A SYNTHESIS OF RECENT DEVELOPMENTS IN THE THEORY OF CAPITAL TAX COMPETITION

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This version: October 5, 2004

Abstract This paper proposes a unifying framework for theories of capital tax competition, and surveys and synthesizes the literature within this framework. The synthesis covers various standard tax competition models, models allowing for leviathan governments and democratic elections, in addition more recent contributions to the literature such as cross hauling of investment and models allowing for agglomeration forces to be associated with capital mobility.

Keywords: Tax competition; Capital taxation; Capital mobility
JEL Classification: H20; F2

[α] Comments and suggestions from Richard Baldwin, Peter Birch Sorensen, Gianmarco Ottaviano and Charles Wyplosz are gratefully acknowledged. Errors and omissions remain the responsibility of the author. Address for correspondence: Signe Krogstrup, IUHEI, 11A, Avenue de la Paix, 1202 Geneve. E-Mail: krogstru@hei.unige.ch. Fax: +41 22 733 30 49.

1. INTRODUCTION

The notion of international capital tax competition originates from an extensive theoretical literature on tax competition with roots back to Tiebout (1956) and Oates (1972), and which took shape with the seminal papers of Zodrow and Mieszkowski (1986) and Wildasin (1988). The literature investigates what international capital mobility means for nationally set capital taxes, and the general result is that source taxes on mobile capital will be competed downward while the public good will be under provided, or alternatively, that taxation of labor and other less mobile tax bases will have to finance more of the public spending when capital mobility increases. These results are, however, based on a set of rather restrictive assumptions about the economies in which tax competition takes place. Moreover, the stylized facts contradict the predictions of the standard tax competition literature. For example, capital taxes have not fallen over the last 20 years in the European Union, in spite of the fact that capital mobility increased dramatically in the EU during those years. In fact, EU average tax revenues from corporate taxation increased during the last 20 years, both in percent of GDP and in percent of total tax revenues[i].

Amendments to the basic tax competition model have been proposed in order to explain these facts, notably allowing for political economy consideration to play a counteracting part in the tax competition game, and tax exporting effects of increased international diversification of ownership of economic activity. And currently, an entirely new modeling framework for analyzing the effects of increasing international capital mobility on capital taxation, namely that of new economic geography, is evolving rapidly with promising results and important policy implications. New economic geography models challenge the conclusions of the standard tax

competition modeling framework in allowing for location specific rents to capital which can be taxed without triggering capital flight within certain limits, in turn allowing for situations where capital mobility leads to increasing capital taxation rather than the contentious race to the bottom in tax rates.

This paper reviews the capital tax competition literature and proposes a single unifying framework for analysis, or a synthesis of the literature, as a means to compare and evaluate the arguments of different tax competition models. The starting point of the review is the standard tax competition model of Zodrow and Mieszkowski (1986), and each new contribution to the literature is subsequently incorporated into this model by relaxing or making the respective assumptions that lead to the particular result.

The first section presents the central arguments of the standard tax competition model. These arguments are based on a model of tax competition for productive capital between an infinity of symmetric countries, where the only production input and tax base is capital, and the government is assumed benevolent in choosing the tax rate on capital. The assumption of an infinity of countries, or equivalently, that countries are small, is relaxed in Section 3, where national policy makers are assumed to have an effect on the international after-tax return to capital through their tax policy. Section 4 looks at the consequences for equilibrium capital tax rates of letting the competing countries be asymmetric in size while Section 5 summarizes the differences of residence and source based capital taxes and what the consequences are for tax policy if residence taxation is available as a tax instrument. The effect on capital income taxation of access to more than one tax base is presented in Section 6. Section 7 relaxes the assumption that the government is benevolent, and looks at how tax rates are set by a "leviathan government"

maximizing own utility or income and not that of its citizens. Section 8 adds democratic elections to the model and looks at how the political equilibrium may change the outcome for capital income taxation. Partial foreign ownership of firms is allowed for in the model in Section 9, where tax exporting effects result. Section 10 reviews the recent argument concerning capital income taxation derived from the new economic geography literature, and demonstrates a simple way of incorporating these arguments into the framework of the traditional tax competition literature. Section 11 takes a brief look at the empirical evidence, and the final section concludes.

Finally, it should be pointed out that the overview and synthesis is limited to the major part of the literature concerned with the effects of capital mobility on national capital taxes and national capital tax revenues. There is thus no explicit discussion of labor and commodity tax competition issues, except in so far as it relates to how capital is taxed. Nor is there any discussion of contributions proposing corrective measures (subsidies, etc), strategic tax policy concerning specific sectors, harmonization or coordination, although all these issues are highly relevant.

2. A BASIC MODEL OF TAX COMPETITION

The basic tax competition model presented by Zodrow and Mieszkowski (1986) investigates the effects of capital mobility on capital income taxation in a simplified - and hence rather restrictive - framework, and leads to the central conclusion of the literature: Capital mobility results in sub-optimally low capital taxation and under-provision of public goods.

An infinity of identical countries play a one-shot game in capital tax rates. Capital is perfectly mobile internationally, and no country can affect ρ, the international after-tax return to capital.

The same number of identical residents lives in each country, and all variables are measured in per capita terms. Each country has three sectors: production, the representative citizen and the government, and all countries have access to the international financial market.

There are two inputs in production: mobile capital and a fixed factor which Zodrow and Mieszkowski call land, but which can just as well be thought of as labor. The fixed factor is supplied by the representative citizen, who hence alternatively can be viewed as the owner of a production process using only capital, or as a worker in domestic production. Capital enters the production process with decreasing marginal productivity:

$$(1) \qquad y_i = f(k_i), \quad f_{k_i} > 0, \quad f_{k_i k_i} < 0$$

where k_i is the amount of capital per head invested in production in country *i*.

