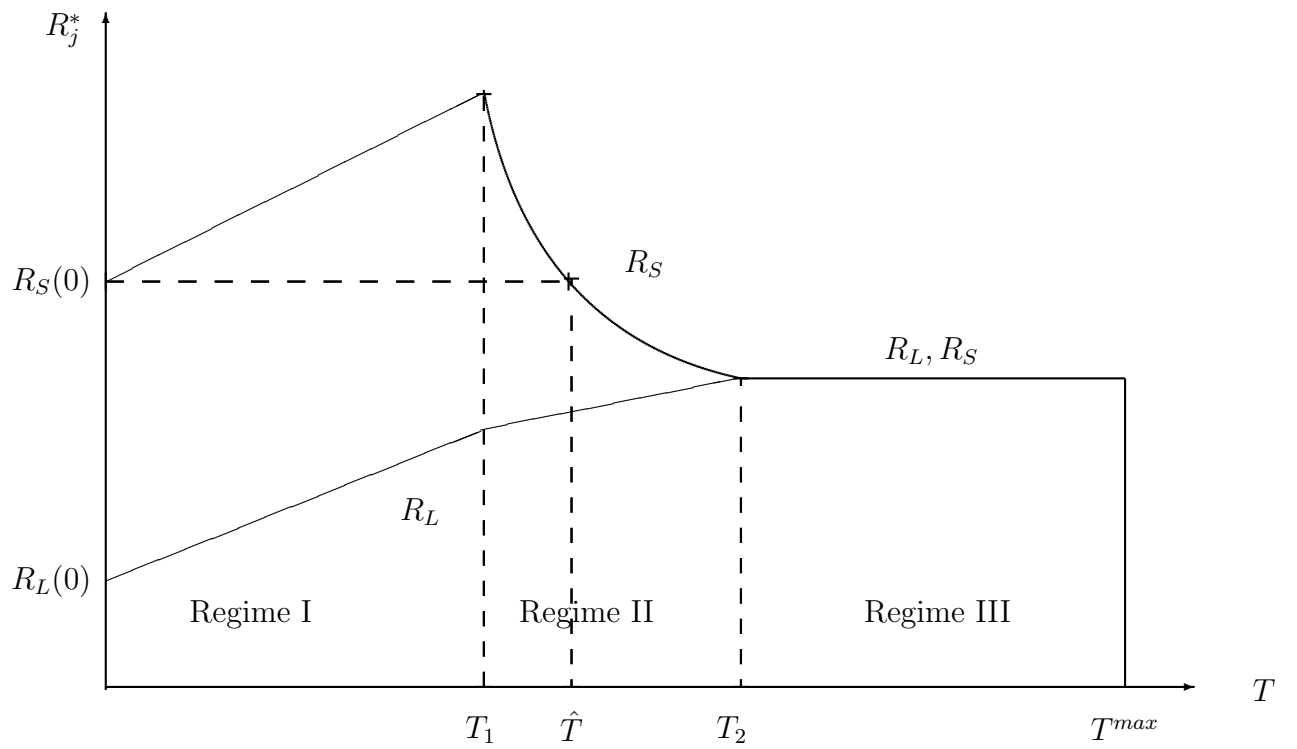
where the second step has used the first-order condition for the optimal (interior) tax rates t_S^{**} . Since $k_S^* > K$, tax revenues in the small countries unambiguously falls throughout Regime II when the federal tax rate T is increased.

Finally, for all federal tax levels across Regime III, the interregional allocation of capital is symmetric, and total unit taxes are at their maximum. Accordingly, revenues $R_j(T)$ are invariant in T , and are identical to those under a cooperative solution with the federal tax rate T^{max} .

Figure 1 illustrates how the per-capita tax revenues of the large and the small countries evolve in the different regimes. The starting point is $T = 0$, where per-capita tax receipts in each small country exceed those in the large country (cf. Proposition 1c). In Regime I (for $T < T_1$), tax revenues are increasing in T in both countries [eq. (20)].

²⁰Notice that, for country L , the envelope theorem cannot be applied for the second term on the right-hand side of (21), because this country's tax rate is exogenously constrained.

Figure 1: Tax revenues in the large and small countries for different levels of T



In Regime II (for $T_1 < T_2$), there is a direct conflict of interests between the large and the small countries, as R_L is increasing in T in this region, whereas R_S is decreasing [eqs. (22a)–(22b)]. Moreover, note that condition (15) implies that $R_S(T_2) < R_S(0)$, as the small country gains from pure local tax competition without a federal tax. This implicitly defines a level of the federal tax $\hat{T} < T_2$ within Regime II, where $R_S(\hat{T}) = R_S(0)$. Finally, in Regime III, per-capita tax revenues are equal in all countries and reach a minimum for the small countries, but a maximum for the large country.

