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When do small countries win tax wars?

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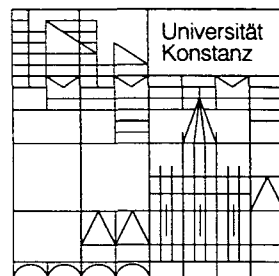
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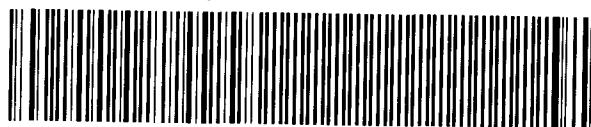
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**When do Small Countries
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When do Small Countries Win Tax Wars?

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Abstract

The paper analyzes the conditions under which the smaller of two otherwise identical countries prefers the non-cooperative Nash equilibrium to a situation of fully harmonized tax rates. A standard two-country model of capital tax competition is extended by allowing for transaction costs, additional countries, and additional tax instruments. The effects of introducing either mobility costs or a wage tax instrument are theoretically ambiguous because they lower both the costs and the benefits of non-cooperation from the perspective of the small country. Numerical simulations indicate, however, that for a wide range of parameter values all model extensions considered reduce the possibility that the small country gains from tax competition.

JEL classification: H73, H77, F15

1 Introduction

Rapidly increasing international mobility of capital has raised concerns worldwide about the sustainability of capital income taxation. These concerns are particularly strong in the European Union, where many of the obstacles to capital market integration have been eliminated as part of the internal market program and transaction costs of foreign investment will be further reduced in the planned monetary union. A first attempt to overcome fiscal competition for mobile capital tax bases has been the 1989 proposal of the European Commission to introduce a minimum withholding tax of 15 per cent on interest income. This measure, however, failed to receive the required unanimous support among member states and was strongly opposed by Luxemburg, by far the smallest member in the EU and a well-known tax haven. A second coordination attempt was launched in 1992, when a committee of independent experts chaired by Onno Ruding made specific recommendations for the harmonization of corporate tax rates and withholding taxes on dividends in the EU (Commission of the European Communities, 1992). However, fearing a renewed defeat, the European Commission has not yet submitted any of these proposals to the Council of Ministers.

The EU example demonstrates that, to be politically feasible, tax coordination must be strictly welfare improving for all members.¹ While it is rather straightforward to establish this result in the case of identical countries (Zodrow and Mieszkowski, 1986), conflicts of interest may arise when countries differ in some systematic way. Several authors have focused on country size as one determinant of international differences in tax rates. A core result – obtained for both capital and commodity taxation – is that the small country undercuts its large neighbour, and has the higher per capita welfare in the non-cooperative Nash equilibrium (Bucovetsky, 1991; Wilson, 1991; Kanbur and Keen, 1993).²

To determine whether small countries may nevertheless have an incentive to agree to coordination measures, the relevant comparison is whether the smaller country can be better off in the Nash equilibrium as compared to the case of full coordination. From the

¹Another problem faced by geographically restricted tax coordination is that capital may flow to third countries (Razin and Sadka, 1991). Empirical evidence shows, however, that European investors favour locations in other EU countries (Bhandari and Mayer, 1990), suggesting that intra-European tax coordination measures would be effective. This basic assumption also underlies the proposals in the Ruding report.

²For a model of asymmetric tax competition focusing instead on different preferences for public goods, see Haufler (1996).

perspective of the small country, this comparison depends on the sum of two counter-acting effects: it benefits from the redistributive effect of cutting into the large country's tax base, but at the same time it incurs some part of the aggregate welfare loss that results from non-cooperative tax setting. Which of these effects dominates in a particular situation is a question, however, that cannot be answered by theoretical analysis alone. Furthermore results will generally depend on the specific features of the underlying tax competition model. Possible extensions discussed in the literature include the introduction of transaction costs for foreign investment (Persson and Tabellini, 1992), a variable number of competing jurisdictions (Hoyt, 1991), and the availability of other sources of government revenue (Bucovetsky and Wilson, 1991). However these theoretical analyses are either restricted to an endowment model (Persson and Tabellini), or consider only the case of identical countries.

Related issues have been discussed in the trade literature, where it is the large region that can win a tariff war by improving its terms of trade. The original analysis of this issue in Johnson (1954) has been extended by Kennan and Riezman (1988). The authors argue from a simple theoretical model that the possibility of the large country gaining from tariff competition is by no means remote. However a CGE study for the United States and Canada (Markusen and Wigle, 1989) – while supporting the qualitative predictions derived from theoretical models – found that tariff competition is quantitatively weaker than predicted by the model and the large country (the U.S., with a GDP more than ten times as high as the Canadian) does not gain from non-cooperation, despite its relative size. This indicates that simple analytical models may not provide reliable guidelines for a welfare comparison between two different tax equilibria.

In a similar way, the present paper uses both theoretical and numerical methods to obtain some first insights into the question how likely a small country is to gain from capital tax competition. For this purpose a standard two-country model of capital tax competition is extended by introducing transaction costs, additional countries involved in the tax game, and an additional (wage) tax instrument. Section 2 of the paper summarizes and extends existing theoretical contributions on asymmetric capital tax competition. It also shows that several of the extensions considered have theoretically ambiguous effects on the chances of the small country to benefit from non-cooperation. For this reason section 3 turns to a numerical analysis of the different scenarios. The simulation results indicate that the possibility of the small country winning a tax war seems to be rather high in the standard model of capital tax competition, but this result becomes much less

likely under the different model extensions. Section 4 concludes and discusses some of the limitations of our analysis.

2 Basic Analytical Results

This section brings together some basic analytical results derived from a standard model of capital tax competition.³ Section 2.1 summarizes the basic model for the case of differences in country size and extends the analysis by introducing convex mobility costs of foreign investment. Section 2.2 then provides a systematic discussion of the factors that determine the small country's welfare in the non-cooperative Nash equilibrium.

2.1 A Tax Competition Model with Transaction Costs

Consider a static model of two countries $i \in \{1, 2\}$ which are identical in all respects except for population size. Each individual in each jurisdiction supplies one unit of labour and owns k^* units of capital. Thus k^* is also the average capital-labour ratio in the world. Capital is (imperfectly) mobile between countries whereas labour is immobile. In the presence of international capital flows, the capital-labour ratio employed in each country, k_i , thus differs from the world average. Denoting by s_i the exogenous share of country i in the world population, the capital market clearing condition for the world is⁴

$$s_1 k_1 + s_2 k_2 = k^*, \quad s_1 + s_2 = 1. \quad (1)$$

Both countries produce a single, homogeneous output good whose price is normalized to unity. The production function is identical across countries and exhibits constant returns to scale; hence it can be written as $f(k_i)$. It is twice differentiable, with the usual properties $f'(k_i) > 0$, $f''(k_i) < 0$. Output and factor markets are perfectly competitive.

