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

Andreas Haufler
University of Munich and CESifo

Christoph Lülffesmann
Simon Fraser University and CESifo

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2Seminar for Economic Policy, Akademiestr. 1/II, D-80799 Munich, Germany. Phone: +49-89-2180-3858, e-mail: Andreas.Haufler@econ.lmu.de.

3Department of Economics, Simon Fraser University, 8888 University Drive, Burnaby BC, V5A 1S6, Canada. Phone: +1-(778)-782 8504, e-mail: cluelfes@sfu.ca.
Abstract

The tax competition for mobile capital, in particular the reluctance of small countries to agree on measures of tax coordination, has ongoing political and economic fallouts within Europe. We analyse the effects of introducing a two tier structure of capital taxation, where the asymmetric member states of a union choose a common, federal 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. Moreover, it distributes the gains across the heterogeneous states in a way that yields a strict Pareto improvement over a one tier system of purely local tax choices. We also discuss the effects of diverging capital endowments within the union and capital flows to third countries.

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

**JEL Classification:** H25, H77, H87
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 roughly half of all worldwide inflows and outflows (Barba Navaretti and Venables, 2004). Moreover, the growth of FDI has also been stronger in Europe than elsewhere, as a result of deepening economic integration in the European Union (EU). With capital mobility being particularly high in Europe, tax competition can also be expected to be more aggressive. And indeed, recent empirical work confirms the existence of strategic interaction in corporate tax setting among OECD countries in general, but in particular among the member states of the EU (Devereux et al., 2008; Cassette and Paty, 2008; Redoano, 2014).\(^1\)

The implication of tax competition are very different across countries, however. In particular, a substantial theoretical and empirical literature starting with Bucovetsky (1991) and Wilson (1991) has shown that small countries will undercut their larger neighbours in the tax competition equilibrium, as those countries display a higher elasticity of their capital tax base. Moreover, this differential tax response works to the advantage of small countries, which benefit from an inflow of capital to their jurisdiction.

Table 1 illustrates these findings for the EU-15 member states, differentiating between small and large countries. Since the mid-1990s, corporate tax rates in the small EU member countries have been substantially lower, on average, than in the large EU member states.\(^2\) At the same time, small EU countries are characterised by a larger share of corporate profits, as a share of GDP, indicating an inflow of capital into these countries. In sum, small EU countries have achieved higher shares of corporate tax revenues to GDP than their larger neighbors despite - or because of - their lower tax rates. A prominent example for this pattern is Ireland which sets a very low tax rate, attracts a large amount of foreign capital, and as a consequence, features a very

\(^1\) In the well-known study of Devereux et al. (2008), 15 of the 21 countries in the sample are members of the EU. Hence, this contribution is to a large extent a study on strategic tax interaction in Europe.

\(^2\) An important factor not covered in Table 1 is tax competition from the new EU member states in Central and Eastern Europe. On average, statutory corporate tax rates in these countries were around 20% in 2010, and thus even lower than in the small EU-15 states.
Table 1: Corporate tax rates and tax revenues in EU and non-EU countries

<table>
<thead>
<tr>
<th>statutory tax rate&lt;sup&gt;a&lt;/sup&gt;</th>
<th>corporate profit share&lt;sup&gt;b&lt;/sup&gt;</th>
<th>corporate tax revenue&lt;sup&gt;c&lt;/sup&gt;</th>
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**large EU-15 countries (population > 20 million)**

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**small EU-15 countries (population < 20 million)**

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**large non-EU countries (population > 20 million)**

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<td>United States</td>
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<sup>a</sup> including state and local taxes  
<sup>b</sup> gross operating surplus in % of GDP  
<sup>c</sup> in % of GDP  
<sup>d</sup> unweighted average  
<sup>e</sup> 2002

**Sources:**  
OECD (2012), Table 11 http://dx.doi.org/10.1787/888932720948  
OECD Tax Database (http://www.oecd.org/tax/tax-policy/tax-database.htm)  
UN National Accounts Official Country Data, Tables 1.1 and 4.8.  
substantial corporate tax base.\(^3\)

Table 1 also includes some large non-EU countries. On average, these countries have maintained higher tax rates and secured larger shares of corporate tax revenues than the large EU countries. The numbers suggest that non-EU countries were less exposed to the forces of tax competition than EU members.

As indicated by these developments, the most important obstacle to effectively constrain corporate tax competition within a union appears to be the existence of winners (and losers) under the existing system. 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 redistributive side payments can be made to the low-tax countries in exchange for their consent to a reform. Making such transfers is difficult, however, because governments often face political resistance against monetary disbursements 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).\(^4\)

These political economy issues are likely to explain why no attempt for tax rate harmonisation has been made in the European Union for the last twenty years, since the failed attempt of the Ruding Committee (1992) to establish a harmonised minimum corporate tax rate of 30% among EU member states. Instead, the EU has focused on other areas of corporate taxation, such as the elimination of preferential tax regimes\(^5\), or the proposal to establish a common consolidated corporate tax base for multinational

\(^3\)Another factor relevant for diverging corporate profit and tax revenue shares is profit shifting by multinational firms into small, low-tax European countries. This factor is likely to be the main explanation for the very high tax revenue share of Luxembourg. More generally, however, a meta analysis by de Mooij and Ederveen (2008) explicitly compares the elasticities of corporate investment versus profit shifting decisions in response to international tax differentials and finds them to be of comparable magnitude.

\(^4\)An example of such delays is the EU savings tax directive, which has introduced a system of information exchange to reduce the evasion of interest income tax. The directive was proposed in 1998 but it only came into effect in 2005. Even then, several small countries that had objected to the coordination measure (Austria, Belgium and Luxembourg) were allowed to gradually phase in the reform over several years, and to keep part of the taxes collected from foreigners in the transition.

\(^5\)See Nicodème (2009) for an account of the policy developments in this area.
companies (European Commission, 2011). Under both of these coordination measures, member states remain completely free to set (non-discriminatory) corporate tax rates in a non-cooperative way. Several analyses have concluded that these measures will not reduce the incentives to engage in tax competition, and they may even offer further arguments for tax rate harmonisation (Keen, 2001; Bettendorf et al., 2010).

Against this policy background, we explore an economic model where ‘small’ members of the federation are the winners of tax competition, and have no incentive to agree on a common federal tax on capital. To remedy this situation, the paper proposes a dual structure of capital taxation where the asymmetric member states of a union agree on some uniform, federal tax rate in the first stage, and then non-cooperatively set local tax rates in the second stage. We show that such a simple mechanism succeeds in reducing tax competition among the members of the union. At the same time, it distributes 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 payment mechanism to compensate potential ‘losers’. This last property makes our analysis especially relevant for a union of countries that starts out with weak taxing powers at the federal level, as is true, for example, for the EU.

The beneficial effects of a dual capital tax arise because this structure combines the advantages of a uniform federal tax with the advantages that decentral taxation rights provide to small members in the federation. The federal tax raises aggregate revenues within the union when the intra-union competition for mobile capital is the binding constraint for tax policy. In the dual tax equilibrium, this positive revenue effect is achieved by distributing the proceeds of the federal tax in proportion to each country’s capital endowment. At the same time, permitting each country to levy additional local taxes in a non-cooperative way preserves the tax advantage that small countries enjoyed prior to the reform. While this tax advantage is shown to be less pronounced than in a purely decentralised system, the continued right to tax locally ensures tax coordination to become agreeable for all asymmetric member states within the union.

In the tax optimum that results under such a dual capital tax, the sum of federal and local tax rates will be constrained by the worldwide competition for mobile capital. Given the asymmetric local taxes, this constraint will be binding only for the large,

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6In technical terms, the distribution of federal tax revenues follows the residence principle, whereas local taxes are levied under the origin principle.
high-tax countries. As a result the tax gap narrows in equilibrium, relative to a one tier capital structure, leading to greater production efficiency in the union. At the same time, the federal tax will never be chosen so high that there is no room for additional local taxes: if the federal tax rate becomes ‘too high’, the local tax differential shrinks to a level at which small countries would refuse to participate in the mechanism. Hence the equilibrium tax structure will always feature positive federal and local tax rates.

A critical assumption underlying our analysis is that intra-union tax competition is stronger than the simultaneous tax competition between union members and the rest of the world. There are, however, good theoretical and empirical reasons for this presumption. From a theoretical perspective, tax harmonisation within a subgroup of countries is welfare improving whenever the union is large in the world economy (Konrad and Schjelderup, 1999; Sørensen, 2004; Conconi et al., 2008). Moreover, tax competition within the union can be expected to be particularly severe, as European countries offer otherwise similar location conditions. The substitutability of locations in different EU member states arises from economic integration in the common European market, but also from common technological standards and a common top level of the judiciary. Any location rent that arises from the existence of the common market can thus be taxed by the union as a whole, but only if competition between its members is prevented (Keen, 1993; Haufler and Wooton, 2006). Empirically, several studies suggest that foreign direct investment responds more sensitively to international tax differentials within an economic union (Devereux and Griffith, 1998; Grubert and Mutti, 2000), and that strategic tax interaction is stronger between the members of a union than with outside countries (Davies and Voget, 2011; Redoano, 2014).