It is then obvious that the mutually agreed upon federal tax rate T must lie in Regime 2 and, more specifically, within the range $[T_1, \hat{T}]$. The reason is that all federal tax rates below T_1 are inefficient, in the sense that revenues in *all* countries could be increased by raising T to T_1 . On the other hand, the small countries will lose from any $T > \hat{T}$, relative to a situation with a federal tax rate $T = 0$, and hence will object such a choice in the absence of side payments.

Which particular federal tax $T^* \in [T_1, \hat{T}]$ is agreed upon, depends on the bargaining position of the two groups of countries. Under Nash bargaining, the initial agreement specifies a $T^*(\gamma)$ that maximizes the generalized Nash product

$$\Delta(T) = [R_S(t_S(T), t_L(T)) - R_S(0)]^\gamma [R_L(t_S(T), t_L(T)) - R_L(0)]^{1-\gamma},$$

where $R_j(0)$ is region j 's revenue under local tax competition with no federal tax. The first-order condition $d\Delta(T)/dT = 0$ yields

$$\frac{\gamma}{1-\gamma} \frac{[-dR_S(T)/dT]}{[dR_L(T)/dT]} = \frac{R_S(T) - R_S(0)}{R_L(T) - R_L(0)}. \quad (23)$$

Note from (22a)–(22b) that the left-hand side of (23) is constant in T and increasing in γ . Since the right-hand side is decreasing in T throughout the relevant range $[T_1, \hat{T}]$, the solution $T^*(\gamma)$ is unambiguously decreasing in the small regions' bargaining parameter γ . Hence the higher is γ , the closer is the federal tax to the level T_1 at which the small countries' tax revenues are maximized.

Our results are summarized in:

Proposition 4: *With dual-tier capital taxation, regions will agree on a federal tax of size $T^* \in [T_1, \hat{T}]$, where the small countries' tax revenues at \hat{T} equal those in the absence of a federal tax. In this coordinated equilibrium the following holds:*

- a) tax revenues in all countries are higher than in the tax competition equilibrium without a federal tax;*

- b) *the local capital tax equilibrium remains asymmetric with $t_S < t_L$ and $k_S > k_L$, but each region L attracts a larger share of capital relative to one-tier tax competition.*
- c) *the negotiated federal tax T^* strictly decreases in γ , the bargaining strength parameter of small countries.. The higher is γ , the larger is the local tax gap ($t_L - t_S$), and the more asymmetric is the allocation of capital.*

Proposition 4 conveys that even if side payments are (politically or otherwise) infeasible, large and small regions find it attractive to agree on a cooperatively set federal tax. We also characterize the range of potential taxes. Specifically, T must be set sufficiently high to have a restraining effect on the local tax choices made by large countries, who set the larger capital taxes in a fully decentralized system. Even with cooperation, local equilibrium taxes will be asymmetric in a dual-tier system, and so will be the allocation of capital. Specifics depend on the relative amount of bargaining power of both regions. If the small country has a sufficient bargaining strength, the federal tax is relatively small, and the positive local-tax gap between large and small countries remains sizable. Conversely, if large regions are in a dominant bargaining position, negotiations yield higher federal taxes and local tax rates are more closely aligned.

4 Discussion and Extensions

In this section we discuss several extensions and modifications of our basic model.

1. *Side payments possible but costly*

As a first alternative to our benchmark model, one can envision a scenario where monetary side payments from one region to the other are feasible but costly. As we have discussed in the introduction, these costs may represent political costs to the negotiating governments because voters resist against monetary inter-regional side payments in exchange for political concessions. In a different interpretation, determining the level of side payments may involve costly delays of policy reform (Harstad, 2007).