Each country levies a source tax at rate t_i on each unit of capital employed in its jurisdiction. With identical per-capita endowments, technologies and preferences across

³Wildasin (1991, 397) gives a brief overview of the use of this model in analyses of tax incidence and fiscal competition. Most of the applications have been on regional tax competition within a single country. We believe, however, that the possibility to gain from non-cooperative tax setting is even more relevant in an international context where no higher-level authority with strong redistributive powers exists and compensation is thus more difficult than in a national setting.

⁴To derive this per capita formulation, let $K^* = K_1 + K_2$ denote the more conventional full employment condition in levels. Dividing through by the world labour endowment, L^* , and using the definitions $s_i = L_i/L^*$ for the shares of each country's population size then gives eq. (1).

countries, differences in tax rates are the only possible reason for equilibrium capital flows. We assume, without loss of generality, that $t_1 \geq t_2$. Then, if capital flows occur in equilibrium, the high-tax region 1 exports capital to country 2.

The model is extended by introducing convex transaction costs for international capital transactions. These costs reflect all extra complications of foreign operations such as additional information requirements or diverging regulations. A convenient and frequently used specification is that transaction costs are quadratic in the volume of foreign investment.⁵ This gives the per capita transaction cost function

$$\tau(k^* - k_1) = \frac{1}{2} \beta (k^* - k_1)^2, \quad \tau' = \beta (k^* - k_1), \quad (2)$$

where $k^* - k_1 > 0$ gives the amount of capital exported by country 1 and τ' denotes the marginal transaction costs of foreign investment. Producer profit maximization implies that the gross return to capital equals its marginal product. Arbitrage by investors is based on a comparison of net-of-tax returns, $f'(k_i) - t_i$, across countries. In the arbitrage equilibrium the net return to investment in the two countries must then differ by the marginal mobility costs incurred in equilibrium

$$f'(k_1) - t_1 = f'(k_2) - t_2 - \beta (k^* - k_1). \quad (3)$$

Solving (1) for k_1 and k_2 respectively, substituting in (3) and implicitly differentiating gives the change in each country's capital-labour ratio in response to a domestic tax increase

$$\frac{\partial k_i}{\partial t_i} = \frac{(1 - s_i)}{(1 - s_i) f''(k_i) + s_i f''(k_j) - s_2 \beta} < 0 \quad \forall \quad i, \quad i \neq j. \quad (4)$$

It is seen from equation (4) that the numerator is larger for the small country, and this effect must dominate the change in the denominator.⁶ Hence the small country faces the larger reduction in its capital-labour ratio following a domestic tax increase. This is the crucial effect for the asymmetric incentives that exist in the present model when countries of different size engage in capital tax competition. Also the mobility cost parameter β increases the absolute value of the (negative) denominator and thus reduces the effect of a tax increase in each country.

⁵Gordon and Bovenberg (1994), for example, summarize empirical studies finding a low degree of international capital mobility and argue that this may be explained by information asymmetries between domestic and foreign investors. A quadratic transaction cost function underlies the analysis of cross-border commodity purchases in Kanbur and Keen (1993) and is also assumed in parts of the Persson and Tabellini analysis (1992, 699).

⁶This is most easily seen for the case of quadratic production functions, where $f'' = \text{const.}$ and the denominator is the same for both countries.

The government of each region i maximizes the utility of a representative individual $u_i(x_i, g_i)$, where x_i and g_i denote private and public consumption per capita. Thus the public good considered is a quasi-private good and there are no economies of scale in its consumption (cf. Wilson, 1991, 426). The private and the public good represent different uses of the same output so that the marginal rate of transformation between x and g is equal to one. In the benchmark model the only tax instrument available to the government is a source tax on the capital employed in its jurisdiction. The (per capita) government budget constraint of each country is

$$g_i = t_i k_i \quad \forall \quad i. \quad (5)$$

Residents of each country receive both wage and capital income. Private budget constraints differ for the capital-exporting and the capital-importing country if transaction costs are present. A representative resident of the exporting country 1 invests some share of its capital endowment in each of the two jurisdictions, whereas residents of the importing country 2 invest everything at home. We also assume that all transaction costs must be born by the capital exporter. Thus the per capita private budget constraints in the two countries are

$$x_1 = f(k_1) - f'(k_1) k_1 + (k^* - k_1) [f'(k_2) - t_2] + k_1 [f'(k_1) - t_1] - \tau, \quad (6)$$

$$x_2 = f(k_2) - f'(k_2) k_2 + k^* [f'(k_2) - t_2]. \quad (7)$$

Each country's government maximizes the utility of a representative resident, taking as given the tax rate in the other region. The first-order conditions for the optimal source tax on capital are determined by

$$\frac{\partial u_i}{\partial t_i} = \frac{\partial x_i}{\partial t_i} + m_i(x_i, g_i) \frac{\partial g_i}{\partial t_i} = 0 \quad \forall \quad i, \quad (8)$$

where the marginal rate of substitution $m(x, g) = (\partial u / \partial g) / (\partial u / \partial x)$ is non-decreasing in x and non-increasing in g . Differentiating (5)–(7) with respect to t_i and substituting in (8) gives the best-response functions⁷

$$[f''(k_1) - \beta] \frac{\partial k_1}{\partial t_1} (k^* - k_1) - k^* + m_1 \left(k_1 + t_1 \frac{\partial k_1}{\partial t_1} \right) = 0, \quad (9)$$

⁷The derivation of (9) uses the arbitrage condition (3) to give in a first step

$$f''(k_2) \frac{\partial k_2}{\partial t_1} (k^* - k_1) - k_1 + m_1 \left(k_1 + t_1 \frac{\partial k_1}{\partial t_1} \right) = 0.$$

Adding and subtracting $(k^* - k_1)$ and using the relationship obtained by differentiating (3) with respect to t_1 , this can be rewritten to give eq. (9).

$$f''(k_2) \frac{\partial k_2}{\partial t_2} (k^* - k_2) - k^* + m_2 \left(k_2 + t_2 \frac{\partial k_2}{\partial t_2} \right) = 0, \quad (10)$$

where the partial derivatives $\partial k_i / \partial t_i$ must be inserted from (4). Under the usual assumptions that the second-order conditions are fulfilled and that reaction functions are continuous, there must be at least one Nash equilibrium. In the absence of mobility costs ($\beta = 0$), equations (9) and (10) coincide (cf. Bucovetsky, 1991). In the more general case $\beta > 0$, however, mobility costs enter both first-order conditions by influencing the change in national capital-labour ratios in response to a domestic tax increase [eq. (4)], and by affecting the capital exporter's budget constraint.