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 jurisdictions of each type. It is also related to the literature on tax competition in federal states, but there are important differences. One often studied issue in the federalism literature 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 (Wrede, 2000; Keen and Kotsogiannis, 2014).

\[\text{An additional factor that affects tax competition within a union, but is not covered in our analysis, is labour mobility. See Kessler et al. (2002) and, more recently, Wildasin (2011) for tax competition models that include both labour and capital mobility.}\]
2002). In contrast, we focus on a setting where horizontal externalities dominate in tax competition. Another important element of federations is the existence of fiscal equalisation schemes. This literature has shown that redistributive transfer schemes imposed by the federal government reduce the incentives for tax competition (Köthenbürger, 2002, Hindriks et al., 2008). The resulting allocation is not a strict Pareto improvement, however, as revenue sharing generally occurs at the expense of jurisdictions with a large corporate tax base. In our model, the dual tax structure also reduces effective tax competition, but the underlying mechanism generates utility gains for all the heterogeneous countries, and it is therefore unanimously agreed upon.

We also contribute to the general literature on fiscal federalism (Oates, 1972, Lockwood, 2002; Besley and Coate, 2003; Janeba and Wilson, 2011), where a central issue is the choice between uniformity and differentiation of policies within a federation. Regarding its focus on taxation issues, our paper is closest to Keen and Smith (1996), who propose a two tier structure for the European value-added tax, with a harmonised federal rate and differentiated local tax rates. Their case for a dual system of value-added taxation is primarily based on administrative concerns and the compatibility with the EU internal market, however, rather than on mitigating tax competition as in the present paper.

Finally, our analysis can be linked to the growing literature on the dual provision of goods and services, as pioneered by Epple and Romer (1996). This literature explores a scenario where a group of ‘agents’ — which can be states within a federation - provides a publicly provided good through a two tier mechanism (see also Cremer and Palfrey, 2000; Fernandez and Rogerson, 2003; Alesina et al., 2005). In a first stage, group members take a political decision over collective funding via majority vote, and share the ‘publicly provided’ good in a uniform fashion. In a second stage, each agent is allowed to ‘top up’ her personal consumption of the good by privately buying additional amounts. Alesina et al. (2005), for example, analyse the federal and local provision of public goods in the presence of interregional benefit spillovers and find that dual provision of this sort raises welfare for a majority of regions and citizens. Our paper shares the main finding of this literature about the desirability of a dual structure of decision making in a federation. However, we crucially differ from earlier contributions in using unanimity as the collective choice rule when states decide on the federal tax.

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 analyses 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 federal tax rate in the first stage of the game. Section 4 discusses several modifications and extensions of our basic model. In particular, we discuss alternative ways to disburse the proceeds from the federal tax, and we incorporate diverging per capita endowments in small and large countries and capital flows from the union to the rest of the world. Section 5 concludes.

2 One Tier Capital Taxation

2.1 Asymmetric tax competition

We set up a workhorse model of capital tax competition within a union of asymmetric countries. Our model extends the analysis in Bucovetsky (1991) and Wilson (1991), where two countries of different size compete against each other, to allow for a variable number of both small and large countries. This implies that in our model there will be tax competition within the groups of small and large countries, as well as competition between countries of different size.

We index the two groups of countries, large and small, by $L$ and $S$, respectively. There are $n_L$ identical large countries and $n_S$ small countries, where $n_L$ and $n_S$ are sufficiently small so that strategic interaction between countries remains relevant. In our benchmark model small and large countries differ only in their absolute sizes, but have the same per capita endowment of capital.\(^8\) We normalize the total population in the union to be unity. The population share of a single large country is given by $\alpha_L$, whereas the population share of each small country is $\alpha_S$, with $\alpha_L > \alpha_S$. The adding-up constraint for the entire union’s population is then

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

Each worker in the union has the same per capita capital endowment $e$. Since we normalize the union’s population to be one, this is also the total capital stock in the union. Capital is freely mobile across jurisdictions, implying that the per capita capital stock employed in each country, $k_i$, may differ from this country’s capital endowment. Each country $i$ of type $j = S, L$ produces output using a quadratic per capita production

\(^8\)The assumption of equal per capita endowments will be relaxed in Section 4.2.
function \( f(k_i) = k_i(a - bk_i/2) \), with \( a \) and \( b \) being positive parameters. Capital market clearing implies

\[
n_S \alpha_S k_S + n_L \alpha_L k_L = e. \tag{2}
\]

Due to perfect capital mobility, the net return to capital must be identical everywhere. We introduce local capital taxes \( t_i \) that are levied under the source principle.\(^9\) The net return to capital \( r \) then equals

\[
r = a - bk_i - t_i > 0 \quad \forall \quad i, \tag{3}
\]

which we assume to be positive in all countries.\(^\text{10}\)

To isolate the strategic incentives that exist for each individual country in our model with several countries of each type, it will be useful to define average tax rates on a per capita basis. Specifically, define the federation wide average (per capita) tax rate in all countries \( m \) other than \( i \) as

\[
\bar{t}_{-i} = \frac{1}{1 - \alpha_i} \sum_{m \neq i} \alpha_m t_m.
\]

Then the federation wide average tax rate can be written as

\[
\bar{t} = \left[ \bar{t}_{-i} + \frac{\alpha_i t_i}{1 - \alpha_i} \right] (1 - \alpha_i) = (1 - \alpha_i) \bar{t}_{-i} + \alpha_i t_i. \tag{4}
\]

Invoking the arbitrage condition (3), country \( i \)'s capital stock, as a function of its own tax rate \( t_i \) and the average tax rate in the rest of the union, can now be written as\(^\text{11}\)

\[
k^*_i(t_i, \bar{t}_{-i}) = e + \frac{(1 - \alpha_i)(\bar{t}_{-i} - t_i)}{b}. \tag{5}
\]

Equation (5) immediately reveals that \( k^*_i \) is decreasing in \( t_i \) and increasing in the average of tax rates in all other countries.\(^\text{12}\) Also, the lower is country \( i \)'s weight \( \alpha_i \), the more does the per capita capital employed vary in the tax difference \((\bar{t}_{-i} - t_i)\).

\(^9\)The source principle implies that capital is taxed in the country where it is employed, whereas the country in which the capital owner resides exempts this income from tax. For the corporate tax, this scheme is employed by almost all OECD countries, with the notable exception of the United States.

\(^\text{10}\)See Bucovetsky (1991, sec. 4) for an analysis of the (mild) conditions that rule out Nash equilibria in an ‘excess supply’ regime with a zero return to capital.

\(^\text{11}\)Multiplying the arbitrage condition (3) with the weights \( n_{SOS} \) and \( n_{LLO} \), respectively, and summing over these two terms gives \( a - be - \bar{t} = r \). Subtracting this from (3) and using (4) yields (5).

\(^\text{12}\)Specifically, notice that country \( i \)'s capital stock only depends on an aggregate of the taxes in other countries, that is, the composition of those tax rates does not matter in our linear model.
Each government maximizes the welfare of its representative consumer, which is a linear function of private and public good consumption. As is standard in this literature, the public good is a quasi-private good, i.e., there are no economies of scale in its provision. This assumption is made to avoid differences in per capita welfare that are unrelated to differences in country size (cf. Wilson, 1991). Moreover, the marginal rate of substitution between the public and the private good is constant and given by $\varepsilon > 1$. One possible motivation for this specification is that countries finance most of their spending thorough a large, distortionary tax (such as the personal income tax), which creates an excess burden of $\varepsilon - 1$ per unit of tax revenue collected. Higher revenue collections from the corporate tax can then reduce the distortion from this other tax while keeping the overall level of public good supply constant.\footnote{See e.g. Keen and Lahiri (1998) for a similar motivation and an application in a different tax policy setting. In our setting, the assumption finds support in the empirical fact that corporate income tax revenue accounts for less than 10% of total tax receipts (including social security contributions) in most OECD countries. Cf. the figures in Table 1.}