Hence, assume that side payments can be made to the small country in exchange for its willingness to agree to a federal tax rate T , but these side payments involve a shadow cost of λ per unit for the large country. To simplify further (and without qualitative effect), we assign all the bargaining power to region L . In this scenario, side payments

from L to S compensate the small country for its loss from a federal tax rate larger than \hat{T} , the rate it would find agreeable in absence of side payments. This payment is described as $s(T) = \max\{R^S(\hat{T}) - R^S(T), 0\}$ for $T \geq T_1$.²¹ The negotiated federal tax T^* maximizes total revenue net of shadow costs, i.e., $R^L(T) + R^S(T) - \lambda s(T)$. Notice that the solution satisfies $T^* \geq \hat{T}$ because for smaller federal taxes, the revenues of small countries exceed $R^S(\hat{T})$ by construction, and $s(T) = 0$. Moreover, the optimization yields a maximizer T^* , which in case of an interior solution $T^* \in [\hat{T}, T_2]$ satisfies

$$\frac{dR^L(T)}{dT} = -(1 + \lambda) \frac{dR^S(T)}{dT}. \quad (24)$$

In words, the optimal T is found at a point where the marginal revenue increase for the L country balances the marginal revenue loss for the small country, weighted with the shadow costs of public funds. Note that an interior solution does not always arise: since total revenues $R^L(T) + R^S(T)$ strictly increase across regime II , a corner solution at $T^* = \hat{T}$ prevails if shadow costs λ are sufficiently high, ie. if side payments are very costly. Conversely, when shadow costs are absent ($\lambda = 0$), regional tax revenues become fully transferable and the federal tax rate is chosen so as to maximize total tax revenues in the union. The bargaining solution T^* must then satisfy $t_j + T = T^{max}$ for all regions $j = L, S$ and, as discussed in the previous section, this is achieved with any $T \geq T_2$. Since total tax revenues in each region remain unchanged once T exceeds T_2 , the equilibrium is not unique in this special case and the outcome of negotiations is found arbitrarily as $T^* \in [T_2, T^{max}]$.

For the leading case of all intermediate shadow costs which support an interior solution $T^* \in [\hat{T}, T_2]$, (24) suggests a unique T^* which is strictly decreasing in λ . As shadow costs λ become very high, the equilibrium level of the federal tax approaches \hat{T} . Conversely, as λ falls, the solution converges to T_2 .

We summarize these results in:

Proposition 5: *Assume that side payments are feasible but subject to political shadow costs λ .*

- a) *For strictly positive levels of λ there is a unique bargaining solution that satisfies $T^* \in [\hat{T}, T_2]$, with T^* decreasing in λ . The capital allocation across countries*

²¹Alternatively, the large country may compensate a small country only for the revenue difference it receives at T , $R^S(T)$, and the one in absence of any agreement on federal taxes, $R^S(0)$. Qualitative results for this case would be qualitatively identical to those discussed in the main text.

remains asymmetric and total government revenues are not maximized.

- b) For $\lambda = 0$, the outcome of negotiations is an arbitrary federal tax $T^* \in [T_2, T^{max}]$, along with properly chosen side payments to small regions. Hence, negotiations yield an efficient outcome.*

Proposition 5 shows that monetary side payments from large to small regions, as part of a negotiated solution, facilitate a more efficient outcome. When shadow costs are absent, total tax revenues are maximized and tax revenues in all countries become completely symmetric. Positive shadow costs lead to a bargaining solution with a smaller federal tax, in order to reduce the need for monetary exchange. The outcome in this case is not fully efficient and the capital allocation remains asymmetric. However, as long as the shadow costs of side payments is not too large, the federal tax rate, and hence aggregate tax revenues, will still exceed those in our benchmark case of Proposition 4.

Intuition may suggest that in a world where side payments are feasible, a dual tier capital tax system is not really needed to direct a more efficient use of resources, and to maximize government revenue objectives. As our analysis shows this intuition is correct only when the political shadow costs associated with monetary side payment are negligible (Proposition 5b). In this case the bargaining solution entails symmetric taxes and hence a symmetric allocation of capital across countries. This outcome can easily be replicated with a single, federal tax, set at level T^{max} , and side payments identical to those in a dual tier system. However, a dual-tier system remains strictly superior, and local taxes cannot completely be replaced by federal taxes, when political shadow costs are more pronounced. In this case the bargaining solution in Proposition 5a calls for a federal tax level that does not completely eliminate local taxes. The asymmetric tax burden between large and small countries persists under the second-best solution, which is incompatible with a uniform federal tax.

2. Timing of federal/local tax decisions

The timing of decisions is important to our arguments. To see this, suppose that in contrast to the above analysis, local tax rates are the long term strategic decision, which means that they are set before the federal tax is agreed upon. Suppose (t_L, t_S) has been chosen in stage 1 and regional governments negotiate the federal tax T in stage 2. Regardless of the choices made in stage 1, both regions now have a common

interest to set T to the maximum admissible level, $T = T^{max} - \hat{t}$ with $\hat{t} = \max\{t_S, t_L\}$. The reason is simple. In the present setting, T neither affects local taxes nor the interregional capital allocation. Instead, the federal tax only determines the total tax burden of investors. Hence, each region wishes to implement a federal tax as large as possible.