In the following we discuss the factors that influence the small country's utility in the non-cooperative Nash equilibrium. We first consider the standard model without mobility costs, focusing on the role of relative country size and the elasticity of substitution between private and public consumption. In a second step we then take up the effects of several model extensions, covering (1) mobility costs, (2) additional countries and (3) additional tax instruments.

2.2 Determinants of the Small Country's Welfare

Relative Country Size: As a benchmark, let us first consider the case of full coordination. Since there is no motive for trade in the present model, the best that a coordinated policy can do is to replicate the closed-economy equilibrium. In the absence of capital mobility we have $\partial k_i / \partial t_i = 0$ and $k_1 = k_2 = k^*$. It is then seen immediately that both first-order conditions (9)–(10) reduce to $m_i = 1$, which is the condition for an efficient provision of the public good. In the open economy, global efficiency requires that optimal tax rates are the same in both countries, equalizing the marginal product of capital across countries from (3). Identical technologies then imply $k_1 = k_2 = k^*$ and there are no capital movements between countries of different size in the coordinated open economy equilibrium. Furthermore no country needs to fear a capital outflow from a *coordinated* tax increase and $m_i = 1$ will again be attained. From a global perspective the capital tax is a lump-sum instrument, allowing to redistribute purchasing power from the private to the public sector at no extra cost.

Against this benchmark, we can now discuss two special cases of tax competition:

- The first is the symmetric case, $s_1 = s_2 = 0.5$, which implies that the first-order conditions (9)–(10) are identical for the two countries and a Nash equilibrium with

equal tax rates exists. Hence there will be no capital movements in equilibrium. However the partial derivatives $\partial k_i / \partial t_i$ in (4) are negative in the case of symmetric tax competition since each country perceives a capital outflow in response to a domestic tax increase, conjecturing a *constant* tax rate in the other region. Substituting this and $k_1 = k_2 = k^*$ into the best response functions (9)–(10) gives

$$m_i = 1 / \left(1 + \frac{t_i}{2 f''(k^*)} \right) > 1 \quad \forall \quad i \quad (11)$$

in the symmetric Nash equilibrium. Since no country can influence the international distribution of income to its own advantage, the only effect of opening the economies to trade is a reduction in the level of public good provision below its efficient level. Hence welfare in both countries must be unambiguously lower than in the coordinated case.

- The other special case arises when the share of country 1 in the overall population approaches one. From (4) the derivative $\partial k_1 / \partial t_1$ then approaches zero and country 1 will choose the same tax rate as in the coordinated case (or in the closed economy). For the small country 2 this implies that the utility level under coordination can always be attained by also setting its tax rate equal to the closed-economy level. However equation (10) shows that this cannot be optimal since the derivative $\partial k_2 / \partial t_2$ is non-zero for this country. By a revealed preference argument the welfare level of an *infinitesimally small* country must then be higher than under coordination. Hence there must be a critical level of s_2 where the small country is just indifferent between coordination and the non-cooperative Nash equilibrium.⁸ In contrast it is clear that the large country must always lose from asymmetric tax competition, because it underprovides the public good and at the same time loses tax revenue to its small trading partner.

The Elasticity of Substitution: Clearly results will also depend on the elasticity of substitution between public and private consumption in each country. To see this consider once again the first-order condition in the case of two identical countries as given by equation (11). Since tax competition raises the shadow price of the public good above unity, the marginal rate of substitution (of x for g) must also rise in the optimum. For

⁸More precisely, there will be exactly one such level if the per capita utility level in the small country is a monotonously rising function of the other country's share in the world population. This is the case in all the simulations carried out in this paper.

any given increase in m , the reduction in the level of public good supply will be the more pronounced, the higher is the elasticity of substitution

$$\sigma = \frac{d(x/g)}{d m} \frac{m}{x/g}. \quad (12)$$

By the standard optimal tax intuition a high level of σ implies an elastic response to the (perceived) change in the relative price of public vs. private consumption, leading to a high excess burden imposed by capital tax competition. Thus while the relative size parameter s_2 is an indicator of the potential gains that a small country can reap through tax competition, the elasticity of substitution σ is a quantitative indicator of the welfare losses incurred by non-cooperation. In the simulations of the following section, we will therefore focus on the range of (s_2, σ) -combinations under which the small country gains from a tax war and analyze how this range is affected by different relaxations of the benchmark scenario.

Mobility costs: Introducing mobility costs to the standard model reduces the sensitivity of national capital-labour ratios to a domestic tax change by increasing the absolute value of the (negative) denominator in equation (4). Other things being equal the intensity of tax competition – and the undersupply of public goods – is reduced when the transaction cost parameter β is raised. At the same time, however, it is seen from the arbitrage condition (3) that the amount of capital that the small country can attract by underbidding its large neighbour is reduced for any given tax differential. Thus both the efficiency losses from tax competition and the redistributive gains that accrue to the small country are limited by imperfect capital mobility.

In the appendix, these counteracting effects are worked out in more detail for the case of quadratic production functions. It is shown that, at unchanged tax rates, the small country will unambiguously lose from a small increase in the transaction cost parameter β (direct or ‘impact’ effect). This effect describes the reduced capital flows from the large to the small country when capital mobility is imperfect. At the same time, however, reduced tax competition – as implied by a higher level of β – induces a tax increase in the large country, and this in turn benefits the small region (indirect effect). Hence it is unclear from a theoretical perspective whether the incorporation of mobility costs makes it easier or more difficult for a small country to benefit from tax competition.

Additional countries: The case where a finite number n of identical countries engages in capital tax competition has been analyzed, among others, by Bucovetsky and

Wilson (1991) and Hoyt (1991). This case is easily incorporated in the above framework by noting that with n identical countries $s_i = 1/n$ from the adding-up constraint in the capital-market clearing condition (1). Since $k_i = k^* \forall i$ from the assumption of symmetric countries, equation (4) changes to

$$\frac{\partial k_i}{\partial t_i} = \frac{(1 - s_i)}{f''(k^*)} = \frac{[1 - (1/n)]}{f''(k^*)} < 0. \quad (13)$$

The intuition behind equation (13) is the same as in the case of two asymmetric countries: the smaller a country is, the higher is the perceived tax base loss that is incurred by a given rise in the domestic tax rate. In the case of n identical countries this implies that the more regions are playing the tax competition game, the higher is the (perceived) elasticity of each country's tax base. While this demonstrates that the number of competing regions is crucial for the utility level attained by any one of them, all countries must necessarily lose in the case of symmetric tax competition. However a scenario with asymmetric tax competition between more than two players rapidly becomes intractable analytically.