Hence, each government’s objective function is $u_i = c_i + \varepsilon R_i$, where $c_i$ is private consumption and $R_i$ is corporate tax revenue, both in per-capita terms. Private consumption is given by the residual income from domestic production, $f(k_i) - f'(.)k_i$, plus the net return to its capital endowment in the arbitrage equilibrium, $e(f'(.) - t_i)$. Using the properties of the quadratic production function gives the welfare function

$$u_i = c_i + \varepsilon R_i = \frac{b}{2} k_i^2 + e(a - bk_i - t_i) + \varepsilon t_i k_i.$$  \hfill (6)

We are now prepared to explore the optimal tax policies in each country. Taxes $t_i$ are set non-cooperatively in order to maximise $u_i$. Using the response of the domestic capital stock from (5) gives the first-order condition

$$(k_i - e)b \frac{\partial k_i}{\partial t_i} - e + \varepsilon \left[ k_i + t_i \frac{\partial k_i}{\partial t_i} \right] = 0.$$  \hfill (7)

In a second step, we substitute the equilibrium capital stock and its derivative with respect to $t_i$ from (5). For a given vector $t_{-i}$, this yields country $i$’s best response function

$$t_i^*(t_{-i}) = \frac{b(\varepsilon - 1)e}{(1 - \alpha_i)(2\varepsilon - 1 + \alpha_i)} + \frac{(\varepsilon - 1 + \alpha_i)}{(2\varepsilon - 1 + \alpha_i)} \bar{t}_{-i}.$$  \hfill (8)

In a symmetric equilibrium, all countries $i$ of type $j$ choose an identical tax rate. As a result, average equilibrium tax rates in countries other than $i$ (with country $i$ being of
type $j$) satisfy
\[ \bar{t}_j = \frac{(n_j - 1)\alpha_j t_j + n_h \alpha_h t_h}{1 - \alpha_j} \quad \forall j \neq h. \]  
(9)

Substituting this in (5) and using (1) gives each country’s capital stock, as a function of the tax differential between country types
\[ k_j = e + \frac{n_h \alpha_h (t_h - t_j)}{b} \quad \forall j \neq h. \]  
(10)

Moreover, using (9) in (8) gives equilibrium taxes for each country type $j = S, L$, as a function of the other type’s tax rate
\[ t_j^* = \frac{b(e - 1)e + (\varepsilon - 1 + \alpha_j)n_h \alpha_h t_h}{\varepsilon[2 - \alpha_j(n_j + 1)] - (1 - \alpha_j)(1 - \alpha_j n_j)} \quad \forall j \neq h. \]  
(11)

Equilibrium taxes in reduced form can then be computed as
\[ t_j^* = \frac{b e(e - 1)[(1 - \alpha_h) + (\varepsilon - 1) + \alpha_j \alpha_h (n_j + n_h)]}{\rho} \quad \forall j \neq h, \]  
(12)

where the denominator (the product of the two denominators in eq. (11)) is computed in the appendix and given by
\[ \rho = \frac{\varepsilon^2[2 - \alpha_j(1 + n_j \alpha_j) - \alpha_h(1 + n_h \alpha_h) + \alpha_j \alpha_h]}{(1 - \alpha_j)(1 - \alpha_h)}. \]  
(13)

From (12) it is straightforward to derive the equilibrium tax differential between a large and a small country:
\[ t_L^* - t_S^* = \frac{b e (\varepsilon - 1)(\alpha_L - \alpha_S)}{\rho}. \]  
(14)

Hence, the large country unambiguously levies the higher tax rate and the tax differential is the larger, the higher is the valuation of tax revenues ($\varepsilon$) in all countries. The final step is to substitute the equilibrium tax rates in (12) along with the resulting tax bases (10) into the welfare function (6). This gives
\[ u_j^*(t_j^*) = \frac{b}{2} k_j^2(t_j^*, t_h^*) + e[a - bk_j(t_j^*, t_h^*) - t_j^*] + \varepsilon t_j^* k_j(t_j^*, t_h^*) \quad j \neq h. \]  
(15)

In Appendix 1 we show that per capita utility in each small country exceeds the per capita utility level in a large country. We can then state:

**Proposition 1** In the one tier model of asymmetric capital tax competition, small countries choose taxes more aggressively than large countries, $t_S^* < t_L^*$, and attract more capital in per capita terms, $k_S^* > k_L^*$, for any $(\alpha_L, \alpha_S, n_L, n_S)$. Moreover, small countries display a larger welfare per capita than large countries.
Proof: The first result follows directly from (14) and $\alpha_S < \alpha_L$. The second result follows from substituting (12) in (10). For the last result, see Appendix 1.

Proposition 1 extends previous findings in the literature on asymmetric tax competition (Bucovetsky, 1991; Wilson, 1991). Their basic insight that small countries underbid their larger neighbours carries over to our setting where tax competition occurs not only between large and small countries, but also within each size group. Capital arbitrage then implies $k_S^* > e > k_L^*$. By setting a lower tax rate than their larger neighbours, each of the small countries attracts a larger per capita share of mobile capital in equilibrium.

A simple revealed preference argument then shows that this strategy must yield higher utility: a small country could simply replicate the utility of a large country by raising its tax to $t_L^*$. Moreover, when a small country deviates and chooses $t_L^*$ instead of $t_S^*$, it not only replicates the per capita welfare of a large country but, by reducing the number of low-tax players, it increases welfare in each large country above $u_L^*$. Hence the small country will underbid only if this raises its welfare beyond this reference level.

Proposition 1 also corresponds closely to the empirical evidence for the EU-15 countries. As Table 1 shows, the small union members have lower corporate tax rates, on average, than the larger members. At the same time, per capita corporate tax revenues of the small EU countries are higher, on average, than in larger EU states, suggesting that small countries have been able to attract internationally mobile capital and profit tax bases from their larger neighbours.\footnote{See Romalis (2007) for an empirical evaluation of the growth-enhancing role of low corporate taxes in Ireland.}

\subsection*{2.2 Tax harmonisation}

We now assume that governments in all countries have the option to harmonise their tax policies, by raising capital taxes $t_i$ up to a common, exogenous level $t_{\text{max}} > 0$.\footnote{Our one tier model thus adopts a strict view of tax harmonisation, requiring that tax rates are fully equalised in all countries. An alternative would be the imposition of a minimum tax rate. As the literature has shown, minimum tax rates do not eliminate strategic interactions between countries and results depend strongly on whether tax competition is analysed in a Nash or in 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 analysed below.}
The most straightforward interpretation of $t_{\text{max}}$ is as being the maximum tax rate that is sustainable in the competition for mobile capital with third countries, where this outside tax competition is taken as exogenous in our analysis. To give a specific example, assume that moving capital from a union member to an outside country involves constant mobility costs of $\mu$ per unit of capital,\textsuperscript{16} while the net return to capital invested in the rest of the world is $r^W$. Then, the maximum tax rate to prevent the relocation of capital to third countries is defined by $r = a - be - t_{\text{max}} = r^W - \mu$ and hence, $t_{\text{max}} = a - be - r^W + \mu$. Once the threshold $t_{\text{max}}$ is surpassed, all capital will leave the union, and tax revenues in each member state will be zero. While modelling capital flows to third countries in this ‘all-or-nothing’ form is clearly an oversimplification, this approach allows us to focus on tax competition within the union in our benchmark model. As said in the Introduction, this focus is motivated by empirical studies showing that tax competition between EU members is more aggressive than tax competition between EU countries and the rest of the world (Davies and Voget, 2011; Redoano, 2014).\textsuperscript{17}

In the following, we impose two natural assumptions on $t_{\text{max}}$. First, we require the maximum tax rate to lie below the expropriation level so that the net return to capital in (3) remains positive even when all countries set $t_i = t_{\text{max}}$. Second, $t_{\text{max}} > t^*_L$ which guarantees the equilibrium tax rates in (12) to represent an interior Nash equilibrium, even with the additional constraint $t_i \leq t_{\text{max}}$ for each country $i$.

In this setting, it is obvious that aggregate tax revenue in the union would be maximised if each country set the tax rate $t_{\text{max}}$. Moreover, this tax rate would also maximize aggregate union welfare: a coordinated tax below or equal to $t_{\text{max}}$ is a lump sum instrument in our framework, and the constant marginal rate of substitution between tax revenue, and private consumption ($\varepsilon$) exceeds unity. On the other hand, this harmonized outcome does not necessarily constitute a Pareto improvement. This is true in particular for the small countries, who undercut the large countries’ capital tax rates in the non-cooperative tax equilibrium and secure a higher per capita welfare level (Proposition 1). Let $u_i(t)$ denote country $i$’s utility under a cooperative solution with a

\textsuperscript{16}These mobility costs of capital can be interpreted, for example, as the costs of investing in a different institutional and legal environment, as well as the costs of foreign currency risk.