The representative citizen in country *i* will hence receive income from invested savings, $\overline{k}$, and wage income from domestic production. The budget constraint of the representative citizen is thus[ii]:

$$(2) \qquad x_i = f(k_i) - f_{k_i} \cdot k_i + \rho \cdot \overline{k}$$

Where ρ is the after-tax return to capital in country *i.* Since there is no tomorrow, the representative citizen will spend all her/his current income on private consumption, *x*, hence the equality sign. The utility of the representative citizen depends positively on public and private spending:

$$(3) \qquad u(g_i, x_i), \quad u_{g_i}, u_{x_i} > 0, \quad u_{g_i g_i}, u_{x_i x_i} < 0, \quad u_{g_i x_i}, u_{x_i g_i} = 0$$

The population size is scaled to one, such that the total amount of capital in each country is equal to $\bar{k}$. The government provides public goods *g*, which are financed with source taxes *t* on capital employed within the borders of the country in question. The government budget constraint of country *i* is thus:

$$t_i \cdot k_i = g_i \quad (4)$$

The Government's Problem under Zero Capital Mobility

The government is benevolent and chooses the tax rate that maximizes the utility of the representative citizen subject to the government budget constraint, and taking the tax rates of other countries as given. If capital cannot be moved abroad in response to a domestic tax rate increase, taxation of capital resembles a lump sum tax. In this case, the cost of increasing public spending by one unit in terms of lost private spending is one to one. The government will hence increase the tax rate as long as the marginal utility of public spending is higher than that of private spending. The first order condition for optimum under zero capital mobility is therefore:

$$\frac{u_g(g,x)}{u_x(g,x)} = 1 \quad (5)$$

The Government's Problem under Perfect Capital Mobility

When capital is perfectly mobile, the representative citizen can move her/his capital abroad to attain the world after-tax return to capital if the domestic net return to capital is lower. The international financial market is therefore characterized by the equilibrium condition:

$$f_{k_i} - t_i = \rho \quad (6)$$

for all *i*, where ρ is the world after-tax return to capital, considered fixed by the small countries. An increase in the tax rate on capital would have to be met by an identical increase in the gross

rate of return to capital in order for the after-tax rate of return to be equal to the world rate of return. Therefore, an increase in the tax rate initially triggers a capital outflow, which will only stop when the marginal return to capital has increased by the same as the increase in the tax rate. How much capital has to flow out of the tax-increasing country to re-gain equilibrium depends on the second derivative of the production function[iii]:

$$(7) \qquad \frac{\partial k_i}{\partial t_i} = \frac{1}{f_{k_i k_i}}$$

For later use, the elasticity of capital to the tax rate is defined as:

$$(8) \qquad \varepsilon^{S}{}_{k_i} = -\frac{t_i}{k_i \cdot f_{k_i k_i}} > 0$$

where the superscript S denotes the small country case. $\varepsilon^{S}{}_{k_i}$ is assumed to be smaller than one, which ensures staying on the left side of the laffer curve[iv].

In the case of perfect capital mobility, there are two costs associated with an increase in the domestic tax rate besides the direct cost of decreasing private spending. First, the associated outflow of capital lowers the gross return to the fixed factors of production and in turn reduces private spending. The second cost is the tax base erosion effect: the reduced domestic employment of capital would leave less capital to tax, which isolated from the tax revenue due to the higher tax rate applied to the infra-marginal units of capital would lower public spending. These two distortionary effects of a tax increase are not present when capital is immobile because a higher tax rate would translate into a one for one reduction in the after-tax return to capital, leaving the overall cost of capital as well as the amount of taxable capital unchanged.

Consequently, when a government increases the tax rate, each unit of additional tax revenue costs not only one unit of private income, but also the two costs described above. One additional unit of public expenditure therefore costs more than one unit of private expenditure for the country as a whole, or said with the terminology of public finance, the marginal cost of public funds is greater than one. This argument is summarized in the first order condition for the government's problem, derived by maximizing the utility of the representative citizen (3) with respect to the tax rate, and subject to the two budget constraints (2) and (4) and the financial market equilibrium condition (6)[v]:

$$\frac{u_g(g,x)}{u_x(g,x)} = \frac{1}{1-\varepsilon^S{}_k} > 1 \qquad (9)$$

where $\frac{1}{1-\varepsilon^S{}_k} = \frac{k}{k+\frac{t}{f_{kk}}} = MCPF$ is the marginal cost of public funds, and is always larger than one when the elasticity of capital with respect to the tax rate is positive.

The government will set the tax rate where the marginal cost of increasing public spending by one unit, the *MCPF*, is equal to the marginal utility increase of switching resources from private spending to public spending through an increase in the tax rate. Since the price of increasing public spending in terms of lost private consumption is larger than one, the marginal utility of public spending must be larger than the marginal utility of private consumption in equilibrium. This is the source of inefficiency in the model. If the government had access to a lump sum transfer tool to move resources from private to public consumption, utility would be increased.

Tax Competition Equilibrium

Under zero capital mobility each country employs its own endowment of capital and taxes are set optimally in that the marginal utility of private and public spending are equal. This changes when capital becomes mobile. The term “tax competition” describes how the countries compete for the fixed international amount of capital by undercutting each other's tax rates, effectively engaging in a “race to the bottom” in tax rates. Each country sets its tax rate assuming that tax rates in all other countries remain unchanged, but each time a tax rate is lowered in one country, the other countries will lose capital to that country and will have an incentive to decrease their tax rate as well. The "bottom" describes the symmetric equilibrium level of tax rates on capital. At this "bottom", the cost of decreasing the tax rate in terms of lost tax revenue is perfectly balanced with the benefit of the capital inflow that such a decrease would entail, given all other tax rates on capital in the world. Notice that in this setting, the "bottom" is not a zero tax on capital, but a positive although sub-optimally low level of capital taxation. Since the model is symmetric, each country will employ $\bar{k}$ amount of capital, as in the case of zero capital mobility, and all countries will set the same tax rate and provide the same sub-optimal level of public goods.

Gains from Cooperation

If all countries could credibly commit to increasing the tax rate marginally from the tax competition equilibrium level, such that the international allocation of capital would remain unchanged, overall utility in all countries would increase. Such a coordinated increase in the tax rate would be Pareto-improving, since resources would be moved one to one from private spending to public spending. Coordinated tax increases would be Pareto improving as long as the marginal utility of public spending exceeds that of private spending. The Pareto-optimal tax rate

would be the one, which equates the marginal utility of private spending with that of public spending.

Predictions of the Basic Model

To summarize, the basic model of tax competition therefore predicts that countries will increasingly compete for productive capital when capital mobility increases, by lowering the tax rates on capital. In equilibrium, capital mobility will result in capital income taxes and public spending being sub optimally low compared to the situation with zero capital mobility.

3. WHEN COUNTRIES ARE LARGE

The basic tax competition model presented above assumes an infinite number of countries such that the world after tax return to capital is not influenced by the decisions of any government. Wildasin (1988) modifies the above basic modeling framework to include a finite number of countries that can influence the after-tax return to capital with tax policy. The assumption of a finite number of countries turns out not to affect the results of the model qualitatively, i.e. capital taxes are still found to be sub optimally low, but there are quantitative differences. To see this, assume the simplest case of two identical countries competing for a fixed and internationally mobile amount of capital. Each country is characterized as the countries of the infinite country model above. The total amount of capital is now the sum of capital employed in country 1 and 2:

$$k_1 + k_2 = 2\bar{k} \quad (10)$$

where k_i is capital employed in the country i and $\bar{k}$ is the amount of capital owned by the representative citizen in each country (still normalizing the size of the population to one). The financial market equilibrium condition is now given by:

$$f_{k_1} - t_1 = f_{k_2} - t_2 \quad (11)$$

Totally differentiating (11) with respect to the tax rate gives the elasticity of capital employed in country 1 to the domestic tax rate:

$$\varepsilon^L{}_{k_1} = -\frac{t_1}{k_1 \cdot (f_{k_1 k_1} + f_{k_2 k_2})} > 0 \quad (12)$$

Where the superscript *L* denotes the large country case. Clearly, the elasticity of capital with respect to the domestic tax rate is smaller under the large country assumption than under the small country assumption, and this is the key to the difference between the outcomes of the two models.