Additional Tax Instruments: Another assumption that has been maintained so far is that the source tax on capital is the only instrument to finance the provision of public goods. This assumption is relaxed in Wilson (1991, sec. 6) and in Bucovetsky and Wilson (1991), who allow for a distortionary wage tax as a second tax instrument. To prevent the wage tax from being a lump-sum instrument, the standard model must be modified such that each individual allocates a fixed time endowment between labour (l) and leisure (h). Labour continues to be immobile across countries. Utility is then a function of three arguments $u(x, h, g)$ and a distinction must be introduced between per capita values and capital-labour ratios. Thus $f(k_i, l_i)$ is the per capita output from capital k_i and labour l_i , and the private budget constraints change accordingly. The government budget constraint incorporates the new instrument of a wage tax t_i^w (again modelled as a unit tax for algebraic simplicity) and changes to $g_i = t_i k_i + t_i^w l_i$.

The theoretical discussion of this case in Bucovetsky and Wilson (1991) considers identical regions and thus precludes the possibility of a small country gaining from tax competition. On the other hand, the analysis in Wilson (1991) is confined to the case where both countries face a fixed revenue requirement. From our discussion above, this excludes the deleterious effects of tax competition on the small region because the elasticity of substitution between public and private consumption is effectively fixed at zero and inefficiencies in the supply of public goods cannot arise.

More generally since both countries face finite elasticities of both capital and labour supply, they will choose some combination of the two distortive instruments in the optimum while still undersupplying the public good. We can then ask again how the introduction of the second tax instrument affects the small country's gains and losses from tax competition in the Nash equilibrium. On the one hand, adding a wage tax instrument is likely to reduce the marginal costs of public good supply and thus decrease the welfare losses from inefficient public good provision. On the other hand, the reduced reliance on capital taxes will also lower the redistributive gains that the small country can reap by undercutting its large neighbour. Hence one would generally expect ambiguous results from this extension, similar to the case of mobility costs discussed above.

To summarize there are two possible approaches if the goal is to add some more realistic features to a standard model of asymmetric capital tax competition. The first alternative is to extend the existing theoretical work. There are, however, clear limits to this analytical approach when more than two countries are taken into account or when countries compete in two independent tax instruments. Furthermore, even if analytical results can be obtained, they are likely to be less than clear-cut. In the following we will therefore follow an alternative route and carry out several simulation experiments that isolate the implications of different model extensions and weigh the counteracting effects.

3 Numerical Analysis

3.1 Model Specification and Benchmark Scenario

The only change between the theoretical model presented above and the numerical model used in the following is that the latter incorporates an endogenous labour-leisure choice in the benchmark scenario. This allows to consider a distortive wage tax in one of the counterfactual experiments without further changes in the model. The specification of production and utility functions in the numerical model is as follows: in each country per capita output is generated according to the Cobb–Douglas production function

$$f(k_i, l_i) = k_i^\alpha l_i^{(1-\alpha)}, \quad 0 < \alpha < 1, \quad (14)$$

where technologies are identical across countries and the share of capital has been set at $\alpha = 0.25$. This is in accordance with the distribution of national income in most OECD countries, where capital income (“profits”) accounts for roughly one third of wage income.

The utility function of the representative individual is of the nested constant elasticity of substitution (CES) form. As is well-known, CES functions allow to specify any substitution elasticity between zero (implying that goods are demanded in fixed proportions) and infinity (implying that demands respond infinitely elastic to changes in relative prices). We define a composite private good, denoted by z , which consists of leisure and the private consumer good. Using a nested CES specification has the advantage that the elasticity of substitution between the public good g and the composite private good z in the top nest can be varied without affecting the substitution elasticity between leisure h and commodity consumption x in the lower nest. The utility function in each country is specified as

$$u_i(x_i, h_i, g_i) = \left[\theta_z^{1/\sigma} \left(\varphi_x^{1/\varepsilon} x_i^{\frac{\varepsilon-1}{\varepsilon}} + \varphi_h^{1/\varepsilon} h_i^{\frac{\varepsilon-1}{\varepsilon}} \right)^{\frac{\varepsilon-1}{\varepsilon-1} \frac{\sigma-1}{\sigma}} + \theta_g^{1/\sigma} g_i^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}, \quad (15)$$

where the parameters φ denote the shares of private commodity consumption and leisure in the lower nest whereas θ gives the shares of the composite private good and the public good in the top nest. All share parameters and substitution elasticities are assumed to be equal across countries, thus isolating the effects of differences in country size. For CES functions the adding-up restriction on the shares in each nest implies $\theta_x^{1/\sigma} + \theta_g^{1/\sigma} = 1$ and $\varphi_x^{1/\varepsilon} + \varphi_h^{1/\varepsilon} = 1$. This leaves one degree of freedom to choose the *ratio* of the shares in each nest.

Our specification assumes $\varphi_x/\varphi_h = 4$ and $\theta_z/\theta_g = 4$. The first ratio roughly corresponds to the weights calibrated by Ballard, Fullerton, Shoven and Whalley (1985, 130) for a large-scale tax reform model based on U.S. data. The latter choice reflects the fact that the ratio of government expenditures (excluding transfers to individuals) in GDP is in the range of 25 per cent in many OECD countries. Sensitivity analyses have shown that our results are quite robust with respect to the choice of share parameters in both the production and utility functions.

In contrast elasticities of substitution are clearly critical for our results. The elasticity of substitution between leisure and private commodity consumption in the lower nest, ε , will be important mainly when a wage tax is introduced in section 3.2. When the share of ‘leisure expenditures’ in the individual utility function is very small, then this elasticity is approximately equal to the uncompensated labour supply elasticity, but it will exceed the latter as the consumption of leisure grows. The numerical study by Ballard, Fullerton, Shoven and Whalley (1985, 125-130) assumes an uncompensated labour supply elasticity of 0.15, an estimate that is supported by most econometric work (cf. Hausman, 1985).