\textsuperscript{17}In Section 4.3 we extend our basic model to incorporate tax competition with the rest of the world explicitly. We will show there that our qualitative conclusions remain intact when capital flows between the union and the rest of the world occur in equilibrium.
common tax rate $t$ and compare this with each country’s revenue under decentralised tax competition, $u_j^*$ [see eq. (15)]. Then, a coordinated outcome that is unanimously approved by all countries cannot be achieved under a one tier structure of capital taxation iff the following condition holds:

$$u_S^* > u_S(t_{max}) = e \left[ a - \frac{b}{2} e + (\varepsilon - 1) t_{max} \right],$$

where $u_S(t_{max})$ follows from (6) when $t_S = t_L = t_{max}$, and hence $k_i = e$. To understand this condition, notice first that for each country the cooperative utility level $u_i(t)$ increases in $t$. Hence, the case for harmonisation is most compelling when countries agree on the maximum tax $t_{max}$. Moreover, the large country is always in favour of tax coordination: tax harmonisation 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, $u_L^* > u_L(t_{max})$ will never be binding. Small countries, in contrast, attract a disproportional share of total capital in the non-cooperative equilibrium. When they agree to harmonise taxes, they will therefore suffer from a reduction in per capita capital supply and a corresponding decrease in utility that might well offset the positive effect of a larger common tax rate. Hence it is the small countries who decide whether cooperation is accomplished or not. This gives:

**Corollary 1** Tax harmonisation fails if and only if small countries oppose it.

The remainder of the paper focuses on an economic scenario where condition (16) is fulfilled and hence tax harmonisation 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.

### 3 Dual Tier Capital Taxation

We now explore a scenario that combines capital taxation at the federal level with subsequent taxation at the decentralised level of government.\(^{18}\) The key element of this system is that in a stage 1, all countries can agree on a uniform federal capital tax $T$. This federal capital tax is levied on the entire capital stock in the union, and returned to the individual countries in proportion to their capital endowments. In our

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\(^{18}\)This timing of federal and local tax decisions is discussed further in Section 4.4.
benchmark model, where these endowments are per capita the same in all countries, this corresponds to equal per capita remittances. Hence the disbursements of tax receipts occurs in a way that does not redistribute federal tax revenues across countries.\footnote{We thus define a ‘non-redistributive’ scheme as one where revenues are allocated to each country as they would be in a closed economy. In other words, the distribution of federal tax receipts corresponds to that under the residence principle of capital taxation. Clearly this distribution of the federal tax differs from the distribution of local tax revenues, which are based on where capital is employed in equilibrium (i.e., the source principle). We will discuss this difference further in Section 4.1.}

Such a tax has a variety of natural interpretations. First, it can literally be interpreted as a tax on capital that is refunded to all countries in proportion to their size, or capital endowment. Alternatively, federal tax revenues finance projects that benefit each country in proportion to its size, thus allowing each country to reduce their local expenditures on these projects. A third interpretation with particular relevance to a EU context is that the own resources of the federal 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 overall tax revenues of each member state. We assume that the outcome of negotiations is such that countries split the negotiation surplus over the non-cooperative tax equilibrium in a Nash bargaining fashion. Specifically, small countries are characterised by a collective bargaining parameter $\gamma \in [0, 1]$, whereas the bargaining power of the large countries is $(1 - \gamma)$. While we can remain agnostic regarding the size of $\gamma$, it might be positively linked to the share of small countries in the union, $n_S/(n_S + n_L)$.\footnote{The specific institutional structure within the federation will clearly also matter for the size of $\gamma$. An important issue is, for example, to what extent the representation of small versus large countries in the union’s governing bodies reflects relative population size.}

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 the same reasons as we have given in the one tier model above, the total taxes $T + t_j$ per unit in country $j$ cannot exceed the exogenous level $T^{max}$, where $T^{max} = t^{max}$ is identical to the maximum (local) tax rate in Section 2. Again, we focus on equilibria where all countries of the same size choose the same tax rate in equilibrium.

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 distribution of capital between countries. Hence, federal taxes do not alter each country’s incentive to attract the mobile factor, and $T$ affects decisions in stage 2 only through its impact on feasible local tax rates. In particular, when setting its local tax rate, each country must satisfy the constraint $t_j \leq T^{\text{max}} - T$, a constraint which becomes tighter the larger $T$ is.

### 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 $[0, T^{\text{max}}]$ into various regions.

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

$$T_1 = T^{\text{max}} - t^*_L.$$  \hspace{1cm}(17)

Over this range of federal taxes, the equilibrium local tax rates $(t^*_L, t^*_S)$ in the standard model remain feasible.\(^{21}\) Federal taxes generate lump sum revenues and thus leave each country’s reaction function in the relevant range $t_j \leq t^*_j$ unaltered. As a consequence, the equilibrium in local taxes does not change and $(t^*_L, t^*_S)$ remains the unique equilibrium. Within Regime I, the only impact of federal capital taxes is therefore to increase the overall level of taxation by means of a lump-sum tax, increasing welfare in all countries. Small countries thus continue to have higher per capita utility than large countries in this regime.

Consider now Regime II, characterised by the interval of tax rates $T \in [T_1, T_2]$. Defining $t^{**}_L = T^{\text{max}} - T$, the tax rate $t^{**}_S(T) = t^*_S(t^{**}_L)$ is the best response for country $S$ when $L$ chooses the largest admissible tax. The upper boundary of Regime II is defined as

$$T_2 = T^{\text{max}} - t^{**}_S(T_2).$$  \hspace{1cm}(18)

For federal taxes larger than $T_1$, the constraint not to exceed $T^{\text{max}}$ becomes binding for the large countries, which impose 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 violate the constraint $T + t^*_L \leq T^{\text{max}}$. Conversely, provided that large countries opt for $t^{**}_L$, the maximum-tax constraint for an $S$ country

\(^{21}\)Recall $t^*_S < t^*_L$ and notice from (17) that for $T < T_1$, combined taxes $T + t^*_L$ are less than $T^{\text{max}}$.\(^{15}\)
is slack until $T$ hits the interval’s upper boundary, $T_2$. To understand this, notice that $t_S^{**}(T)$ is the small countries’ unconstrained best response to the large countries’ boundary tax choice $t_L^{*}$. This best response is decreasing in $T$ because the reaction function is upward sloping [see eq. (11)] 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 small countries.

What are the equilibrium local tax rates in Regime II? Suppose first that $S$ countries do not adjust their tax rate and still set $t_S = t_S^{*}$. Then, $L$ countries in response adopt $t_L^{*} = T^{\max} - T$: large countries’ welfare is increasing for any $t_L < t_L^{*}$ so that their best response is the largest admissible tax rate. At the same time, the best response of $S$ countries to $t_L^{*}$ is some $t_S^{**}$ strictly smaller than $t_S^{*}$ because their own reaction function is upward sloping in $t_L$. Substituting the large countries’ constrained choice in the small countries’ best response function (11), the equilibrium $[t_S^{**}(T), t_L^{**}(T)]$ is characterised by

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

$$t_S^{**}(T) = \frac{b[(\varepsilon - 1)e] + (\varepsilon - 1 + \alpha_S)n_L \alpha_L(T^{\max} - T)}{\varepsilon[2 - \alpha_S(n_S + 1)] - (1 - \alpha_S)(1 - \alpha_S n_S)}.$$  \hspace{1cm} (19a)

Note that $t_S^{**}$ is strictly decreasing in $T$ with a slope less than one. Hence, an increase in $T$ is matched by an equal reduction in the $L$ countries’ 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. (10)].

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 $T$ with a slope of one and $t_S^{**}(T^{\max}) = t_S^{*}(t_L = 0) > 0$, it follows that $t_L^{**}(T)$ and $t_L^{**}(T)$ must intersect at positive local tax rates in each country.\hspace{1cm} (19b)

This implies 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.