Under the large country assumption, an increase in the tax rate and the subsequent capital outflow will depress the international after tax rate of return by changing the international supply of capital. This in turn has two effects on the marginal cost of public funds. First, a tax-induced capital outflow will reduce ρ, in turn mitigating the capital outflow and hence reducing $\varepsilon^L{}_k$. Therefore, if the country by tax policy can affect ρ, the tax base effect mentioned above is smaller, and the *MCPF* associated with the tax increase is lower than when the country is too small to affect ρ. Second, when an increase in the tax rate induces a capital outflow and a subsequent fall in ρ, the savings income of the representative citizen falls by the fall in the marginal product of capital, as seen in (2). At the same time, since the capital employed in domestic production is remunerated by its gross rate of return, *f'*, the cost of capital increases by less, and the income from production of the representative citizen falls by less than would have been the case if the tax change were not affecting ρ. Hence, the income effect of the change in the world after tax return to capital will tend to increase the marginal cost of public funds

compared to the case of constant after-tax world returns *if* the country is a net capital exporter, and the opposite holds true if the country is a net capital exporter. This is well illustrated by the first order condition for the government's problem when only two countries are competing:

$$\frac{u_g}{u_x} = \frac{1 - \varepsilon^L{}_k \cdot \left[(\bar{k} - k_1) \cdot \frac{f_{k_2 k_2}}{t_1} \right]}{1 - \varepsilon^L{}_k} \quad (13)$$

The second term of the numerator represents the differential effect on private income compared to the infinite country case, and depends on whether the country is a capital importer or exporter. In symmetric tax competition equilibrium, the capital accounts of the two countries will balance and the two income effects will cancel out, leaving only the tax base effect:

$$\frac{u_g}{u_x} = \frac{1}{1 - \varepsilon^L{}_k} \quad (14)$$

(14) illustrates that since the marginal cost of public funds is clearly lower compared to the infinite countries case due to the lower elasticity of capital to the tax rate, the tax rate which fulfills (14) will be higher than in the infinite countries case. But the tax rate will still be inefficiently low since the marginal cost of public funds continues to be greater than one[vi].

Predictions when Countries are Large

To summarize, the predictions for capital income taxation derived from the model where countries are allowed to have an impact on the after-tax return to capital are qualitatively the same as for when countries are assumed small: Capital income taxes levied at the source should exhibit a downward trend in response to increased capital mobility. The downward pressure, however, is predicted to be smaller than under tax competition between countries taking the after-tax return to capital as given. In reality, some countries may be large enough to have an effect on

the world after-tax price of capital while most other countries are too small in this sense. Models of asymmetric country size and tax competition analyze the tax competition interaction between large and small countries and are reviewed in the next paragraph.

4. ASYMMETRIC TAX COMPETITION MODELS

Symmetry has been used as a tool to simplify the derivation of equilibrium in models of tax competition. But symmetry hardly reflects the real world, and a few studies set out to analyze how the conclusions of the standard tax competition models presented above change when the assumption of symmetry is relaxed. Asymmetric models have been limited to differences in the size of the competing countries (Bucovetsky (1991)) or asymmetries in the endowment of capital per capita of the competing countries (Wilson (1991)). Moreover, Kanbur and Keen (1993) study commodity tax competition with asymmetric endowments. The conclusions of these models are largely the same. The larger country faces a lower elasticity of capital to the tax rate, and hence a lower marginal cost of public funds, and therefore chooses a higher tax rate than the smaller country. Bucovetsky's (1991) argument is presented below in order to show how asymmetry in the size of tax competing countries affects the tax competition equilibrium. Bucovetsky derives a model of two countries, which only differ in their population size, and where all per capita variables within each country are otherwise identical. This asymmetry implies that when the large country changes its tax rate, relatively more capital will flow from the country to the world capital market than when the small country increases its tax rate by the same amount. Hence, a change in the tax rate of the large country changes the world after-tax return to capital more than a similar change in the tax rate of a small country. The large country will therefore perceive the elasticity of capital - the tax base effect of a change in the tax rate - to be lower than the small

country, and will therefore have a lower marginal cost of public funds associated with a tax rate increase.

Let the two countries' per capita variables be described as in the basic model. When s_1 (s_2) is the population of country 1 (country 2) and normalizing s_1+s_2 to one, the financial market equilibrium condition is equal to (11) and the elasticity of capital with respect to the tax rate is equal to[vii]:

$$(15) \qquad \varepsilon^{A}{}_{k_1} = -\frac{t_1}{k_1 \cdot (f_{k_1k_1} + \frac{s_1}{s_2} f_{k_2k_2})} > 0$$

Where the subscript *A* denotes the tax elasticity of capital in the asymmetric model. (15) shows clearly that when country 1 is larger than country 2 ($s_1>s_2$), then the tax elasticity of capital is smaller in country 1 and vise versa. The first order condition for country 1 in the asymmetric model is:

$$(16) \qquad \frac{u_{g_1}}{u_{x_1}} = \frac{1 - \varepsilon^{A}{}_{k_1} \cdot \left[(\bar{k} - k_1) \cdot \frac{f_{k_2k_2}}{t_1} \right]}{1 - \varepsilon^{A}{}_{k_1}}$$

The similarity with the first order condition for the symmetric two-country model is clear. In order to see the difference that the asymmetry results in, assume an initial situation of symmetric allocation of capital between the two countries, such that $\bar{k} = k_1 = k_2$, thus abstracting from income effects of changes in tax rates. The first order condition reduces to:

$$(17) \qquad \frac{u_{g_1}}{u_{x_1}} = \frac{1}{1 - \varepsilon^{A}{}_{k_1}}$$

Note that a symmetric allocation of productive capital can not be an equilibrium situation when population size differ, since this symmetry would imply identical tax rates and distribution of resources between private and public spending, and hence identical *LHS* of (17) across the two countries, while differences in population size imply that the *RHS* of (17) - the marginal cost of public funds - would differ across countries. Assuming that the smaller country fulfills (17) in such an out-of-equilibrium symmetric situation, the larger country would have an incentive to increase its tax rate, and conversely, if the larger country fulfills (17), the smaller country would have an incentive to lower its tax rate. Both changes in tax rates would make the smaller (larger) country a capital importer (exporter), additionally increasing the smaller (larger) country's incentive for cutting (increasing) the tax rate as explained in the two country symmetric model above. In equilibrium, the larger country therefore sets a higher tax rate due to its relatively low marginal cost of public funds compared to that of the smaller country, and the smaller country will set a lower tax rate for the opposite reasons. Bucovetsky shows that higher taxes in the larger country compared to the smaller country is in fact a Nash equilibrium by assuming quadratic production functions and proving the existence of such an equilibrium analytically.