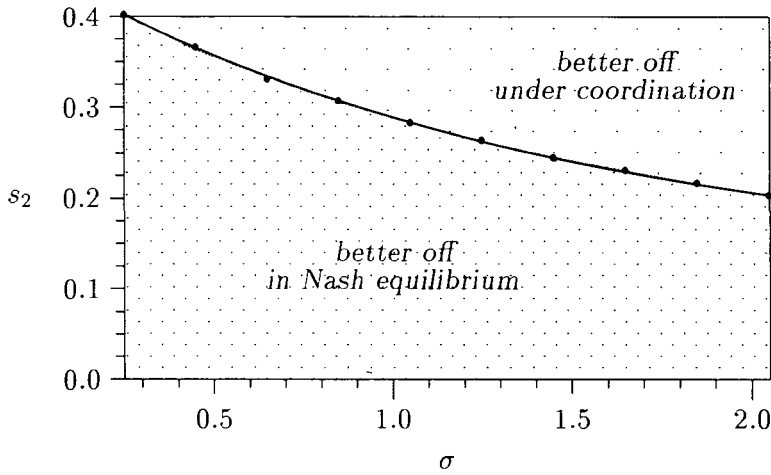


Figure 1: benchmark case $\bullet\text{---}\bullet$

Furthermore for their benchmark data set this labour supply elasticity corresponds to a substitution elasticity of about 0.5, and this is the value of ε chosen here. The crucial role played by the substitution elasticity between the public good and the composite private good in the top nest, σ , has already been emphasized in the previous section. Whalley and Trela (1986, 128) set this elasticity equal to 0.5, but alternative values of σ around this estimate will be considered throughout the following analysis.

The Benchmark Case: As a reference point we first consider the standard two-country model of tax competition when the source tax on capital is the only tax instrument and capital is costlessly mobile internationally. This benchmark scenario is given in Figure 1. The line dividing the graph shows the locus of all combinations of substitution elasticities σ and relative size parameters s_2 for which the small country attains exactly the same utility level under tax competition as it would obtain under full coordination. At any point *on* the curve the smaller country is thus indifferent between an international agreement which ensures coordinated capital tax rates, and the non-cooperative equilibrium with diverging tax rates.⁹ In the darkly shaded area below this curve, the small country is better off in the Nash equilibrium as compared to the cooperative case, whereas the small country loses from tax competition in the lightly shaded area above the curve.

The intuition for the negative slope of the indifference locus should be obvious from our

⁹Consumption patterns differ in both situations, however, since the representative individual of a country which is engaged in tax competition consumes more private and fewer public goods than under coordination.

earlier discussion. The higher is the elasticity of substitution, the larger is the reduction of public good supply and thus the inefficiencies caused by tax competition. Hence for any given distribution of the world's population, a higher σ makes it more difficult for the small country to gain from tax competition. On the other hand, for any given substitution elasticity σ , the small country is the more likely to gain, the larger is the difference in relative country size.

Figure 1 shows that in the benchmark case the chances of country 2 to gain from tax competition – as measured by the size of the area below the indifference locus – are rather large. This result parallels the finding by Kennan and Riezman (1988) for the case of tariff wars, where the large country gains under a relatively wide range of endowment patterns in a two-country, two-good exchange economy. One may thus conclude from simple models of non-cooperative tax or tariff setting that size differences between countries make it quite likely for redistributive effects to dominate the global efficiency losses from non-coordination. Furthermore Figure 1 shows that even a small difference in relative size is sufficient for the smaller country to gain, if the substitution elasticity between private and public consumption is sufficiently low. Rigid revenue requirements do not seem to be a completely unrealistic description of reality, given that public budgets have remained very stable in recent years, despite increasing efficiency costs of taxation due to higher tax base mobility. This even reinforces the argument that small countries have a good chance of winning a tax war in the standard two-country, one-instrument, perfect-mobility model of capital tax competition.

3.2 Extensions

In the following we consider the effects of various model extensions on the range of (s_2, σ) -combinations under which the small country gains from tax competition. The cases considered are the same that have been discussed in the previous section and cover (1) mobility costs, (2) additional countries, and (3) additional tax instruments.

Mobility Costs: We first consider the consequences of introducing mobility costs. Figure 2 shows the effects of setting the transaction cost parameter β [cf. eq. (2)] at 0.2. The figure shows that the effects of this modification, which have been shown to be theoretically ambiguous, also work in both directions in the numerical analysis. For low levels of σ the likelihood of the small country to gain from tax competition becomes smaller in

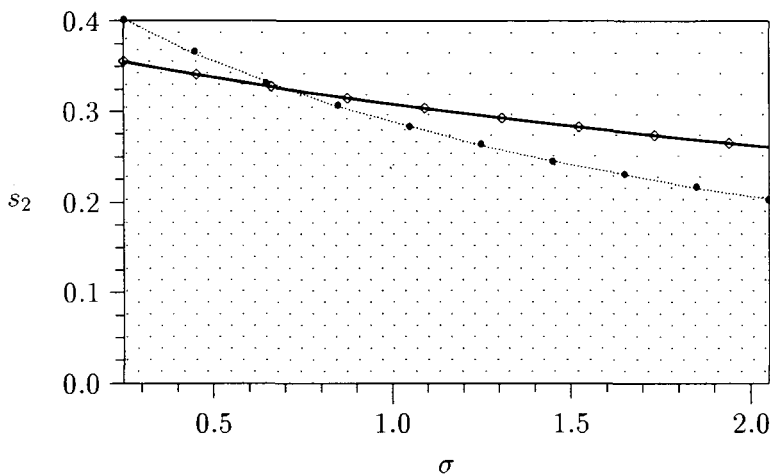


Figure 2: Benchmark case $\bullet\text{---}\bullet$ and mobility cost case $\diamond\cdots\diamond$

the mobility-cost scenario, whereas this likelihood increases for higher values of σ . Hence the indifference loci for the small country in the benchmark and in the mobility-cost case intersect at a critical level, given by $\sigma \approx 0.7$.

This result should be rather intuitive in the light of our earlier discussion. From the small country's perspective introducing mobility costs reduces both the costs of tax competition and the gains from undercutting its large neighbour. When the substitution elasticity between the private consumption aggregate and the public good is low, welfare losses from tax competition are already small in the benchmark scenario and reduced redistributive gains dominate lower efficiency losses for the small country. Furthermore a low level of σ also implies that the large country must compensate any tax base losses suffered by tax competition through higher tax rates, in order to secure a relatively rigid amount of public good supply. Introducing mobility costs reduces equilibrium capital flows and the redistribution of tax revenues from the large to the small country. This allows the large country to lower its tax rate, relative to the benchmark scenario, and this further reduces the redistributive gains for the small region (cf. the analysis in the appendix).

The relative importance of these effects is reversed when private and public consumption can easily be substituted. In the high- σ case the welfare losses from tax competition are large for both countries and dominate redistributive effects for a wide range of relative size parameters s_2 . Introducing mobility costs reduces the degree of tax competition and allows both countries to adjust their tax rates upward and raise public good supply. This will increase the number of cases in which tax competition is beneficial for the small country, relative to the benchmark scenario.