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 small countries as well. Local equilibrium tax rates in all countries are then identical at the level

\hspace{1cm} \footnote{Note 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, it must be true that $T_2 < T^{\max}$ because $t_L^{**}(T^{\max}) = 0.$}
\[ t^*_L = t^*_S = T^{\text{max}} - T, \] and so is the per capita capital stock in each country. At the maximum federal tax \( T^{\text{max}} \), local taxes disappear altogether and all tax revenues are generated at the federal level. Our results are summarised in:

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

\[ T \in (0, T_1) \ (\text{Regime I}): \text{Tax rates are } (t^*_S, t^*_L), \text{ with interior solutions in countries } L \text{ and } S. \text{ Tax rates in all countries are the same as in the one tier model of capital taxation [eq. (12)].} \]

\[ T \in (T_1, T_2) \ (\text{Regime II}): \text{Tax rates are } [t^*_S = t^*_S(T^{\text{max}} - T), t^*_L = T^{\text{max}} - T], \text{ with interior solutions in } S \text{ countries and a boundary solution in } L \text{ countries [eqs. (19b)–(19a)]}. \text{ The tax difference } t^*_L - t^*_S \text{ is falling in } T. \]

\[ T \in (T_2, T^{\text{max}}) \ (\text{Regime III}): \text{Tax rates are } [t^*_S = T^{\text{max}} - T, t^*_L = T^{\text{max}} - T], \text{ with boundary solutions in } L \text{ and } S. \text{ Local tax rates in all countries are identical.} \]

### 3.2 Stage 1: Choosing the federal tax rate

We can now analyze which level of the federal tax rate \( T \) will be chosen by the large and the small countries. For that purpose, we need to explore each country’s welfare for varying levels of the federal tax. Country \( j \)'s per capita welfare in the presence of a dual tax structure that distributes federal tax receipts in proportion to capital endowments is

\[ u_j \equiv (b/2) k^2_j(t_j^*, t^*_h) + e[a - bk_j(t_j^*, t^*_h) - t_j^* - T] + \varepsilon[t_j^*k_j(t_j^*, t^*_h) + T e]. \quad (20) \]

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 one tier Nash equilibrium. Hence, the regime specific effect of increasing \( T \) on each country’s per capita welfare is derived from (20) as

\[ \frac{du_j^l}{dT} = e(\varepsilon - 1) > 0 \quad \forall j. \quad (21) \]

Consequently, all countries 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 countries so that these countries respond to an increase in $T$ with a one-to-one reduction of their local tax $t_L$. Conversely, the small countries 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 country $S$ will opt to reduce $t_S$ at a smaller rate [see eq. (19b)]. As a consequence, an increase in $T$ causes small countries to lose capital to the large countries.

From (20), per capita utility levels in each country respond by

$$\frac{du_{II}^j}{dT} = [b(k_j - e) + \varepsilon t_j] \left[ \frac{\partial k_j}{\partial T} \frac{\partial^* t_j}{\partial T} + \frac{\partial k_j}{\partial t_h} \frac{\partial^* t_h}{\partial T} \right] + (\varepsilon k_j - e) \frac{\partial^* t_j}{\partial T} + e(e - 1) \quad \forall j \neq h. \quad (22)$$

We first turn to the welfare effects on large countries. From (19b) we know that the small countries respond to an increase in $T$ by reducing their local tax rate by less than $dT$; we denote this by $dt_S^*/dT = -c > -1$. In contrast, we have $dt_L^*/dT = -1$ from (19a). Moreover, since all countries of the same type choose the same tax policy, using (10) gives $dk_L^*/dS = n_S \alpha_S/b = -dk_L^*/dT$. Hence we obtain

$$\frac{du_{II}^L}{dT} = (e - k_L) [\varepsilon - n_S \alpha_S(1 - c)] + \varepsilon t_L(1 - c) \frac{n_S \alpha_S}{b} > 0. \quad (23a)$$

This must be positive because $k_L^* < e$, $\varepsilon > 1$, $c < 1$ and $n_S \alpha_S < 1$ from (1). It is intuitive that the increase in $T$ has a positive effect on welfare in the large countries in this regime. Not only do large countries benefit directly from the increase in federal tax revenues, but they also gain from the reduced tax gap vis-a-vis the smaller countries.

For a small country, there are two countervailing effects at work. On the one hand, an increase in $T$ raises its aggregate tax rate $T + t_S$, and hence total tax revenue, which is beneficial for the small countries. At the same time, each small country loses part of its capital to its larger rivals. As the small country chooses an interior tax rate, we can apply the envelope theorem in this case. Using (7) in (22) along with $dt_L^*/dT = -1$ and $dk_S^*/dS = n_L \alpha_L/b$, we obtain

$$\frac{du_{II}^S}{dT} = -[b(k_S - e) + \varepsilon t_S] \frac{n_L \alpha_L}{b} + e(e - 1) = \varepsilon(e - k_S) < 0, \quad (23b)$$

Notice that, for $L$ countries, the envelope theorem cannot be applied on the right-hand side of (22), because the large countries’ tax rate is exogenously constrained.
where the second step has once again used condition (7), along with the fact that \( \frac{dS}{dt} = -S \frac{dL}{dt} \). The derivative is unambiguously negative since \( S > e \), and welfare in the small countries falls throughout Regime II when the federal tax rate \( T \) is increased. This implies that the interests of the large and small countries are directly opposed in Regime II.

Finally, for all federal tax levels across Regime III, the allocation of capital between countries is symmetric, and total unit taxes are at their maximum. Accordingly, welfare for all countries is invariant in \( T \), and is identical to the level under a cooperative solution with the federal tax rate \( T_{max} \).

Figure 1 illustrates how the per capita utilities of the large and the small countries evolve in the different regimes. The starting point is \( T = 0 \), where per capita welfare in each small country exceeds welfare in the large countries (cf. Proposition 1). In Regime I (for \( T < T_1 \)), welfare levels are increasing in \( T \) in all countries [eq. (21)]. In Regime II (for \( T_1 < T < T_2 \)), the interests between the large and the small countries are conflicting, as \( u_L \) is increasing in \( T \) in this region, whereas \( u_S \) is decreasing [eqs. (23a)–(23b)]. Moreover, note that condition (16) implies that \( u_S(T_2) < u_S(0) \), as the small countries gain from purely local tax competition without a federal tax. This implicitly defines a level of the federal tax \( \hat{T} < T_2 \) within Regime II, where \( u_S(\hat{T}) = u_S(0) \).

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 countries.

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 welfare 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.

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 maximises the generalised Nash product

\[
\Delta(T) = \left\{ u_S(t_S(T), t_L(T)) - u_S(0) \right\} \gamma \left\{ u_L(t_S(T), t_L(T)) - u_L(0) \right\}^{1-\gamma},
\]

where \( u_j(0) \) is country \( j \)'s welfare level under local tax competition with no federal tax.
Figure 1: Per capita welfare in large and small countries for different levels of $T$.
The first-order condition \( d\Delta(T)/dT = 0 \) yields

\[
\frac{\gamma}{1 - \gamma} \left[ \frac{-du_S(T)/dT}{[du_L(T)/dT]} \right] = \frac{u_S(T) - u_S(0)}{u_L(T) - u_L(0)}.
\] (23c)

Note from (23a)-(23b) that the left-hand side of (23c) is positive and increasing in \( \gamma \). 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 countries’ bargaining parameter \( \gamma \). Hence the higher is \( \gamma \), the closer is the federal tax to the level \( T_1 \) at which the small countries’ per capita welfare is maximised.

Our results are summarised in:

**Proposition 2** With dual tier capital taxation, countries will agree on a federal tax \( T^* \in [T_1, \hat{T}] \), where the small countries’ welfare level at \( \hat{T} \) equals that in the absence of a federal tax. In this coordinated equilibrium the following holds:

a) Welfare levels 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 country \( L \) attracts a larger share of capital relative to one tier tax competition.

c) The negotiated federal tax \( T^* \) strictly decreases in \( \gamma \), the bargaining strength parameter of small countries. The higher is \( \gamma \), the larger is the local tax gap \( (t_L - t_S) \), and the more asymmetric is the allocation of capital.

Proposition 2 conveys that even if side payments are (politically or otherwise) infeasible, large and small countries find it attractive to agree on a cooperatively set federal tax. We also characterise 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 decentralised 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 the two country types. If the small countries have a sufficient bargaining strength, the federal tax is relatively small, and the local tax gap between large and small countries remains sizable. Conversely, if large countries are in a dominant bargaining position, negotiations yield higher federal taxes and local tax rates are more closely aligned.
These results extend to a setting where large countries are Stackelberg leaders vis-a-vis small countries in local tax competition. In this case large countries will set a tax rate above $t^*_L$, in order to encourage small countries to raise their tax rates as well (though at a smaller rate). In a one tier framework with local taxes only, Wang (1999) has shown that the tax gap between large and small countries will widen, relative to the case of simultaneous tax setting, and more capital flows into small countries. At the same time, both large and small countries generate larger tax revenues and welfare than in a Cournot setting. Implementing a dual-tier institution with federal taxes will still be viable in this setting with a qualitative outcome identical to the one under Cournot: increasing $T$ uniformly increases tax revenues and welfare until large countries hit the maximum-tax ceiling; beyond this level of federal taxes, the tax gap will start to shrink and a larger $T$ lowers the welfare in the small countries. Again, the overall solution will be found within Regime II.

4 Discussion and Extensions

In this section we discuss the robustness of our results. We first investigate alternative schemes to allocate federal tax revenue across the member states of the tax union, and the possibility of costly side payments. In Section 4.2 we explore the implications of allowing for different (per capita) capital endowments in large and small countries. Section 4.3 extends the model to allow for international capital flows to third countries. Finally, in Section 4.4, we discuss the timing of federal and local tax decisions.

