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## Capital mobility, tax competition, and lobbying for redistributive capital taxation

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# Kieler Arbeitspapiere

# Kiel Working Papers

Kiel Working Paper No. 779

**Capital Mobility, Tax Competition,  
and Lobbying for  
Redistributive Capital Taxation**

by Oliver Lorz



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and Lobbying for Redistributive Capital Taxation

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**Abstract:** This paper analyzes the impact of international capital mobility on redistributive capital taxation and on lobbying activities by interest groups. It employs a model where different capital endowments lead to a conflict between households concerning their most preferred capital tax rate. Three main results are derived: First, redistributive source based capital taxes or subsidies decline as international tax competition intensifies. Second, lobbying activities of certain interest groups may explain international differences in the capital tax rate. Third, capital mobility may lead to declining lobbying activities of interest groups and thus may be welfare increasing for all households.

**Keywords:** Tax competition, interest groups, redistribution

**JEL-classification:** F 42, H 77

## Introduction\*

This paper analyzes capital tax competition in a model with endogenous policy formation and interest groups. In an open economy with internationally mobile capital, investors have the possibility to transfer their capital to the country offering the most favorable investment conditions. This opportunity leads to an additional constraint for national tax policy:<sup>1</sup> capital that is taxed heavily in the country where it is invested may escape to other countries with a lower tax burden. Governments then have to compete for this internationally mobile capital as a tax base.

In the last years an extensive theoretical literature has developed that investigates many aspects of interjurisdictional tax competition caused by capital mobility. This literature usually deals with capital taxes raised entirely for allocative reasons, namely to finance public goods or services that the private sector cannot adequately provide.<sup>2</sup> As one of the main results, it implies that tax competition between sufficiently similar countries leads to declining source-based capital taxes and therefore either lower levels of public spending or higher taxes on immobile

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<sup>1</sup> Capital taxation is only one domain where international capital mobility may lead to competition between governments or other national institutions. For a general description of institutional competition caused by international capital mobility, see e.g. Siebert, Koop (1990).

<sup>2</sup> Examples are the works of Zodrow, Mieszkowski (1986), Wilson (1986), Bucovetsky, Wilson (1991), Wildasin (1989), Oates, Schwab (1988, 1991) and Razin, Sadka (1991a, 1991b).

factors compared to a closed economy.<sup>3</sup> Since governments are predominantly assumed to maximize the welfare of their respective representative citizen, capital tax competition with a source-based capital tax is usually viewed as inefficient. A coordination of national tax policies would then increase welfare of all households in all countries.<sup>4</sup>

In contrast to the literature on tax competition with allocative capital taxes, this paper focuses on redistributive capital taxation. The better a household is endowed with capital, the more a declining net interest rate caused by rising capital taxes affects his factor income.<sup>5</sup> Different capital endowments of the households therefore lead to a redistributive conflict concerning the desired capital tax, that can-

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<sup>3</sup> Bucovetsky, Wilson (1991) and Razin, Sadka (1991a) show that this result holds as long as residence-based capital taxes cannot be raised adequately in addition to source-based capital taxes.

<sup>4</sup> In contrast to the assumption of purely welfare maximizing governments, Edwards, Keen (1994) and Rauscher (1996) investigate tax competition in a "Leviathan" model of the government (see also S. Sinn, 1992). They reach ambiguous conclusions concerning the welfare effects of tax competition with international capital mobility.

<sup>5</sup> Ghosh (1991), Persson, Tabellini (1992) and Schulze (1996) also treat tax competition with redistributive capital taxes. Ghosh (1991) combines a model of tax competition with allocative capital taxes with an overlapping generations approach where redistributive conflicts arise between young households, who earn labor income and save for their retirement, and old households, who live entirely from the capital income of past savings. Assuming an exogenously given political objective function, he shows that capital mobility no longer leads to unambiguously decreasing capital taxes. Schulze (1996) considers a tax on capital exports in a model where the tax proceeds are distributed between households according to their share of total factor income. With these assumptions, he shows that the most preferred tax rate of a certain household depends on his capital-labor endowment ratio. The model and the results of Persson, Tabellini (1992) are treated in section 2 below.

not be treated in representative household models.<sup>6</sup> Households with a low capital endowment prefer a relatively high capital tax rate compared to households relatively well endowed with capital preferring a lower capital tax rate or even a capital subsidy. The capital tax rate that is actually imposed then depends on the degree to which the respective interests of the different households are represented in the process of political decision making.