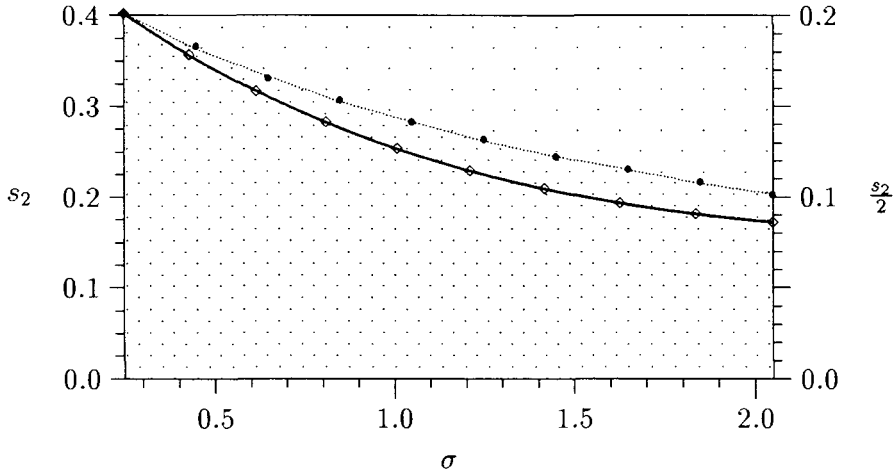


Figure 3: Benchmark case $\bullet\text{---}\bullet$ and three country case $\diamond\text{---}\diamond$

Given the indications of relatively rigid government revenue needs in many countries, it may be argued that the low- σ case is the more plausible one. Nevertheless the changes introduced by mobility costs are likely to be rather small in the relevant range of σ and for the chosen transaction cost parameter β . Sensitivity analyses show that the deviations from the benchmark indifference locus become greater as β is increased. However, barring transaction costs that effectively prohibit international capital movements, the critical level of σ at which the two curves intersect is not significantly changed. Hence the main results of this model modification seem to be rather robust with respect to the specific value of β .

Additional Countries: Next, we consider the introduction of a second small country with the same population size as the first, implying that there are now three countries (one large and two small) involved in the tax game. The effects of this extension are shown in Figure 3. The direct effect of introducing a second small country is that, for any given level of s_1 , *each* of the two small countries now has only half the size as compared to the benchmark case. This follows from the adding-up constraint in eq. (1) and is incorporated in Figure 3 through the scale on the right-hand side of the diagram. The effect of this increase in the number of players can be isolated by assuming for a moment that the two small countries collude and maximize their joint welfare against the large country. It is then obvious that Nash equilibrium tax rates and welfare levels must be the same as in the benchmark case and all that has to be done is to interpret the *benchmark* indifference locus using the scale on the right-hand side of the diagram. This shows in a very direct

way that the critical size of a country that gains from tax competition must necessarily fall as the number of (small) players is increased.

In addition the assumption that the two small countries collude suffers the well-known problem that each party has an incentive to defect when the partial coordination agreement cannot be effectively enforced. Taking the EU as an example, it seems quite unlikely that any subset of (small) member countries could enforce an agreement that leaves out other (large) members of the union. A more realistic behavioural assumption is therefore that the two small countries compete not only against the large region, but also against each other. As was discussed earlier, tax competition becomes more intense when the number of regions increases, because each player will now perceive a higher elasticity of the domestic tax base. This is shown by the new indifference locus in Figure 3, which lies everywhere below the corresponding benchmark line.

Of course it is also possible to modify the benchmark model by introducing another *large* country instead of a small one and assume that the two large countries compete against each other. Our simulation results (not shown here) indicate that the chances for the third, small country to gain from tax competition drop to virtually zero in this case. Recalling our discussion in section 2 it is intuitive that even an infinitely small third country need not gain from tax competition in this case because the two large regions will clearly *not* choose their closed-economy tax rates. This again points out that a two-country model chosen for reasons of analytical tractability may seriously overestimate the possibility that a small country gains from tax competition.

Additional Tax Instruments: Finally we relax the assumption that the governments of both countries have to rely exclusively on the source tax on capital in order to supply public goods. A wage tax is introduced which distorts each individual's labour-leisure choice, and governments now optimize simultaneously over two independent tax instruments. Figure 4 gives the effects of this model extension.

Our results show that, for the range of substitution elasticities σ considered, the introduction of an additional wage tax instrument unambiguously and strongly reduces the likelihood of the small country to gain from tax competition. This result is obtained even though there are counteracting effects in this case, since the new tax instrument reduces both the redistributive gains and the efficiency losses caused by the tax system from the perspective of the small country (recall our discussion in section 2). In the numerical analysis, however, the reduced gains from undercutting the large country's capital tax rate

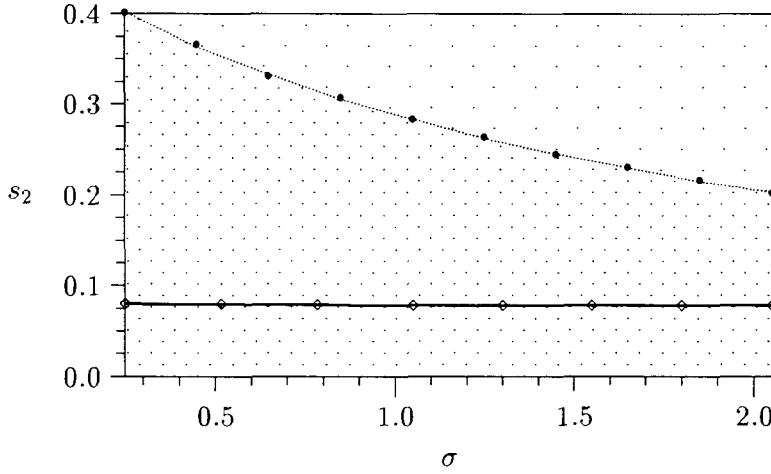


Figure 4: Benchmark case $\bullet\text{---}\bullet$ and labour tax case $\diamond\text{---}\diamond$

emerge as the dominant effect in the relevant parameter range.¹⁰

Figure 4 also shows that with an additional labour tax instrument, the small country's indifference locus is virtually independent of σ and only depends on the relative size parameter s_2 . This is explained by the fact that both the reliance on capital taxation and the efficiency costs of capital tax competition are relatively low in the optimum under the assumed low elasticity of substitution between leisure and private consumption ($\varepsilon = 0.5$). It is then also obvious how changes in the assumed level of ε will influence the results. A continuous increase in ε (representing a more elastic labour supply) leads to a convergence of the indifference loci in the benchmark and in the wage tax case. On the other hand, if the labour-leisure distortion is further reduced ($\varepsilon \rightarrow 0$), only wage taxes are employed in equilibrium and capital tax competition becomes irrelevant.