4.1 Allocating federal tax revenue and costly side payments

In our baseline model, we assumed that federal tax revenue is redistributed on an equal per capita basis or, equivalently in that model, in proportion to each country’s per capita capital endowment. Since the way in which the federal government remits its taxes has obvious implications for the functioning of our dual tier system, the present Section takes a broader look at the issue of tax reimbursements and more generally, monetary redistribution towards small countries.

As an alternative, suppose instead that the distribution of federal tax revenue is proportional to the equilibrium level of capital employed in each country, corresponding to
a source-based distribution of the federal tax. Per capita tax revenues for each country type \( j \) then become \( R_j = (t_j + T)k_j^*(t_j, t_m) \). In this scenario, federal taxes are completely neutral and cease to have any effect on either capital allocation or equilibrium tax revenues. To see this, replace a country’s strategic tax variable \( t_j \) by the new variable \( \tilde{t}_j = t_j - T \). It is then obvious that the new equilibrium in local taxes satisfies \( \tilde{t}_j^* = t_j^* - T \). Intuitively, countries 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 simple 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 small countries 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 local revenues naturally increase in \( T \) to the point where \( T = T^{max} \).

Accordingly, for a source based distribution of federal tax receipts, small countries will not agree on a federal tax if our initial condition (16) holds. In contrast to the base model, tax revenues of the small countries do not increase in Regime I, and they fall in Regime II as a result of the non-negativity constraint. 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.

Could there be other distribution mechanisms for the federal tax revenue that lead to an even better allocation of capital than in our benchmark model? In principle, it is obvious that any distribution mechanism that replicates direct transfers from the large to the small country could achieve the first-best solution, i.e., to buy the small country into accepting the fully coordinated tax \( T^{max} \). In particular, this would be possible if the distribution of federal tax receipts was based on a formula that grants the higher per capita revenues the smaller is the population of a country. Such transfer schemes, even though they could be based on simple exogenous characteristics such as country

\(^{24}\)The reasoning is thus very similar to Section 3.2 [eq. (23b)]. 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 countries was constrained from above.
size, are not observed in real-world federations, however. They are presumably not used because of their very clear redistributive consequences, in particular, their economic equivalence to direct monetary transfers from large to small countries. As mentioned before, direct transfers are generally believed to cause high political (shadow) costs to the governments of payor countries, because voters resist monetary inter-regional side payments in exchange for political concessions. Therefore, we would expect the political shadow costs under such a redistributive allocation of federal tax receipts to be of similar size as a direct, bilateral transfer from large to small countries.\textsuperscript{25}

In contrast, distribution mechanisms that are either based on equal per capita remittances, or granted in proportion to actual capital endowments, can both be perceived as ‘non-redistributive’ schemes for the allocation of federal tax revenue.\textsuperscript{26} In our benchmark model, these two criteria for distributing federal tax revenue coincide. But this is not generally the case, as will be seen in Section 4.2 below. Equal per capita payments have an intuitive appeal as being ‘fair’, whereas a redistribution of tax revenue in proportion to capital endowments implies that remittances flow back to countries in relation to their contribution to the overall tax base. In comparison to a scheme that directly replicates monetary transfers from large to small countries, both of these distribution mechanisms are likely to be associated with much lower political shadow costs, and we have normalized these to zero in our analysis.

Finally, in our working paper version (Haufler and Lülfsmann, 2013), we have formally analysed the question of whether a dual tier tax system can be supplemented by direct monetary transfers, when the latter are politically costly, but not prohibitively so. We find there that positive local tax differentials will remain in an equilibrium where side payments occur. Intuitively, member states have two options to induce small countries to agree to a tax reform. Either large countries make redistributive side payments (either directly, or via formula transfers that have the same effect) or, alternatively, there remains a gap in capital tax rates which channels a disproportionate amount of

\textsuperscript{25}Matters are different when the distribution of tax revenues is based on the level of local tax rates employed by the countries in the last stage, in the direction of rewarding a higher tax rate. A similar mechanism is employed in the German fiscal equalization scheme, at the level of the local business tax (see Buettner, 2006). This mechanism can be used to move tax rates upwards in all jurisdictions, relative to a pure tax competition equilibrium. However, it cannot be tailored directly at the small country and therefore cannot induce this country to agree to a fully coordinated tax rate $T_{\text{max}}$.

\textsuperscript{26}See our definition of a ‘non-redistributive’ disbursement scheme in footnote 19.
capital into small countries. The optimal policy then balances off the higher political shadow costs of the direct monetary transfers with the losses from the remaining tax competition, in particular, the distortion of the capital allocation that results from diverging local tax rates. In any case, however, a dual tax structure remains part of the optimal policy mix whenever the shadow costs of direct monetary transfers are strictly positive.

4.2 Differential capital endowments

So far, we have maintained the assumption that all countries have the same per capita endowments of capital. We now relax this assumption and allow the per capita endowment of capital $e_j$ to differ across region types $j \in \{S, L\}$, but not between countries of the same type. Since capital is perfectly mobile, each country will then still employ the same per capita level of capital in equilibrium, provided local tax rates are identical. The algebra underlying this extension is tedious, but straightforward, and is relegated to Appendix 2. With differential capital endowments $e_L$ and $e_S$, respectively, the equilibrium tax differential is now found as

$$t^*_L - t^*_S = \frac{b \varepsilon^2 (\alpha_L - \alpha_S) \eta + \varepsilon[\alpha_S e_S (1 - \alpha_L) - \alpha_L e_L (1 - \alpha_S)]}{\rho},$$

(23d)

where $\eta \equiv n_S \alpha_S e_S + n_L \alpha_L e_L$ is the average capital endowment in the federation, and $\rho$ is the same as in our benchmark model [see eq. (13)].

The first term in the numerator of (23d) is analogous to the single term in eq. (14), and determined by differences in country size. The novel second term is a consequence of the differences in per capita endowment, and represents a terms of trade effect. This term increases the tax differential if small countries have the higher per capita endowment, whereas it reduces the tax gap when those countries are capital poor. For the latter case, an intuitive explanation is as follows. Since each small country is a capital importer in equilibrium, it will try to reduce the price of imported capital. This is achieved by increasing the domestic capital tax, which reduces the domestic capital demand and thus lowers the equilibrium price of capital, other things being equal.

One might think that because, in comparison to our benchmark case of homogenous endowments, the local tax gap between large and small countries shrinks in equilibrium, capital poor small countries will become more prone to accepting a large federal tax.
However, this is not necessarily the case. The gains from tax competition are higher for each small country, when the larger countries also have the higher per capita capital endowment. Therefore, despite the lower tax gap between large and small countries, small countries may have more to lose from a federal tax with a given formula for distributing its receipts. Assuming, for concreteness, that the large countries hold all the bargaining power and the negotiated federal capital tax rate is therefore at $\hat{T}$, the level of this tax rate can be either above or below the corresponding federal tax rate in the benchmark model. In any event, however, it remains true that the dual tier system continues to be effective.

With heterogenous per capita capital endowments, an important difference arises between the disbursement of federal tax receipts on an equal per capita basis, and a distribution that is proportional to capital endowments. When the small countries are capital poor, they clearly prefer the latter reimbursement formula for any given level of the federal tax rate $T$. Hence, the level of $\hat{T}$ to which the small countries will agree will be larger, and the resulting allocation will be more efficient, when an equal per capita formula is implemented. Effectively, an equal per capita remittance may be seen as a ‘fair’, and hence politically acceptable, way of transferring federal tax revenue to the small countries. But clearly, this pattern is reversed when the small countries are capital rich instead: in this case, a distribution of federal tax revenue in proportion to local capital endowments will support the higher level of $\hat{T}$. In conclusion, which of the two distribution mechanisms is to be preferred from an aggregate efficiency perspective depends on the relative endowment of capital among the heterogeneous union members.

### 4.3 Capital flows to third countries

In our benchmark analysis, we have captured tax competition between the union and the rest of the world in a stylized way, by imposing an upper bound $T^{max}$ on the aggregate federal and local tax rate. We now relax this assumption and explicitly incorporate tax competition with a third country that is not a member of the union.