As section 2 of this paper shows, tax competition with source-based capital taxes leads to declining redistribution between households differing with respect to their capital endowment. As tax competition intensifies, a positive capital tax rate, redistributing from capital rich to capital poor households, declines and a negative capital tax rate, redistributing in the other direction, rises. With a redistributive impact of capital taxes, tax competition can no longer be viewed as unambiguously welfare decreasing for all households. Those households who suffer from the redistributive activities of the government may benefit from the declining degree of redistribution.

The redistributive impact of capital taxes may give households an incentive to influence policy not only through their vote decision but also through lobbying pressure by interest groups. To shed some light on the mutual relations between lobbying and tax competition, this paper explicitly considers lobbying by interest groups in a model of representative democracy. Two main results follow from this investigation: First, as section 2 shows, lobbying by certain interest groups may have an influence on the relative position of a country in the international tax competition game. A relatively high political representation of interest groups that pursue the interests of capital poor households leads to a relatively high capital tax

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<sup>6</sup> In addition to the case of unequal capital endowments, redistributive conflicts connected with capital taxation in an open economy may also arise from an unequal distribution of immobile factors or from a capital tax that is used to finance redistributive expenditure programs.

rate in this respective country and therefore causes capital outflows to other countries.

Second, international capital mobility has consequences for lobbying activities by interest groups. As redistributive conflicts between households with different capital endowments diminish with the introduction of international capital mobility, also the incentives decline for interest groups to influence tax policy through lobbying. Section 3 shows that for certain symmetry conditions the lobbying expenditures of all interest groups decrease as international tax competition intensifies. Thus, international capital mobility has welfare implications that have not been treated at all in the existing literature on tax competition: International tax competition may lead to a declining amount of resources invested in lobbying and may therefore increase welfare of all households.

## 1. Redistributive Capital Taxation in an Open Economy

This section provides a basis for analyzing tax competition with redistributive capital taxation using a simple neoclassical representation of an international capital market equilibrium. It shows how source-based capital taxes influence the allocation of internationally mobile capital and how they affect the remuneration of capital and that of immobile factors. As was mentioned in the introduction, the redistributive effects of capital taxes follow from an unequal distribution of capital between households. The last part of this section shows that the redistributive impact of a capital tax continuously declines with the introduction of capital mobility and with a rising number of countries.

According to the model, the world consists of  $N$  countries. A representative firm has the possibility to produce in each of these countries the same internationally tradable composite commodity. The firm takes the prices of the good and that of production factors as given. Production factors are internationally perfectly mobile



capital and internationally immobile labor.<sup>7</sup> The firm produces with constant returns to scale. It chooses its capital input  $K^i$  and its labor input  $L^i$  to maximize its expected profit that is defined as follows:

$$\pi = \sum_{i=1}^N \left[ F(K^i, L^i) - t^i K^i - w^i L^i - [1 + \rho] K^i \right] \quad (1)$$

In this equation, the price of the composite commodity is normalized to 1. The term  $w^i$  denotes the wage rate as the price of the immobile factor in country  $i$  whereas  $\rho$  measures the interest rate as the price of capital. Capital mobility equalizes the price of capital internationally. In addition to the factor prices, the firm has to pay a constant capital tax rate  $t^i$  in every country for the amount of capital invested there. This capital tax rate represents an aggregate measure of the burden of source based capital taxes. It depicts the difference between the gross capital return realized in one country and the net return arriving at the household level.<sup>8</sup> A negative  $t^i$  corresponds to a net capital subsidy in country  $i$ . The factor employment decision of the representative firm determines capital and labor demand in every country.

In each country, there exist  $n$  households. Every household supplies inelastically  $l$  units of labor. Aggregate savings of the households determine capital supply. The households save to maximize utility from present and future consumption. Present consumption of a household  $k$  equals the difference between an exogenous income

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<sup>7</sup> Labor can be interpreted as a representation of all internationally immobile factors.