The small country enjoys a lower cost of capital and will employ a greater amount of capital per fixed factor in equilibrium, with the consequence that the returns to these fixed factors is higher compared to the larger country. The representative citizen of the smaller country therefore enjoys a higher net income than the representative citizen of the larger country. Since the tax base is larger and the tax rate is lower in the small country, it depends on the parameters of the model whether public good consumption is higher or lower in the smaller country relative to the larger country. But it can be shown that in any case, the small country is better off than the large country in equilibrium. If the small country is small enough, it may have such high returns to the

fixed factors owned by the residents that it is better off under tax competition with a larger country than it would be if taxes were set cooperatively to maximize overall welfare between the two countries. This result is called "the advantage of smallness" in the literature, and has been put forward as a possible explanation for why tax coordination is so difficult to agree on in the European Union.

The interaction of the two countries on the common capital market is solely responsible for the asymmetric outcome. If capital mobility is assumed zero in the otherwise identical model of two asymmetrically populated countries, both countries irrespective of size choose the same tax rate, namely the one which equates the marginal utilities of private and public spending.

Predictions from Asymmetric Models

The central message of tax competition models allowing for differences in the size of the countries is that larger countries have higher tax rates of capital compared to smaller countries when capital is mobile across countries. In contrast, if capital is immobile, all countries irrespective of size choose the same tax rate. Combining these two findings allows posing the hypothesis that the higher the mobility of capital becomes, the more the tax rates on capital differs between large and small countries.

5. RESIDENCE VS. SOURCE BASED CAPITAL TAXES

Capital tax competition models generally study the consequences of tax base mobility when taxes are levied at the source. There are many justifications for not focusing on residence taxation of capital, the most important one being that residence taxation, where is it implemented, is hard to enforce due to lack of information sharing among countries[viii].

Since there is no time dimension and consumption/savings trade-off in the basic tax competition model, including a residence based tax on capital is wholly non-distortionary. In this case, the marginal cost of public funds would be unity and the first order condition would be equal to (5). The allocation of resources between private and public spending would be Pareto optimal. If the residence tax on capital is not enforceable, i.e. if the tax authorities cannot observe the foreign capital income of their residents and the residents do not declare this income (which is generally the case for capital income taxation), source based taxation would be used as in the basic model above.

Regimes where both residence and source taxation are allowed have been investigated in more complex models allowing for saving/consumption trade-offs. Razin and Sadka (1991) assume two small competing countries (taking the international after-tax return to capital as given and in this way ignoring effects on the elasticity of capital to the tax rate) allowing both source and residence taxation of capital as well as taxation of internationally immobile labor in a two period model with savings. Both labor and savings are assumed elastic to their after-tax returns. Tax competition results in a symmetric Nash equilibrium where the withholding tax rate on capital is zero and only the residence tax on capital is used to tax capital. Moreover, this equilibrium is second best – there are no gains to be made from coordination between the two countries. These conclusions depend crucially on the assumption that capital can effectively be taxed at residence. This is not the case in the model of Frenkel et al. (1991) , who use the same model augmented with a rest of the world (ROW) to which capital may flow freely. Assuming that ROW does not provide information about foreign investors' capital income to the tax authorities of these investors, and assuming that investors do not declare their overseas capital income, capital

income will not be taxed at all, and the entire tax burden will be switched to labor. Moreover, cooperation between the small number of countries would be futile as long as there is a non-cooperative ROW. The complete absence of capital taxation in this model depends on the assumption of an alternative tax base - here in the form of labor income. Situations where other tax bases are available are briefly considered in the simple model framework in the following section.

Predictions for Residence Taxation

If residence taxation of capital is enforceable, the above analysis shows that the source principle for taxation of capital income should not be used. Taxation of capital would in this simple setup be non-distortionary and hence optimal, and there would be no gains from international cooperation in setting taxes. If residence taxation is not enforceable, however, the basic models predict the use of distortionary and hence inefficiently low source based capital income taxes. If an income tax on immobile labor is available, the entire tax burden will be put on labor, as shown in the following section as well.

6. MORE THAN ONE TAX INSTRUMENT – PROFIT AND LABOR TAXATION.

In their model of capital tax competition, Zodrow and Mieszkowski (1986) allow for a lump sum transfer from the representative citizen to the government in addition to the capital income tax, and show that only when this lump sum transfer does not cover the cost of optimal provision of the public good will the capital income tax tool be employed. By analogy, if a non-distortionary tax base is added to the basic model of tax competition of Section 2, and this tax base generates sufficient tax revenues, then the tax rate on capital will be zero. Such a non-distortionary tax base could be profits, as assumed in for example, Huizinga and Nielsen (1997) and Haufler and

Schjelderup (2000). Huizinga and Nielsen show that in the absence of such profit taxation, the distortionary source taxation of capital will lower the profits due to the distortions, and conclude that capital income taxation can be thought of as an indirect way of taxing profits, when taxing profits directly is not possible. Haufler and Schjelderup (2000) assume that only profits are taxed, but allow for deductions for the cost of capital to differ from economic cost of capital, thereby creating a source of distortion of the profit tax rate and triggering a tax competition game for taxable streams of profits rather than capital.

Moreover, when a non-distortionary tax tool is available in addition to source based capital income taxation, capital mobility will lead to a shift of the relative tax burden from the mobile toward the immobile tax base. To see this, assume two inputs, labor and capital, in the constant returns to scale technology production in the basic model of Section 2:

$$y_i = f(k_i, l_i) \quad (18)$$

Assume moreover that the representative citizen provides a fixed amount of labor, $\overline{l}_i$, which is remunerated by its marginal product and allow for unit taxation of labor. These alterations change the private and public budget constraints[ix]:

$$x_i = f(k_i, \overline{l}_i) - f_{k_i} \cdot k_i + (f_{k_i} - t_i) \cdot \overline{k} - t^w{}_i \cdot \overline{l}_i \quad (19)$$

$$t^r{}_i \cdot k_i + t^w{}_i \cdot \overline{l}_i = g_i \quad (20)$$

The government maximizes (3) with respect to the two tax rates and subject to (19) and (20). The first order conditions for the labor tax and the capital tax are equal to (5) and (9) respectively. (5) and (9) can only be fulfilled simultaneously when the tax rate on capital is equal to zero. Capital will therefore not be taxed at all in equilibrium. If capital were taxed under

zero capital mobility, for example due to equity or fairness considerations, the change from zero to positive capital mobility hence leads to a shift in the tax burden toward immobile labor income.