Can small countries win tax wars? The simulation results reported in this section indicate some more clear-cut answers to this question than the theoretical analysis has been able to provide. Under plausible restrictions on parameter values – in particular substitution elasticities – it seems that a standard model of capital tax competition generally overstates the possibility that a small country gains from tax competition. This is due primarily to the fact that the standard model reduces tax competition to a game between only two countries, and assumes that a source tax on capital is the only instrument to

¹⁰We note, however, that over the *entire* range of possible substitution elasticities σ the effects of this model extension are indeed ambiguous in the numerical analysis. Further simulations show that the indifference loci for the benchmark and the wage tax scenario do intersect, but this point occurs only at an unrealistically high level of $\sigma \approx 6$.

finance the provision of public goods. The introduction of mobility costs is also likely to reduce the incentives for small countries to engage in capital tax competition, but here the effects are less significant. If these isolated extensions are combined, however, then a net benefit from non-cooperation is rather unlikely to obtain – except, perhaps, for the smallest member of a tax union.

4 Conclusions

It has been shown in two-country models of capital tax competition that the smaller of two otherwise identical countries can be better off in the non-cooperative Nash equilibrium as compared to a cooperative scenario, and hence may not have an interest in the coordination of capital income taxes. Given the immediate policy relevance of this result, our aim in this paper was to obtain some quantitative measure as to how realistic this scenario is, and to explore the robustness of the results with respect to the incorporation of several model extensions. For the standard model our simulation results actually suggest a rather high chance for the smaller country to win a tax war, in particular under the ‘plausible’ assumption that government revenue needs are rigid. However this possibility is generally – and sometimes strongly – reduced when real-world features like mobility costs, multiple countries and multiple tax instruments are considered. These findings for the case of tax competition correspond to earlier results for the case of tariff wars, where simple analytical models have also been shown to overestimate the probability that one country gains from non-cooperative behaviour.

It goes without saying that the results obtained from our highly stylized model should not be applied directly to the policy issues in the European Union or elsewhere. However they may nevertheless be suggestive in certain respects. Even if all model extensions are incorporated, the possibility that a uniquely small country such as Luxemburg gains from capital tax competition cannot be excluded. On the other hand, it is also true that a large majority of EU members shows an interest in capital tax coordination, despite significant differences in size between them. Furthermore Luxemburg mainly attracts international portfolio investments in debt instruments, where transaction costs are relatively small. Therefore, while Luxemburg may not have an interest in tax coordination for foreign interest income, it may be more willing to cooperate, say, in the field of corporate profit taxation. The need to differentiate between different forms of international capital flows by the degree of mobility costs that they face has been stressed, for example, in the Ruding

Report of the European Commission (1992, Ch. 7).

Finally at least two limitations of the present analysis should be emphasized. First we have assumed labour market clearing, whereas a relevant scenario for many OECD countries would incorporate unemployment due to some kind of real wage rigidity. In this case any increase in labour productivity following a foreign capital inflow boosts national income by the full amount of wage income earned by previously unemployed workers. Numerical analyses of capital tax reform – though not in a context of strategic interaction – suggest that these labour market effects can be crucial for the induced welfare changes (Jensen et. al, 1993). Therefore high levels of unemployment may increase the incentives for small countries to pursue beggar-thy-neighbour policies.

On the other hand, we have also assumed that labour is immobile internationally. While this is still a defensible assumption at the current stage of integration in Europe (or in the NAFTA), labour mobility is likely to gain importance in the future. Incorporating (imperfect) labour mobility along with capital mobility in a tax competition model (Burbidge and Myers, 1994) implies that any utility differential induces migration flows to the country with the higher per capita utility (the small country). Other things unchanged this extension is thus likely to reduce the small country's incentive to engage in globally inefficient capital tax competition.

Appendix

The appendix presents the effects of a change in the mobility cost parameter β on welfare in the small country 2. Indirect utility in country 2 can be written as a function of β and the two tax rates, $V_2[t_1(\beta), t_2(\beta), \beta]$. Differentiating and setting $\partial V_2 / \partial t_2 = 0$ (since country 2's own tax rate is optimized in the initial equilibrium), we have to evaluate

$$\frac{dV_2}{d\beta} = \left. \frac{\partial V_2}{\partial \beta} \right|_{t_1, t_2 = \text{const.}} + \frac{\partial V_2}{\partial t_1} \frac{dt_1}{d\beta}. \quad (\text{A.1})$$

The first effect in (A.1) gives the direct (impact) effect at unchanged tax rates whereas the second, indirect effect derives from the induced change in the tax rate of country 1. To keep the comparative static analysis manageable, we consider the special case of quadratic production functions, thus neglecting third-order derivatives with respect to k_i :

$$f(k_i) = (a - b k_i) k_i, \quad f'(k_i) = a - 2b k_i, \quad f'' = -2b, \quad a, b > 0.$$

In the quadratic production case the wage rate in each country is given by $f(k_i) - f'(k_i)k_i = b k_i^2$ and private consumption in country 2 is $x_2 = b k_2^2 + k^* [f'(k_2) - t_2]$. Thus V_2 simplifies to

$$V_2 \left\{ b k_2^2 + k^* (a - 2b k_2 - t_2), t_2 k_2 \right\}. \quad (\text{A.2})$$

The capital-labour ratio in each country can then be derived from (1) and (3) as

$$k_i = k^* - (t_i - t_j) \frac{(1 - s_i)}{2b + \beta} \quad \forall i, \quad i \neq j, \quad (\text{A.3})$$

from which follows [cf. eq. (4) in the main text]

$$\frac{\partial k_i}{\partial t_i} = \frac{-(1 - s_i)}{2b + \beta} < 0, \quad \frac{\partial k_i}{\partial t_j} = \frac{(1 - s_i)}{2b + \beta} > 0, \quad \forall i, \quad i \neq j, \quad (\text{A.4})$$

$$\frac{\partial k_i}{\partial \beta} = (t_i - t_j) \frac{(1 - s_i)}{(2b + \beta)^2} \begin{matrix} > \\ < \end{matrix} 0 \quad \text{if } t_i \begin{matrix} > \\ < \end{matrix} t_j, \quad \frac{\partial^2 k_i}{\partial t_i \partial \beta} = \frac{(1 - s_i)}{(2b + \beta)^2} > 0. \quad (\text{A.5})$$

It is then straightforward to show that the impact effect of a rise in β is negative for the small (low-tax) country

$$\left. \frac{\partial V_2}{\partial \beta} \right|_{t_1, t_2 = \text{const.}} = \left[\frac{\partial u_2}{\partial x_2} 2b (k_2 - k^*) + \frac{\partial u_2}{\partial g_2} t_2 \right] \frac{\partial k_2}{\partial \beta} < 0, \quad (\text{A.6})$$

since $t_2 < t_1$ [and consequently $k_2 > k^*$ from (A.3)] and thus $\partial k_2 / \partial \beta < 0$ from (A.5). The intuition for this effect is that, at constant tax rates, a rise in marginal transaction costs lowers the capital inflow to the low-tax country, and this in turn reduces both its

wage rate and the tax base. Note that this effect is zero when the initial equilibrium is symmetric ($s_1 = s_2 = 0.5$) and thus $t_1 = t_2$.