<sup>8</sup> Since this model does not differentiate between international capital movements on the firm level and on the household level, a source-based capital tax raised from the households would influence the capital market equilibrium in the same way as the investment tax considered here. The linear capital tax equalizes the so called "tax-wedge" introduced by King, Fullerton (1984) to estimate the burden of capital taxation.

$v_k$  minus savings  $s_k$ . Future consumption equals the sum of factor income from capital and labor and each household's share of the public income from the taxation of capital. This paper assumes that a positive or negative public income from the capital tax or subsidy is distributed directly and equally as a lump sum transfer among the households. The savings decision of a household  $k$  in country  $i$  thus can be represented as follows:

$$\max_{s_k^i} U \left( v_k^i - s_k^i, s_k^i [1 + \rho] + w^i l + \frac{t^i K^i}{n} \right). \quad (2)$$

In equilibrium, households maximize their utility and the representative firm maximizes its profit. Worldwide aggregate capital supply through savings equals capital demand of the representative firm. Moreover, in each country aggregate labor supply equals labor demand. Thus, the following equations describe the equilibrium on the world capital market ( $i=1\dots N, k=1\dots n$ ):<sup>9</sup>

$$F_1(K^i, nl) - t^i = 1 + \rho, \quad (3)$$

$$F_2(K^i, nl) = w^i, \quad (4)$$

$$\frac{U_1 \left( v_k^i - s_k^i, s_k^i [1 + \rho] + w^i l + \frac{t^i K^i}{n} \right)}{U_2 \left( v_k^i - s_k^i, s_k^i [1 + \rho] + w^i l + \frac{t^i K^i}{n} \right)} = 1 + \rho, \quad (5)$$

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<sup>9</sup> As long as the marginal rate of substitution between present and future consumption is sufficiently high as  $s_k^i$  approaches zero and the marginal product of capital is sufficiently high as  $K^i$  approaches zero, an interior solution for the capital market equilibrium exists. It also meets the conditions for local dynamic stability (see appendix a).

$$\sum_{i=1}^N \sum_{k=1}^n s_k^i = \sum_{i=1}^N K^i \quad (6)$$

These equations determine the effects of a source-based capital tax on the aggregate capital stock of the world and its international allocation. The impact of an increasing domestic capital tax rate can be derived with the additional assumption of a utility function separable between present and future consumption and exhibiting constant absolute risk aversion (see appendix a). Starting from a symmetric equilibrium where all countries choose the same capital tax rate, a marginal increase of the domestic capital tax rate affects the domestic and foreign capital stock according to the following equations (see appendix a):<sup>10</sup>

$$\frac{dK^1}{dt^1} = \frac{1}{F_{11}} \left[ 1 + \frac{\psi}{N} \right] < 0, \quad (7)$$

$$\frac{dK^{-1}}{dt^1} = \frac{\psi}{N F_{11}} > 0, \quad \text{with } -1 < \psi < 0. \quad (8)$$

The term  $\psi$  stands for the marginal impact of an increasing capital tax rate on the domestic interest rate before an international relocation of capital takes place. This term is negative implying a negative relationship between the capital tax rate and the net return to capital in a closed economy. Since an increasing capital tax decreases aggregate savings in a closed economy, the term  $\psi$  is larger than minus one.<sup>11</sup> In an open economy, the impact of the domestic tax rate on the net return

<sup>10</sup> The adjuncts 1 and -1 denote the domestic country and a representative foreign country respectively.

<sup>11</sup> Aggregate savings decrease with a rising capital tax rate, because the capital tax raises the relative price of future consumption and thereby causes a substitution from future consumption to present consumption. In addition to this substitution effect, an increasing capital tax also causes an income effect on individual savings depending on whether

to capital causes an international relocation of capital. The invested capital stock in country 1 therefore decreases to a larger extent in an open economy ( $N > 1$ ) than in a closed economy ( $N = 1$ ). This follows from equation (7), that implies that the absolute value of the domestic capital reaction on a changing domestic tax rate increases with the number of competing countries.