These results only confirm the inverse elasticity rule of optimal taxation: the optimal tax rate is inversely proportionate to the elasticity of the tax base. Razin and Sadka (1991) show that if labor supply elasticity is allowed for in a small open economy, the entire tax burden will still be levied on labor in spite of the positive elasticity. The reason is that the capital elasticity goes to infinity in a small open economy while labor supply elasticity remains finite. Bucovetsky and Wilson (1991), also allowing for labor supply elasticity, look at a finite number of countries and show that this implies that capital supply elasticity is also finite, which in turn implies that capital is taxed in equilibrium, in addition to labor income. Moreover, they show that when the number of countries goes to infinity, the tax on capital goes to zero, i.e. the limit case of small countries modeled by Razin and Sadka (1991). If increasing capital mobility is interpreted as an increase in the elasticity of capital to the tax rate, Bucovetsky and Wilson's model can then be taken to imply that when the mobility of capital increases, more of the tax burden will fall on labor relative to capital.

But these conclusions are based on the assumption that the tax revenue from the immobile tax base will be sufficient to ensure that (5) is fulfilled in equilibrium. If this is not the case, and assuming again that labor income is immobile, capital taxation will be employed in addition to taxation of labor, and (9) will be the equilibrium condition. The distortionary effect of the capital tax will hence preserve the central result of the standard tax competition model of under-provision of the public good in spite of the limited availability of a non-distortionary tax tool. The

tax rate on capital in equilibrium will, however, be lower when tax revenues from other sources are allowed for, and the level of distortions to the economy will hence be lower. In this case, an increase in capital mobility will also lead to a lower tax rate on capital while the tax rate on immobile labor will remain unchanged. The tax burden on labor relative to that on capital will hence increase with capital mobility.

Predictions When Adding a Second Tax Base

Allowing for non-distortionary taxation of an immobile tax base in the standard model of tax competition shows that this leads to optimal provision of the public good. Moreover, the literature analyzing the effects of capital tax competition when taxation of less mobile tax bases is possible, predicts that as mobility of capital increases, tax rates on other less mobile tax bases, such as labor income, will increase relative to capital tax rates.

7. THE LEVIATHAN POLICYMAKER

In spite of the compelling arguments of the models presented above, no consensus exists as to whether tax competition is good or bad for welfare. This disagreement has its roots in the view of government objectives and/or efficiency. The conclusion that tax competition lowers welfare crucially depends on the assumption that the policymaker is benevolent, and hence aims at maximizing welfare under the resource and behavioral constraints of the economy. Another branch of the tax competition literature, taking its starting point in the public choice literature, models government as a self-serving "Leviathan" and looks at how tax competition affects tax rates and welfare.

In Leviathan models, the government has as objective either the maximization of the size of the state (tax revenue) or the maximization of own consumption or utility, which in turn may depend on several things in combination. In most cases, tax competition is efficiency enhancing when the government is modeled as a Leviathan. The intuition for this result is straightforward. In the absence of tax competition, a government maximizing the size of the state will most likely be imposing sub-optimally high tax rates from a welfare point of view. Symmetric tax competition provides a downward pressure on the tax rate, which in turn increases the utility of the representative citizen without changing the capital allocation between competing countries in equilibrium. The government Leviathan can also be modeled as maximizing a combination of the probability of reelection and own wasteful consumption, where wasteful consumption can be thought of as spending tax revenue in a manner that does not enter into the utility function of the representative citizen. Spending on public good provision or lowering the tax rate so as to increase the representative citizen's utility increases the reelection probability. Again, tax competition provides a check on the overall tax revenue, but the effect on welfare (defined by the utility of the representative citizen) is not unambiguous in this case. Depending on the policymaker's trade off between reelection probability and wasteful consumption, the representative citizen may suffer or gain from this check.

Edwards and Keen (1996) reconciles the two different views of government by including in the basic model a government objective function including a Leviathan term and a benevolent term. The policymaker derives utility from own wasteful consumption, c, and from the representative citizen's utility from public good provision and private consumption, u:

$$V = V(c, u(g, x)) \quad (21)$$

The policymaker maximizes utility with respect to wasteful consumption and the tax rate (hence letting public spending be determined by the budget constraint as a residual). The two resulting first order conditions are equal to (9) and:

$$V_c = U_g \cdot V_u \qquad (22)$$

The former first order condition is known from the basic model above, and is due to the fact that the utility of the representative citizen is included in the objective function. If (9) is not fulfilled, then for a given level of wasteful consumption, the government can increase utility by changing the tax rate and private and public spending, without changing the utility derived from wasteful consumption. The latter first order condition states that the marginal utility derived from public spending (the right hand side of (22)) should equal the marginal utility of wasteful consumption, since there is no distortionary cost involved in transferring resources from public to wasteful consumption.

In the case of the closed economy where capital is not mobile, the two first order conditions for government optimization are (5) and (22). Tax competition changes the equilibrium by decreasing the tax rate given the symmetric amount of capital that remains in the country in equilibrium. If the fall in tax revenue is entirely financed by lower spending on public goods, the utility of the representative citizen will fall. To see this, remember that the marginal utilities of private and public consumption are equal before the fall in tax revenue. The fall in tax revenue translates into a one to one increase in private consumption, of which the marginal utility is decreasing. If it also translates into a one-to-one fall in spending on public goods, the marginal utility of this public good provision will increase, subtracting more utility from the representative citizen than the increase in private consumption added. On the other hand, if the entire fall in tax

revenue translates into a decrease in wasteful consumption, the representative citizen obviously gains. Depending on the parameter values of the policymaker's objective function, the outcome lies somewhere in between.

The main differences between the conclusions of Leviathan models and models where the government is benevolent are normative. Both types of models predict a fall in the tax rate due to an increase in capital mobility, but in the Leviathan model, this fall enhances efficiency by constraining a tendency to spend too much and too wastefully, while if the government is benevolent, the downward pressure on the rate leads to a sub-optimally low provision of public goods.

Predictions of Leviathan Models

Leviathan models of tax competition also predict that capital income taxes are subject to a downward pressure due to increased tax competition, while public spending may or may not fall depending on how the Leviathan is modeled (tax revenue maximizing or wastefully spending).

8. TAX COMPETITION AND POLITICAL ECONOMY

The models of tax competition reviewed till now all have in common that they predict a fall in the tax rate on capital when capital mobility increases. The next three contributions to the theoretical literature differ in this respect. This section takes a closer look at what the political science literature has to say about capital tax competition.