But this coherence of ex-post preferences has important implications for the tax equilibrium in stage 1. Specifically, large regions lose their interest to choose relatively high local taxes. Suppose the stage-1 equilibrium satisfies $t_i > t_j$ for countries i, j . Then, country i would like to lower its taxes (at least) to t_j : since $T = T^{max} - t_i$ in this range, lowering t_i leaves region i 's effective tax $t_i + T$ unaffected, while at the same time raising the region's capital endowment.

By the same token, raising t_i in a symmetric situation with $t_i = t_j$ cannot benefit i because its own capital allocation shrinks while its effective total tax rate $t_i + T$ does not. As these arguments show, only symmetric tax rates can potentially be sustained in equilibrium. And in fact, a combination of identical regional tax rates $t_L = t_S = 0$ forms an equilibrium.²²

We thus find that timing is crucial: federal taxes must be designed as long run, strategic choices. In a dual tier scenario in which regions move first and federal taxes are set subsequently, the capital allocation would be symmetric and the outcome of a one-tier federal taxation would be replicated. Clearly, small regions do not find such a regime agreeable if they oppose uniform taxes (or a one-tier federal tax) in the first place.

3. Federal tax allocation proportional to equilibrium capital

Remember that in our baseline model, we assume federal tax revenue to be spent on a per capita basis – or, equivalently, in proportion to capital endowments. As a possible alternative, suppose now that spending is proportional to the equilibrium level of capital *employed* in each country, so that regional (per capita) tax revenues

²²In addition, any combination of identical taxes $t_L = t_S$ which is small enough (in particular, sufficiently smaller than t_S^*) that S does not find it beneficial to undercut t_L , forms an equilibrium. To see that positive tax rates with this property exist, note that in tax competition, both countries' reaction functions are increasing with $t_i^*(t_j = 0) > 0$ and unique intersection at $t_L^* > t_S^*$. Consequently, there exists a strictly positive $t_L (< t_S^*)$ for which $t_S^*(t_L) = t_L$ holds. For any smaller t_L , region S 's best response would be $t_S^*(t_L) > t_L$ in the basic tax competition model, and $t_S^*(t_L) = t_L$ in our two-tier model where raising taxes above those of an opponent can never be profitable.

become $R_j = (t_j + T)k_j^*(t_i, t_j)$. In this latter scenario, federal taxes are now completely neutral: they cease to have any effect on either capital allocation, or equilibrium tax revenues.²³ To see this, note that replacing a region's strategic tax variable t_j by the new variable $\tilde{t}_j = t_j - T$, it is obvious that the new equilibrium in local taxes satisfies $\tilde{t}_j^* = t_j^* - T$. Intuitively, regions can undo the federal tax in stage 2, so that the overall economic results are the same as in the absence of such a tax.

This argument must be modified, however, when taxes are subject to a non-negativity constraint. Note first that small federal taxes T do not constrain any country's ability to set its preferred local tax rate (Regime I), but substantial federal taxes do. Since $\tilde{t}_S^* < \tilde{t}_L^*$, the non-negativity constraint first becomes binding for small countries (Regime II). These countries will then set the boundary tax $\tilde{t}_S^* = 0$, which reduces the tax gap between large and small countries. Union-wide tax revenues increase in T while the revenues of region S shrink.²⁴ With an even larger T , the constraint $t_L \geq 0$ becomes binding for large countries as well (Regime III). Only federal taxes are now levied, and all regional revenues naturally increase in T to the point where $T = T^{max}$.

In this scenario, small regions will *not* agree on a federal tax if our initial condition (15) holds. This is because, in contrast to the base model, tax revenues of the small region do not increase in Regime I. Clearly, designing a two-tier system in this way is of no help, in contrast to a system that distributes federal tax revenues in proportion to capital *endowments*, that is, on an equal per capita basis.

A different issue is how the distribution rule has to be modified when capital endowments also differ between large and small countries. In a setting where private income also matters for governments (see point 4. below), this would require to distribute federal tax revenues in proportion to capital endowments, rather than on an equal per capita basis, in order to avoid redistributive effects. One possibility would be to tie the distribution of federal tax revenue to the capital tax base that is reported in each country. This solution would also have the desirable side effect of giving each country an added incentive to fight the evasion of individual capital income taxes.