The degree to which the capital stock reacts on a changing tax rate determines the incidence of the capital tax for the income of both factors capital and labor. With international capital mobility, a changing capital tax rate affects the income of the mobile factor capital to a lower degree than in a closed economy; the converse is true for the immobile factor. With a rising number of competing countries, the burden of the capital tax shifts more and more from the mobile factor capital to the immobile factor labor. In the limit case, where the number of countries approaches infinity, the interest rate is not affected at all by a unilateral change of the domestic capital tax rate whereas domestic labor bears all the consequences for net factor incomes.<sup>12</sup> These results can be derived from equations (3) and (4). Total differentiation of these equations leads to the following expressions:

$$F_{11} dK^1 - dt^1 = d\rho, \quad (9)$$

$$F_{21} dK^1 = dw^1. \quad (10)$$

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the household benefits from or is burdened by the redistributive effect of capital taxes at the margin. The different income effects on individual savings, however, cancel out in the aggregate for an individual utility function that exhibits constant absolute risk aversion, so that only the substitution effect remains in the aggregate.

<sup>12</sup> In the limit case, the model therefore resembles that of a small open economy where the interest rate is fixed exogenously. Mc Lure (1969), for example, examines the incidence of fiscal policy in a small open economy.

An increasing domestic fiscal burden then has the following impact on the interest rate and on domestic wages:

$$\frac{d\rho}{dt^1} = \frac{\Psi}{N}, \quad (11)$$

$$\frac{dw^1}{dt^1} = \frac{F_{21}}{F_{11}} \left[ 1 + \frac{\Psi}{N} \right]. \quad (12)$$

With its influences on factor incomes, the redistributive effect of a capital tax or subsidy can now be derived. According to its exogenous income in the first period, each household belongs to one of the household groups  $j = 1 \dots m$ ,  $m \leq n$ . The better a household is endowed with exogenous income in the first period, the higher are its savings.<sup>13</sup> Thus, the endowment of a household with exogenous income in the first period determines its endowment with savings capital. For a given amount of savings, an increasing domestic capital tax rate affects future consumption of a household in group  $j$  according to the following equation:<sup>14</sup>

$$\frac{dc_{zj}^1}{dt^1} = s_j^1 \frac{d\rho}{dt^1} + l \frac{dw^1}{dt^1} + \frac{t K^1}{n} + \frac{t^1}{n} \frac{dK^1}{dt^1}. \quad (13)$$

With equations (7), (11) and (12), equation (13) can be expressed as follows:

<sup>13</sup> A higher value of the exogenous income  $\Psi$  leads to higher savings, if future consumption is a normal good with respect to an increasing lifetime income. The assumption of a utility function separable between present and future consumption ensures this condition to be satisfied.

<sup>14</sup> The increasing capital tax rate also affects present and future consumption through its impact on individual savings. However, this effect is not relevant for the utility of household  $j$  as equation (5) implies.

$$\frac{dc_{ij}^1}{dt^1} = \left[ s_j^1 - \frac{K^1}{n} \right] \frac{\Psi}{N} + \frac{t^1}{nF_{11}} \left[ 1 + \frac{\Psi}{N} \right]. \quad (14)$$

In a closed economy and in an open country where all countries choose the same fiscal policy, average domestic savings equate the capital stock invested per head. The first term in equation (14) then measures the redistributive effect of a capital tax. This term is positive for all household groups whose members save less than the average. These households prefer a positive tax, whereas the opposite is true for relatively capital abundant households. With a rising number of countries the redistributive impact of a capital tax declines.

## 2. Tax Competition when Lobbying Influence is Given

This section derives the equilibrium rate of a redistributive capital tax for a closed and for an open economy. It thus shows how international capital mobility and tax competition affect redistributive capital taxation. As the preceding section has shown, the redistributive effects of a capital tax lead to conflicting interests between households differing according to their capital endowment. Interest groups of these households therefore may exert political pressure through lobbying to influence capital taxation in their favoured direction. In the last part of this section the effects are derived of an increasing political influence of certain interest groups on capital tax rates. These effects determine the impact of lobbying on redistributive capital taxation in an open economy.