The political science literature on the effects of globalization explicitly deals with financial integration as part of a current ongoing globalization, and as part of this looks at the effects of

increased capital mobility on tax rates. In this branch of the literature[x], increasing financial integration is usually supposed to have two opposite effects on tax rates. The first effect is the tax competition effect, which Swank (1998) calls diminished democracy, reflecting the decreasing power of a democratically elected government to collect tax revenues from mobile capital. The second effect is the compensation hypothesis, stating that the more open a country is to the rest of the world, the greater are the fluctuations in economic activity, and the greater the public demand for social insurance will be, in turn requiring higher tax rates for financing[xi]. Increasing capital mobility can hence both mean higher and lower tax rates, depending on which of the two forces is greater. Persson and Tabellini (1992) touch on similar issues with a more formal approach, when modeling tax competition in a two-country median voter setup, where the policy maker is elected democratically from the population. While the policymaker is modeled to take the tax rate of the other country as given in choosing the optimal tax rate (the Nash equilibrium concept), the median voter takes the equilibrium tax rate as given and associated with the policymaker's preferences, and hence elects a policymaker with preferences which will maximize his/her utility. The policymaker is therefore not necessarily the median voter, and Persson and Tabellini show that the higher the capital mobility is, the further to the left in the political spectrum the elected policymaker will be, hence counteracting the downward pressures of tax competition[xii]. The political "move to the left" effect hence mitigates the downward tax competition pressure on tax rates, but the tax competition effect is shown to always outweigh the political effect.

Predictions of Political Economy Models

The branch of the literature taking into account the political reaction to increased capital mobility predicts that tax competition pressures are mitigated by a popular demand for more social insurance and in turn higher taxes for financing. Hence, according to these arguments tax rate

should be expected to fall when capital mobility increases, but less than predicted by traditional tax competition models.

9. TAX EXPORTING

Another often neglected aspect of increasing capital mobility is the increasing international diversification of portfolios and real capital facilitated by capital mobility. Financial liberalization and integration implies that investors will invest in the production of foreign countries, and receive income from foreign investments, which are taxed in the foreign country. A government, who cares about the welfare of the domestic resident, does not care about the welfare loss experienced by the foreign investor when she or he is taxed. Huizinga and Nielsen (1997), and later Eijffinger and Wagner (2002) show that in this case, the marginal cost of increasing the tax rate in terms of lost private domestic net income is lower when some of the tax incidence is on foreigners. Policymakers will hence have an incentive to increase the tax rate, all else being equal. The effect on capital taxes is called tax exporting, and has the opposite effect on capital taxes of the tax competition effect that has been in focus till now.

The tax exporting effect is not present in the standard modeling framework of Section 2 because all tax incidence ultimately falls on the return to the domestically owned fixed factors of production when capital is perfectly mobile. Thus, when the tax rate on capital is increased, the employment of capital will be reduced until the after-tax return to capital is the same as before the tax increase. The owner of the fixed factors pay in terms of lost production, and in the model of Section 2, this owner is the representative citizen. Following Eijffinger and Wagner (2002)[xiii], assume that the fraction μ of the domestic production is owned by foreigners, and that the domestic representative citizen equally owns a fraction of foreign production, from which the net

income is δ. Everything else is as in the basic model of Section 2. The private net income of the representative citizen becomes:

$$x_i = (1-\mu)(f(k_i) - f_{k_i} \cdot k_i) + \rho \cdot \bar{k} + \delta \quad (23)$$

Maximizing (3) with respect to the tax rate and using (4), (6) and (23) yields the first order condition for equilibrium with cross ownership of firms:

$$\frac{u_{g_1}}{u_{x_1}} = \frac{1-\mu}{1-\varepsilon^S_k} \quad (24)$$

The elasticity of capital with respect to the tax rate in this case remains as under the symmetric basic model without cross ownership of firms. But the effect of a change in the tax rate on the returns to the fixed factor, of which only (1- μ) is owned domestically, is smaller. The fraction μ of the tax incidence is "exported" to foreigners. (24) shows that if $\mu < \varepsilon$, tax competition pressures will still result in too low a capital tax rate although tax exporting effects will mitigate the downward pressure. However, if $\mu > \varepsilon$, the opposite will be case in that the tax exporting effect of financial integration will dominate, and the tax rate on capital will be too high from a social optimum point of view.

Predictions of Models with Tax Exporting

When the increased international diversification of economic activity following financial liberalization is allowed for in the standard tax competition model, the marginal cost of public funds is lower, and the tax rate on capital will be higher in equilibrium, all else equal.

10. AGGLOMERATION ECONOMIES

The downward pressure on capital tax rates due to tax competition is often argued to be counterbalanced by the many other factors relevant for the location decision of a firm. Among

such other factors are level of education of the work force, infrastructure and market access for final products as well as for intermediates. Recently, a different theoretical setup, namely that of new economic geography models, has been employed for analyzing capital tax competition issues, with very interesting results. New economic geography models generally show that a race to the bottom in capital tax rates does not have to take place even though capital is becoming increasingly mobile. One reason is the presence of agglomeration economies and the possibility of differential economic rents across countries. Ludema and Wooton (2000), followed by Andersson and Forslid (2003) and Baldwin and Krugman (2003), using economic geography models with mobile skilled and immobile unskilled labor, have pointed out the possibility of taxation of the mobile labor under the presence of agglomeration rents, without triggering an outflow of this factor to other countries. Moreover, and more in line with the traditional tax competition models, Kind et al. (2000) and Ottaviano and Van Ypersele (2002) assume that the mobile factor is capital and allow the purchasing power of the income of capital to be detached from the location of investment. They find that when all economic activity is agglomerated in one country, the gross return to capital in that country is higher than the potential return to capital in the other country. This cross-country difference in gross returns to capital allows for positive taxation of capital in the country hosting the agglomeration/cluster without giving an incentive for capital to flow out. Additionally, both studies find that if production activity is not completely clustered in one of the two countries, both countries will use their tax rate to compete for capital and will end up with negative tax rates in equilibrium. This result is not qualitatively different from standard tax competition models allowing for the lump sum taxation of another factor (see Section 6 above)[xiv]. In an attempt to solve the dispute between the tax competition results of the new economic geography literature and the standard tax competition literature, Fernández (2004) incorporates external economies of scale directly into a standard tax competition modeling

framework, and finds that under the assumption that the firm specific decreasing marginal product of capital is stronger than the external economies of scale, the race to the bottom result will still obtain, and even be magnified. Taking one step further, Krogstrup (2004) shows that when external economies are allowed to outweigh firm specific decreasing marginal product of capital, the standard tax competition model augmented with external economies yields results similar to those of the new economic geography literature. In order to see this, allow for external economies of scale in the otherwise standard two country basic modeling framework of Section 3[xv]. The per capita production function is now given by:

(25) $y_i = f(k_i)h(k_i)$,

where $f(k_i), \quad f_{k_i} > 0, \quad f_{k_i k_i} < 0$, $h'(k_i) > 0$ and k_i is the amount of capital per capita invested in production in country *i, i* =1,2. $f(k_i)$ is a constant returns to scale per capita production function index, where the fixed factor is suppressed. $h(k_i)$ gives the external economies of scale of capital accumulation in the country in question. $h(k_i)$ is treated as given by firms when making decisions regarding input demand and output supply. Thus, on the micro level, firms operate with a constant returns to scale technology, while on the macro level, agglomeration of production leads to external economies of scale. The representative citizen in country *i* receives income from invested savings, $\overline{k}$, and income from ownership of the fixed factor in production, leading to the private budget constraint:

(26) $x_i = f(k_i)h(k_i) - f'(k_i)h(k_i)\cdot k_i + \rho \cdot \overline{k}$

In all other respects, the model is the same as that of Section 3. Now, when assuming, as Fernandez (2004), that the effect on the return to capital from agglomeration economies are

dominated by the decreasing marginal productivity of capital, $\frac{\partial f'(k)h(k)}{\partial k} < 0$, capital movements will be stabilizing, in the sense that when capital moves in response to a net return differential across countries, the net return differential will narrow. In this case, the standard tax competition result of a race to the bottom in tax rates still obtains, and is in fact magnified. When making the opposite assumption, however, that $\frac{\partial f'(k)h(k)}{\partial k} > 0$, a capital flow from one country to another will increase the net return differential and create stronger incentive for further capital flows. There are two possible Nash equilibria in tax rates in this setup: a symmetric equilibrium where capital is evenly distributed between the two countries and an asymmetric equilibrium (henceforth called the core-periphery equilibrium following the terminology of the new economic geography literature) in which all capital and production is located in only one of the countries. The symmetric equilibrium is characterized by zero tax rates, but is not stable and will not be treated further here[xvi]. The core-periphery equilibrium on the other hand is stable, in that a small outflow of capital or a small increase in the tax rate in the core would not trigger further capital outflows, since the gross return to capital in the core would be higher than that of the periphery under increasing returns to capital.

In the core periphery equilibrium, all capital is invested in the production of one country - the core - while the other country – the periphery - does not have domestic production at all. The net of tax income of the representative citizen in the core consists of returns to fixed factors and invested savings:

$$(27) \quad x_c = \left[f(2\bar{k}) - f'(2\bar{k}) \cdot 2\bar{k} \right] \cdot h(2\bar{k}) + \left[f'(2\bar{k}) \cdot h(2\bar{k}) - t_c \right] \bar{k},$$

while the net of tax income of the representative citizen in the periphery consists of savings invested in the core:

$$(28) \qquad x_p = \left[f'(2\bar{k}) \cdot h(2\bar{k}) - t_c \right] \bar{k} ,$$

where *c* and *p* subscripts stand for core and periphery respectively. Tax revenues and the government budget constraint in the core are given by:

$$(29) \qquad g_c = t_c \cdot 2 \cdot \bar{k}$$

While tax revenues and government spending in the periphery are zero:

$$(30) \qquad g_p = 0$$

The citizen in the periphery spends her net repatriated earnings from capital on imports of the private good, while there is no public good provision since there is no tax base in the periphery. In this setup, the country hosting the core can tax capital without triggering a flow of capital to the other country, since the difference between the gross return to capital in the core and the potential gross return to capital of the periphery is strictly positive. As long as the tax rate does not exceed this difference, the net return to capital will stay greater in the core. Within this upper limit to the tax rate, capital is effectively immobile, and can be taxed without distortions. The government in the core hence chooses the tax rate that maximizes the utility of its own representative citizen, given the relevant budget constraints and a zero tax rate in the periphery, and assuming that capital is immobile within the given upper bound. The resulting first order condition for optimum becomes[xvii]:

$$(31) \qquad \frac{u_g(x_c, g_c)}{u_x(x_c, g_c)} = \frac{1}{2}$$

An equilibrium characterized by (31) is not driven by tax competition pressures, which are absent due to the assumed strength of external economies. Two other factors - the income effect and the tax exporting effect – affect capital tax rate here. Due to external economies, global production and hence global income increase when production is agglomerated in the core. Depending on the parameters of the utility function, higher income may affect relative preferences for the public good and in turn the optimal tax rate. If preferences for example conform with Wagner's Law, the public good is a luxury good and public good demand should increase relative to private goods as income increases, implying a higher tax rate all else equal. But the income effect could also be neutral or negative. The tax exporting effect can only be positive on the other hand. In the core periphery allocation of capital, only half of the tax revenues of the core comes from the domestic citizen, while the foreign capital owner – whom the core government does not care about in choosing the optimal tax rate – pays the other half. This implies that the marginal cost of public funds is one half, or in other words, that a tax increase is cheaper in terms of private consumption than in the standard tax competition case, leading to a higher optimal tax rate.

In conclusion, under strong external economies of scale, if the income effect is non-negative, the core periphery equilibrium will be characterized by a higher tax rate than in the autarky situation, thus implying a race to the top rather than a race to the bottom. Note also that an equilibrium given by (31) is characterized by over provision of the public good, contrary to the result o the standard tax competition model, since the marginal cost of public funds is lower than one.

Predictions of Economic Geography Models

The conclusions drawn concerning capital income taxation from the literature of economic geography are here restricted to those of the basic tax competition model modified to allow for external economies. When capital mobility increases, the capital tax rate is predicted (assumed) to fall in countries with low concentration of production while in countries with high concentration of production are predicted to raise their capital income tax levels.

11. THE EMPIRICAL EVIDENCE

There is no doubt that capital has become highly mobile on the global level, and even more so among OECD countries, and capital tax competition is therefore prone to be taking place. Foreign capital has been found to be responsive to host country tax rates (see Devereux and Griffith, 2002, for a review of the literature on the link between FDI and corporate tax rates). And recent estimations of tax reaction functions show that national tax rates do seem to respond to taxes of neighboring countries, implying that strategic interaction in tax rates are likely to be taking place (see for example Besley et al., 2001). However, the results of the nascent literature testing for the existence of tax competition pressures are mixed at best, and no firm empirical evidence has been found so far to support the hypothesis of a race to the bottom in capital tax rates. Devereux et al (2002) show that while statutory tax rates have been falling, the average tax burden on capital has not been decreasing in the European Union over the last few decades. Moreover, studies estimating correlations between measures of capital mobility and the tax burden on capital for OECD country panel data find no support for tax competition. On the contrary, some of these studies found a significantly positive relationship between capital mobility and the tax burden on capital, which is more in line with the predictions of the new economic geography literature (Quinn, 1997; Swank, 1998; and Garreth and Mitchell, 2001).