For simplicity, we normalise the total world population to unity and assume that the union comprises only one large and one small country, with shares $\alpha_L$ and $\alpha_S$ in the world population, respectively. The population share in the rest of the world, coun-
try $W$, is thus given by $\alpha_W = 1 - \alpha_L - \alpha_S$. Also, let the production function and the per capita capital endowment in country $W$ be the same as for the union members. Denoting the amount of capital employed in the third country by $k_W$, the condition for capital market clearing [cf. eq. (2)] becomes

$$\alpha_L k_L + \alpha_S k_S + \alpha_W k_W = e. \quad (23e)$$

As in our benchmark model (and in line with the empirical evidence given in the Introduction), we assume that capital is imperfectly mobile between the union and the rest of the world, but perfectly mobile within the union. In contrast to the benchmark, however, we now introduce marginal mobility costs which are increasing in the volume of capital flows to the rest of the world. Moreover, we exogenously set the capital tax rate in country $W$ to zero and assume zero marginal mobility costs for the first unit of capital flowing into this country. With this specification, there will always be positive capital flows from the union to the rest of the world in equilibrium. In this sense, we now consider a more general model than in our benchmark analysis, where the constant mobility cost of capital precluded any capital flows to the rest of the world in equilibrium.

Specifically, we consider mobility costs of the form $\tau = (\delta / \theta) (k_W - e)^\theta$, where $\delta > 0$ is a linear cost parameter while $\theta > 1$ parameterizes the curvature of the mobility cost function. Using the quadratic specification of production, the arbitrage condition for capital owners (3) under a dual tier tax structure in the union then extends to

$$bk_W + \delta (k_W - e)^{\theta-1} = bk_L + t_L + T = bk_S + t_S + T. \quad (23f)$$

Finally, we assume that the federal government in the union can only tax the capital stock that remains in countries $L$ and $S$. From (23e), the per capita capital base of the federal tax is then $(e - \alpha_W k_W) / (\alpha_L + \alpha_S).^{27}$

Table 2 collects the results of some illustrative calculations carried out in this three-country model.\textsuperscript{28} Our benchmark specification is given in row (1). We consider a scenario where country $L$ is five times larger than country $S$ and the union of countries

\textsuperscript{27} Note that this per capita tax base will just equal $e$ when there are no capital flows between the union and country $W$, i.e., when $k_W = e$.

\textsuperscript{28} We note that these results should not be taken as being representative for existing economies. One reason is that the quadratic production structure, while being analytically convenient, makes it difficult to incorporate realistic factor shares and substitution elasticities. Evaluated at a no-tax
Table 2: Illustrating the dual tier capital tax in a three-country model

<table>
<thead>
<tr>
<th></th>
<th>$\alpha_L$</th>
<th>$\alpha_S$</th>
<th>$\delta$</th>
<th>$\theta$</th>
<th>(a)</th>
<th>(b)</th>
<th>(c)</th>
<th>(d)</th>
<th>(e)</th>
<th>(f)</th>
<th>(g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>0.20</td>
<td>0.04</td>
<td>3.50</td>
<td>1.50</td>
<td>0.41</td>
<td>0.23</td>
<td>0.17</td>
<td>0.39</td>
<td>0.22</td>
<td>3.4%</td>
<td>0.6%</td>
</tr>
<tr>
<td>(2)</td>
<td>0.20</td>
<td>0.04</td>
<td>3.75</td>
<td>1.50</td>
<td>0.41</td>
<td>0.23</td>
<td>0.24</td>
<td>0.39</td>
<td>0.22</td>
<td>4.9%</td>
<td>1.0%</td>
</tr>
<tr>
<td>(3)</td>
<td>0.20</td>
<td>0.04</td>
<td>3.50</td>
<td>1.45</td>
<td>0.41</td>
<td>0.23</td>
<td>0.28</td>
<td>0.39</td>
<td>0.22</td>
<td>5.9%</td>
<td>1.5%</td>
</tr>
<tr>
<td>(4)</td>
<td>0.22</td>
<td>0.044</td>
<td>3.50</td>
<td>1.50</td>
<td>0.41</td>
<td>0.23</td>
<td>0.23</td>
<td>0.39</td>
<td>0.22</td>
<td>4.7%</td>
<td>1.0%</td>
</tr>
<tr>
<td>(5)</td>
<td>0.195</td>
<td>0.045</td>
<td>3.50</td>
<td>1.50</td>
<td>0.38</td>
<td>0.22</td>
<td>0.14</td>
<td>0.36</td>
<td>0.21</td>
<td>2.1%</td>
<td>0.4%</td>
</tr>
</tbody>
</table>

Note: Parameters held constant: $a = 1.0$, $b = 0.04$, $e = 5$, $\varepsilon = 2$.

$L$ and $S$ comprises roughly a quarter of the world population (24%). With this specification, the gains from asymmetric tax competition for country $S$ are so large that this country refuses any uniform coordinated tax rate $t \leq 1$. Hence, the fundamental condition (16) underlying our analysis is met.

In contrast, a dual tax structure is sustainable and benefits both countries, despite the outflow of capital to the rest of the world. Columns (a)-(b) in Table 2 provide the one tier local tax rates for countries $L$ and $S$ in the absence of a federal tax. Column (c) gives the federal tax rate $T_1$, for which the small country’s total per capita tax revenues are maximised (see Figure 1). Columns (d)-(e) show the second tier local tax rates at this level of $T_1$. In the benchmark case of row (1), the total capital tax rate $T + t_j$ thus rises from 41% to 56% [the sum of columns (c) and (d)] for country $L$, and from 23% to 39% [columns (c) and (e)] for country $S$. At the same time, the equilibrium tax differential falls (albeit only slightly) under the dual tier tax system. Finally, columns (f)-(g) give the percentage increase in per capita utility under the optimised dual tier tax structure, in comparison to the one tier system with purely local tax competition. This per capita utility increase is always more substantial for country $L$, because the larger country gains from both the higher aggregate tax rate.

28 equilibrium, the factor share of capital in our benchmark specification (see the note to Table 2) is $rk_i/f(k_i) = (a - bk_i)/(a - 0.5bk_i) = 8/9$, whereas the elasticity of factor substitution is $(-dk_i/dr) * (r/k_i) = (a - bk_i)/bk_i = 4$. Clearly, both of these values are unrealistically high.

29Hence, this level of the federal tax would be chosen if country $S$ held all the bargaining power within the union. Note that, in contrast to Figure 1, tax revenues in $L$ will also eventually fall in the federal tax rate $T$ when the union-wide capital tax base is endogenized. However, since country $S$’s tax revenue always starts to fall at a lower federal tax, $T_1$ has the same interpretation as in Figure 1.
and the reduced intra-union tax differential.

The benchmark specification is then modified along several lines. Rows (2) and (3) show that the federal tax rate rises, and larger tax revenue gains can be secured, if capital mobility to the third country falls (i.e., if \( \delta \) rises), or if the elasticity of capital flows to country \( W \) is reduced (\( \theta \) falls).\(^{30}\) Row (4) indicates that, for any given parameterization of mobility costs, the revenue gains for the union are larger when the total size of the union \( (\alpha_L + \alpha_S) \) rises vis-à-vis the third country. Finally, in row (5) the size differential between the large and the small country is reduced. This increased symmetry reduces the benefits from the dual tax structure for both the large and the small country.

In a qualitative way, these results show that the basic mechanism which aligned capital tax rates between large and small countries in our benchmark model (in a Regime II equilibrium) is also present in a setting where capital tax increases in the union lead to continuous outflows of capital to the rest of the world. In the benchmark model the alignment of local tax rates arose from the large country being constrained by an exogenously given upper tax limit \( T_{\text{max}} \). In the extended model, the stronger pressure on the large country’s local tax rate is instead caused by the higher marginal outflow of capital to the rest of the world, as caused by the large country’s higher tax rate.

### 4.4 Timing of federal and local tax decisions

Finally, we stress that the timing of decisions is important to our arguments. To see this, suppose that in contrast to the benchmark 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 local governments negotiate the federal tax \( T \) in stage 2. Regardless of the choices made in stage 1, all countries now have a common interest to set \( T \) to the maximum admissible level, \( T = T_{\text{max}} - \hat{t} \) with \( \hat{t} = \max\{t_S, t_L\} \). Since for the assumed order of local and federal decisions \( T \) neither affects local taxes nor the capital allocation across countries, the federal tax only determines the total tax burden of investors. Hence, all countries wish to implement a federal tax as large as possible.

But this coherence of ex-post preferences has important implications for the tax equi-\(^{30}\) Implicitly differentiating (23f) shows that \( \partial k_W / \partial \theta > 0 \) when \( 0 < (k_W - \epsilon) < 1 \) in equilibrium. The latter holds in our calculations, because \( \alpha_W \) is large [see eq. (23c)].
librium in stage 1. Specifically, large countries lose their interest to choose relatively high local taxes. Suppose the equilibrium in stage 1 satisfies $t_j > t_h$ for countries $j, h$. Then, country $j$ would like to lower its taxes (at least) to $t_h$: since $T = T^{\text{max}} - t_h$ in this range, lowering $t_j$ leaves country $j$’s aggregate tax $t_j + T$ unaffected, while at the same time raising country $j$’s capital endowment.