²³This neutrality of federal taxes holds unless additional constraints on tax rates exist; see the discussion below.

²⁴The reasoning is thus very similar as in section 3.2 [eq. (22b)]. However, the reduced tax gap now results from the fact that the tax rate of the small countries is constrained from below, whereas in our benchmark model the tax rate of the large region was constrained from above.

5 Conclusions

Our paper starts out from an empirically relevant economic situation in which asymmetric countries within a federation compete for mobile capital. Decentralized taxation yields equilibrium taxes lower than efficient. Moreover, small countries (with a smaller total capital endowment) tax more aggressively, and they attract foreign capital from larger countries. Hence, small countries may benefit from tax competition, which may lead them to resist a reform towards capital tax harmonization.

We propose a two tier tax structure to mitigate this problem. The asymmetric member states of a union choose a common, central tax rate in the first stage, and then non-cooperatively set local tax rates in the second stage. As has been shown in the model, this mechanism effectively reduces tax competition between the members of the union, without completely eliminating tax differences. At the same time, the dual tax structure ensures that the gains from partial coordination are distributed across the federation members in a way that yields a strict welfare improvement for any member countries, ie, a Pareto improvement over a one tier system of decentralized capital tax competition.

Aggregate tax revenues increase notwithstanding the fact that federal taxes constrain local tax rates in the second stage. In equilibrium, this constraint forces larger countries to *reduce* their local taxes in the tax competition game; while small countries respond by also reducing their tax rate, they do so by less than their large neighbors. As a consequence, the tax gap narrows, which allows overall tax revenues to rise as a result of introducing a capital tax at the central level. These advantages of a dual tax structure were shown to extend to a more realistic scenario in which costly interregional side payments are feasible.

The results of our analysis have direct policy implications for federations that maintain strong taxing powers of its individual member states, such as the European Union. A crucial insight of our model is that the European Union should not attempt a complete tax harmonization, which may be politically infeasible because of its adverse effects on small countries. Rather, the Union may want to introduce an additional federal corporation tax, with proceeds being used to finance union wide public good investments in an equitable way. Alternatively, proceeds may be used to reduce contributions of member states that are directly linked to a country's GDP, a good proxy for a country's capital endowment.

Appendix

Derivation of equation (6)

Multiplying the arbitrage condition (3) with the weights $(n_S\alpha_S)/N$ and $(n_L\alpha_L)/N$, respectively, gives

$$\frac{n_i\alpha_i}{N} a - \frac{n_i\alpha_i}{N} b k_i - \frac{n_i\alpha_i}{N} t_i = \frac{n_i\alpha_i}{N} r \quad \forall i \in \{S, L\} \quad (\text{A.1})$$

Summing over these two terms and using (1), (2) and (4) gives

$$a - b\bar{k} - \bar{t} = r \quad (\text{A.2})$$

Subtracting (3) from (A.2) and rearranging yields (6).

Proof of Proposition 3

We differentiate R_S^* in (14) with respect to α_i and n_i . A positive effect of an exogenous parameter on R_S^* implies that tax competition becomes more attractive for a representative small country, and hence coordination is more likely to fail.

For the effects of α_S we get

$$\begin{aligned} \frac{\partial R_S^*}{\partial \alpha_S} = \frac{b\bar{k}^2}{\rho^3} \{ & [2(2N - \alpha_L)(N - \alpha_S)n_S(4N - \alpha_L) + (2N - \alpha_L)^2(n_S - 1)] \rho \\ & - 2N(2N - \alpha_L)^2(N - \alpha_S)(\partial\rho/\partial\alpha_S) \} \end{aligned}$$

where

$$\frac{\partial\rho}{\partial\alpha_S} = 4N(n_S - 1) + \alpha_L(3n_L - n_S + 1)$$

This can be rearranged to

$$\frac{\partial R_S^*}{\partial \alpha_S} = \frac{b\bar{k}^2}{\rho^3} [N(2N - \alpha_L)^2 N(n_S - 1)\phi_1 + (2N - \alpha_L)(N - \alpha_S)\phi_2] \quad (\text{A.3})$$

where

$$\phi_1 = \rho - 8N(N - \alpha_S); \quad \phi_2 = n_S\rho(4N - \alpha_L) - 2N\alpha_L(2N - \alpha_L)(3n_L - n_S + 1).$$

(To be continued.)

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