The effect of a change in t_1 on welfare in country 2 is also easily derived. A rise in t_1 raises both public and private consumption in country 2, thus unambiguously raising welfare:

$$\frac{\partial V_2}{\partial t_1} = \left[\frac{\partial u_2}{\partial x_2} 2b (k_2 - k^*) + \frac{\partial u_2}{\partial g_2} t_2 \right] \frac{\partial k_2}{\partial t_1} > 0, \quad (\text{A.7})$$

where (A.4) has been used to sign the effect. The remaining task is to derive the Nash equilibrium change in t_1 when the mobility cost parameter is varied. In the case of quadratic production functions the best response functions (9)–(10) simplify to

$$\frac{\partial V_1}{\partial t_1} \equiv F_1(t_1, t_2, \beta) = \gamma_1 (k^* - k_1) - k^* + m_1 \varepsilon_1 = 0, \quad (\text{A.8})$$

$$\frac{\partial V_2}{\partial t_2} \equiv F_2(t_1, t_2, \beta) = \gamma_2 (k^* - k_2) - k^* + m_2 \varepsilon_2 = 0, \quad (\text{A.9})$$

where

$$1 > \gamma_1 = \frac{2bs_2 + \beta}{2b + \beta} > 0, \quad 1 > \gamma_2 = \frac{2bs_2}{2b + \beta} > 0, \quad \varepsilon_i = k_i + t_i \frac{\partial k_i}{\partial t_i} > 0 \quad \forall i. \quad (\text{A.10})$$

Totally differentiating $F_1(t_1, t_2, \beta)$ and $F_2(t_1, t_2, \beta)$ gives for the general equilibrium change in t_1

$$\frac{dt_1}{d\beta} = \frac{1}{|J|} \left[-\frac{\partial F_2}{\partial t_2} \frac{\partial F_1}{\partial \beta} + \frac{\partial F_1}{\partial t_2} \frac{\partial F_2}{\partial \beta} \right], \quad |J| = \frac{\partial F_1}{\partial t_1} \frac{\partial F_2}{\partial t_2} - \frac{\partial F_1}{\partial t_2} \frac{\partial F_2}{\partial t_1} > 0, \quad (\text{A.11})$$

where the determinant of the Jacobian matrix is positive from stability (Dixit, 1986). Furthermore the derivative $\partial F_2 / \partial t_2$ in (A.11) must be negative from the second-order condition of country 2's optimal tax problem. To evaluate the other expressions we differentiate equations (A.8)–(A.9) and assume that preferences are homothetic so that the marginal rate of substitution depends only on the *ratio* of public and private consumption. By the chain rule, we have $\partial m_i / \partial \beta = [\partial m_i / \partial (x_i / g_i)] \times [\partial (x_i / g_i) / \partial \beta]$. This allows to insert the (inverse of the) elasticity of substitution (12) to get

$$\frac{\partial F_1}{\partial \beta} = (k^* - k_1) \frac{\partial \gamma_1}{\partial \beta} + (m_1 - \gamma_1) \frac{\partial k_1}{\partial \beta} + m_1 t_1 \frac{\partial^2 k_1}{\partial t_1 \partial \beta} + \varepsilon_1 \frac{m_1}{\sigma} \frac{g_1}{x_1} \frac{\partial (x_1 / g_1)}{\partial \beta}, \quad (\text{A.12})$$

$$\frac{\partial F_1}{\partial t_2} = (m_1 - \gamma_1) \frac{\partial k_1}{\partial t_2} + \varepsilon_1 \frac{m_1}{\sigma} \frac{g_1}{x_1} \frac{\partial (x_1 / g_1)}{\partial t_2}, \quad (\text{A.13})$$

$$\frac{\partial F_2}{\partial \beta} = (k^* - k_2) \frac{\partial \gamma_2}{\partial \beta} + (m_2 - \gamma_2) \frac{\partial k_2}{\partial \beta} + m_2 t_2 \frac{\partial^2 k_2}{\partial t_2 \partial \beta} + \varepsilon_2 \frac{m_2}{\sigma} \frac{g_2}{x_2} \frac{\partial (x_2 / g_2)}{\partial \beta}. \quad (\text{A.14})$$

From (A.10) we can infer $\partial \gamma_1 / \partial \beta > 0$ and $\partial \gamma_2 / \partial \beta < 0$. Using this and (A.4)–(A.5) shows that all effects in (A.12)–(A.14) must be non-negative, except for the second effect in (A.14)

and the last terms in each equation (which are generally ambiguous because x and g change in the same direction). However $dt_1/d\beta > 0$ can be strictly shown if the initial equilibrium is symmetric and $t_1 = t_2$. If there are no capital flows in the initial equilibrium, the last terms in (A.12) and (A.14) are zero because public and private consumption in both countries are unaffected by the impact of a change in β . Furthermore the first two effects in both (A.12) and (A.14) are then also zero from (A.5) and $k_1 = k_2 = k^*$. Thus only the positive third effects remain in (A.12) and (A.14) so that $\partial F_i/\partial\beta > 0 \forall i$. Furthermore from the symmetry of the initial equilibrium and stability we have $|\partial F_2/\partial t_2| > |\partial F_1/\partial t_2|$. Hence t_1 must always rise in response to a small increase in β , even if its reaction function were downward sloping due to a very low level of σ (note that the last term in (A.13) is not zero, in general, when $t_1 = t_2$). Since t_1 must also rise for very high levels of β (which imply that t_1 approaches its autarky level, independent of the size parameter s_1), a monotonous, positive relationship between β and t_1 is the most likely outcome, even if this cannot strictly be shown for the general case.

For the overall evaluation of $dV_2/d\beta$ in (A.1) there are then two counteracting effects. While the impact is always negative for the small country from (A.6), the tax rate in the other region will most likely increase from (A.11)–(A.14), and this in turn benefits the small country from (A.7). These effects correspond to the discussion in the main text.

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