More empirical research of the link between capital mobility and capital tax rates to complement the numerous theoretical contributions to the tax competition literature is clearly warranted.

12. CONCLUSION

This paper has reviewed and synthesized the theoretical literature on tax competition within a single unifying framework. The synthesis shows how the different contributions to the theoretical tax competition literature in general can be summarized and compared in terms of how the elasticity of capital to tax rates is assumed to respond to changes in capital mobility. When the elasticity is higher, the tax competition effect increases and results in lower capital tax rates. Notable exceptions to this finding are the contributions to the literature allowing for democratic elections and for international cross hauling of investment. In each of these cases, the incentives for taxation tax change irrespective of the elasticity of capital to the tax rate.

The synthesis also shows that the different contributions complement each other in providing a fuller picture of how increasing capital mobility affects capital taxation. In particular, while it has been argued that new economic geography models contradict the standard tax competition models, the standard result of a downward pressure on capital tax rates is rather a special case of the new economic geography model. In addition, the new economic geography models illustrate the importance of allowing for agglomeration economies for the outcome of the capital tax competition game.

The standard and basic tax competition theory predicts a downward pressure of capital mobility on capital tax rates – the co-called race to the bottom. But relaxing each of the underlying restrictive assumptions in turn shows that the race to the bottom is not the only possible

consequence of increasing capital mobility. In particular, three amendments to the standard model, namely those of allowing for democratic elections, foreign ownership of firms, and increasing returns to capital, counteract the capital tax race to the bottom prediction, and may in some cases lead to the opposite result that higher capital mobility implies higher tax rates on capital.

No firm empirical evidence has been found to support the hypothesis of a race to the bottom in capital tax rates, as predicted by the standard tax competition model. As mentioned above, the theoretical literature provides several potential mechanisms to explain the lack of a race to the bottom in capital tax rates, and since the policy implications of the different mechanisms differ widely, it is essential to focus future research on identifying the relative empirical importance of each mechanism.

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NOTES

[i] See Devereux et a. (2003), Baldwin and Krugman (2003) for stylized facts regarding the evolution of capital income taxation in the European Union.

[ii] The model chosen here does not include the lump sum transfer from the representative citizen to the government, as is the case in Zodrow and Mierzkowski (1986). As long as the lump sum transfer is less than the optimal level of government spending, this does not change the conclusions.

[iii] Found by totally differentiating the financial market equilibrium condition with respect to the tax rate.

[iv] The assumption ensures that the derivative of tax revenues with respect to the tax rate is always positive. To see this, differentiate the budget constraint with respect to the tax rate and rearrange.

[v] Country subscripts are left out. The second order condition is fulfilled as long as the third derivative of the production function is not too large, i.e. as long as the curvature of the marginal product of capital is not too bent. The intuition for this result is that if the elasticity of capital to the tax rate falls sufficiently when the tax rate increases, the marginal cost of public funds may actually decline faster than the fall in the marginal utility of public relative to private consumption when the tax rate is increased. Formally, the second order condition for optimum states that the derivative of the tax elasticity of capital with respect to the tax rate has to be too negative: $\frac{\partial \varepsilon^{S}{}_{k}}{\partial t} > \frac{k}{u_{g}}\left[u_{xx} + u_{gg}(1-\varepsilon^{S}{}_{k})\right] < 0$. This corresponds to a condition for the third derivative of the production function: $f_{kkk} < \frac{(f_{kk})^{2}}{t} - \frac{f_{kk}}{k} - \frac{(f_{kk})^{2}\cdot k}{\varepsilon^{S}{}_{k}\cdot u_{g}}\left[u_{xx} + u_{gg}(1-\varepsilon^{S}{}_{k})\right] > 0$. Making the assumption that the third derivative of the production function is zero, simplifies the calculations, does not change the conclusions and satisfies the second order condition.

[vi] The analogy to the Cournot oligopoly model of trade and cross hauling is clear. The traded good is capital and the price is the after-tax return to capital. The oligopoly model illustrated that the more countries (i.e. firms) there are, the closer we get to perfect competition situation where each country takes the after-tax return to capital (i.e. the price of the traded good) as given.

[vii] Insert the definition of the capital stock: $k_{2} = \frac{\overline{k} - s_{1}\cdot k_{1}}{s_{2}}$ into the financial market equilibrium condition $f_{k_{1}}(k_{1}) - t_{1} = f_{k_{2}}(k_{2}) - t_{1}$, differentiate with respect to the tax rate to get the derivative of capital. Rearrange. Notice here that not only are all variables in per capita terms, but the production function is also in per capita terms.

[viii] There are many reasons for why sovereign countries do not provide information to the tax authorities of a foreign investor, the most important being that information provision is costly and there is no incentive for the provider to provide the information. For a small survey of reasons for the lack of information sharing, see Tanzi 1995.

[ix] Due to constant returns to scale, labor is paid the rest of the production when capital is paid its marginal product. There is therefore no reason to change notation from the basic model above and include the marginal product of labor in expression for private income.

[x] See for example Swank (1998) and Garreth and Mitchell (2001).

[xi] In this branch of the literature, which is rather informal, it is usually assumed and not questioned that increased openness means increased economic instability. The possibility that increased openness increases diversification and in turn increases stability is not touched on.

[xii] Here, being to the left in the political spectrum should be understood as having preferences for higher taxation and public spending, all else equal.

[xiii] Eijffinger and Wagner (2002) also assume that the same fraction of domestically invested capital is owned by foreigners, such that the private net income becomes $x_i = (1-\mu)(f(k_i) - f_{k_i} \cdot k_i) + (1-\mu)(f_{k_i} - t) \cdot k_i + \rho \cdot (\bar{k} - (1-\mu)k_i)$. But this assumption has no import on the tax exporting argument, and in hence left out in this presentation. Also note that Eijffinger and Wagner (2002) show that if pure profit taxation is allowed for in this model, meaning that the returns to the fixed factor can be taxed directly, there will be no incentive for tax exporting if the profit tax revenues are sufficient for covering the optimal provision of the public good. In this case, the source tax on capital will be zero, as in the standard model.

[xiv] See Baldwin et.al (2003) for a comprehensive treatment of the implications of agglomeration forces for capital tax competition in new economic geography models.

[xv] This paragraph draws extensively on Krogstrup (2004).

[xvi] See Krogstrup, 2004, for further discussion of the symmetric equilibrium.

[xvii] An internal equilibrium fulfilling this first order condition is sub-game perfect if utility in the core is at least as high as the utility which could be derived from letting all capital migrate to the periphery at the periphery's zero tax rate, which is the case when tax payments collected from domestically owned capital do not exceed the returns to the fixed factor in the core. See footnote 14 in Krogstrup (2004).