By the same token, raising $t_j$ in a symmetric situation with $t_j = t_h$ cannot benefit country $j$, because its own capital allocation shrinks while its total tax rate $t_j + T$ remains constant. As these arguments show, only symmetric tax rates can potentially be sustained. And, in fact, a combination of identical local tax rates $t_L = t_S = 0$ forms an equilibrium.\(^\text{31}\)

In a dual tier scenario in which countries move first and federal taxes are set subsequently, the capital allocation would thus be symmetric and the outcome of a one tier federal tax would be replicated. Clearly, small countries would not find such a regime agreeable if they oppose uniform taxes in the first place. Hence, for a dual tier tax structure to have an effect, federal taxes must be designed as long run, strategic choices. This, however, can also be expected in most policy settings, in part because the need for negotiations over the federal tax rate would serve as a commitment not to change this tax rate frequently.

5 Conclusions

Our paper has started out from an empirically relevant scenario where asymmetric countries within a federation compete for mobile capital. Decentralised taxation yields inefficiently low equilibrium tax rates, but small countries may nevertheless benefit from tax competition by undercutting their larger neighbours, in order to attract capital from them. Hence, small countries will resist a reform towards capital tax harmonisation, even if the latter increases aggregate tax revenues within the union.

We propose a two tier tax structure to mitigate this problem. Under this scheme, the asymmetric member states of a union choose a common, federal tax rate in the first

\(^{31}\)In addition, any combination of identical taxes $t_L = t_S$ forms an equilibrium, which is small enough (in particular, sufficiently smaller than $t^*_S$) so that $S$ countries do not find it beneficial to undercut $t_L$. 

30
stage, and then non-cooperatively set local tax rates in the second stage. We show that 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 Pareto improvement over a one tier system of decentralised capital tax competition. Moreover, as the tax gap between small and large countries narrows, the marginal products of capital are also more closely aligned in equilibrium, improving production efficiency within the union. We have argued that these advantages of a dual tax structure apply for various scenarios regarding the distribution of federal tax receipts, and when capital flows to the rest of the world are allowed.

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 critical insight of our model is that the European Union should not attempt a complete tax harmonisation, which may be politically infeasible because of its adverse effects on small countries. Rather, the Union may want to introduce an additional EU-wide corporation tax and use the proceeds to reduce the contributions of member states in relation to each country’s capital endowment. In the case of the European Union, a good proxy for this would be to reduce the GDP-based contributions of each member state to the Community budget. Using an established channel to redistribute the additional tax receipts will also help to limit the possible inefficiencies that may arise from political lobbying for the additional funds.

Our model can be extended in several directions. A first possible extension is to account for capital tax evasion, and for the fact that different schemes of capital taxation may also affect the efficiency of tax administration. To model tax evasion, a tax effort variable could be incorporated into the model, linking the decision on how strictly the capital tax is enforced to the direct gains that the respective jurisdiction has from tighter enforcement. These incentives have been studied before in a setting of fiscal integration (e.g. Cremer and Gahvari, 2000) and similar issues might be relevant under the dual tax scheme discussed here. A second issue is to account for heterogeneity in the preferences of countries, in addition to differences in population size. Tax rates set in an autarky equilibrium would then differ among the members of the union. We would expect this specification to change the distribution of the gains from a dual tier
capital tax structure, while our qualitative conclusions should remain intact. We leave these and other extensions for future research.
Appendix

Appendix 1: Proof of Proposition 1

From (15), and using the arbitrage condition (3), the welfare difference between countries of type \(j\) and \(h\), with \(j, h \in \{S, H\}\) is

\[
    u_j - u_h = \frac{b}{2}(k_j - k_h)(k_j + k_h) + \varepsilon(t_jk_j - t_hk_h) \quad j \neq h. 
\]

(A.1)

We first focus on the term \(t_jk_j - t_hk_h\). Substituting (12) and (10), rearranging and using the adding-up condition (1) gives in a first step

\[
    t_jk_j - t_hk_h = \frac{be^2(\varepsilon - 1)(\alpha_h - \alpha_j)\Delta}{\rho^2} \quad j \neq h, 
\]

(A.2)

The term \(\Delta\) is the product of the two denominators in eq. (11). This is:

\[
    \Delta = \frac{2\varepsilon[2 - \alpha_j(n_j + 1)] - (1 - \alpha_j)(1 - \alpha_jn_j)}{\varepsilon[2 - \alpha_h(n_h + 1)] - (1 - \alpha_h)(1 - \alpha_hn_h)} > 0. 
\]

(A.3)

In the next step we substitute \(t_jk_j - t_hk_h\) from (A.2) along with \(\Delta\) in (A.3) and \(\rho\) into (A.1). Again substituting (12) and (10) gives

\[
    u_j - u_h = \frac{be^2\varepsilon^2(\varepsilon - 1)(\alpha_h - \alpha_j)\Gamma}{\rho^2}, 
\]

(A.4)

\[
    \Gamma = 2\Delta/\varepsilon + (n_h\alpha_h - n_j\alpha_j)(\varepsilon - 1)(\alpha_h - \alpha_j) + \varepsilon^2(\alpha_j + \alpha_h - \alpha_j\alpha_h) 
    + \varepsilon(n_j\alpha_j^2 + n_h\alpha_h^2 - 3) + \varepsilon(1 - \alpha_j)(1 - \alpha_h) + (\varepsilon - 1)\alpha_j\alpha_h(n_j + n_h) + 1. 
\]

Using (A.3), rearranging and cancelling terms eventually gives

\[
    \Gamma = (\varepsilon - 1)[\varepsilon\alpha_j(1 - \alpha_h) + \varepsilon\alpha_h + (1 - \alpha_j - \alpha_h) + (1 - \alpha_j)(1 - \alpha_h)] 
    + \alpha_j\alpha_h(\varepsilon + 1 + n_j) + [1 - \alpha_h - \alpha_j(1 - \alpha_h) > 0. 
\]

(A.5)

Since all terms in (A.5) are positive, it must be true that \(\Gamma > 0\). It then follows from (A.4) that \(\text{sign}(u_j - u_h) = \text{sign}(\alpha_h - \alpha_j) \forall h \neq j. \)  \(\Box\)
Appendix 2: Derivation of Equation (23d)

With differential per capita endowments of capital, the capital market clearing condition becomes

\[ n_S \alpha_S k_S + n_L \alpha_L k_L = n_S \alpha_S e_S + n_L \alpha_L e_L \equiv \eta, \quad (A.6) \]

where \( \eta \) is the average capital endowment in the economy. From the unchanged capital arbitrage condition (3) and (4), the per capita capital stock in a single country \( i \) is then given by

\[ k^*_i(t_i, \bar{t}_{-i}) = \eta + \frac{(1 - \alpha_i)(\bar{t}_{-i} - t_i)}{b}. \quad (A.7) \]

Substituting the type specific endowment in the welfare function (6) yields country \( i \)'s first order condition for the optimal tax rate

\[ (e_i - k_i)(1 - \alpha_i) - e_i + \varepsilon \left[ k_i - t_i \frac{(1 - \alpha_i)}{b} \right] = 0. \quad (A.8) \]

Proceeding analogously to our benchmark model, gives equilibrium taxes for each country type \( j = S, L \), as a function of the other type's tax rate [cf. eq. (11)]

\[ t^*_j(t_h) = \frac{b[(\varepsilon - 1)\eta + \alpha_j(\eta - e_j) + (\varepsilon - 1 + \alpha_j)n_h\alpha_h t_h]}{\varepsilon[2 - \alpha_j(n_j + 1)] - (1 - \alpha_j)(1 - \alpha_j n_j)} \quad \forall \ j \neq h. \quad (A.9) \]

This gives equilibrium taxes in reduced form

\[ t^*_j = \frac{b}{\rho} \left\{ [\varepsilon(1 - \alpha_h) + (\varepsilon - 1)\alpha_j n_j + \alpha_h \alpha_j n_j] \alpha_j(\eta - e_j) \\
+ (\varepsilon - 1 + \alpha_j)n_h\alpha_h^2(\eta - e_h) \\
+ (\varepsilon - 1)[\varepsilon(1 - \alpha_h) + (\varepsilon - 1) + \alpha_j \alpha_h (n_j + n_h)] \eta \right\} \quad (A.10) \]

where \( \rho \) is as in (13). Equation (A.10) can easily be seen to collapse to (12) when \( e_S = e_L = e \) (and hence also \( \eta = e \)). From (A.10), the equilibrium tax differential between a large and a small country can be derived using several straightforward manipulations. This gives eq. (23d) in the main text.
References