To represent the process of political decision-making, this paper employs a probabilistic voting approach with interest groups developed by Coughlin, Mueller, Murell (1990a, 1990b). It describes a political contest between two parties trying to maximize the expected number of votes in a forthcoming election. Both parties announce simultaneously their respective policy platform. Afterwards, all house-

holds vote in a majority-rule election for one of the parties. The winning party then enforces its policy platform.<sup>15</sup>

Coughlin, Mueller, Murell (1990 a, 1990 b) divide the electorate into different groups of equal households - the interest groups. The parties are assumed to be only incompletely informed about the political preferences of the members of these interest groups, so that the median voter theorem does not hold. Instead, parties choose their respective policy platform as if they would maximize a weighted sum of indirect utilities of the interest groups' representative members - with strictly positive weights for all interest groups. The weight of an interest group in the political objective function depends positively on its size and negatively on the degree to which the parties are uncertain about political preferences of the members of this interest group. The uncertainty of the parties is represented by a personal bias term measuring the utility bias of a household  $j$  in favour of one of the parties. This term is assumed to be distributed uniformly on an interval with size  $\phi_j$ .

In addition to Coughlin, Mueller, Murell (1990a, 1990b), this paper assumes that the parties do not expect systematic preferences in favor of one of the parties, and that both parties possess the same degree of uncertainty concerning the voters' preferences. Both parties then announce exactly the same capital tax rate in equilibrium and the outcome of the election is not relevant for the tax rate actually

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<sup>15</sup> Thus, the model abstracts from time inconsistency and enforcement problems where the policy platform announced by a party before an election differs from the policy actually carried out by the winner of the election.

raised.<sup>16</sup> Elections occur simultaneously in all countries.<sup>17</sup> Then the equilibrium capital tax rate  $t^1$  in country 1 is chosen to maximize the following objective function, with  $n_j^1$  as the size of interest group  $j$ ,  $s_j^1$  as utility maximizing savings of household  $j$ , and  $t^{-1}$  as the vector of equilibrium capital tax rates abroad.

$$Z^1(t^1, t^{-1}) = \sum_{j=1}^m \omega_j^1 U \left( v_j - s_j^1, s_j^1 [1 + \rho] + w^1 l + \frac{t^1 K^1}{n} \right), \quad (15)$$

with  $\omega_j^1 = \frac{n_j^1}{\phi_j^1}$ ,  $w^1 = w(t^1, t^{-1})$ ,  $\rho = \rho(t^1, t^{-1})$ ,  $K^1 = K^1(t^1, t^{-1})$ .

The following first order condition characterizes an interior symmetric equilibrium where all countries raise the same capital tax rate:

$$x \equiv \sum_{j=1}^m \omega_j U_{j2} \left\{ \left[ s_j - \frac{K}{n} \right] \frac{\Psi}{N} + \frac{t}{F_{11} n} \left[ 1 + \frac{\Psi}{N} \right] \right\} = 0, \quad (16)$$

with  $t \equiv t^1 = t^{-1}$ ,  $s_j \equiv s_j^1 = s_j^{-1}$ ,  $K \equiv K^1 = K^{-1}$  and  $\omega_j \equiv \omega_j^1 = \omega_j^{-1}$ .

It is assumed that the objective function (15) is strictly concave in  $t^1$  wherever condition (16) is satisfied so that condition (16) suffices for an interior symmetric

<sup>16</sup> Note, that the capital tax rate is the only variable considered here as an instrument of the parties in the political contest.

<sup>17</sup> Coughlin, Mueller, Murrell (1990a, 1990b) have formulated their political model only for a closed country.



equilibrium. The equilibrium is also assumed to be stable.<sup>18</sup> Rearranging equation (16) leads to the following explicit expression for the capital tax rate in equilibrium:

$$t = - \frac{\sum_j \omega_j U_{j2} \left[ s_j - \frac{K}{n} \right] \frac{\Psi}{N} F_{11} n}{\sum_j \omega_j U_{j2} \left[ 1 + \frac{\Psi}{N} \right]}, \quad (17)$$

$$t > (<=) 0, \text{ if and only if } \sum_j \omega_j U_{j2} \left[ s_j - \frac{K}{n} \right] < (>=) 0.$$

Equation (18) shows that the marginal utilities of future consumption and the welfare weights  $\omega_j$  of the interest groups in the political objective function determine whether capital is taxed or subsidized in equilibrium. For a constant marginal utility of future consumption, capital is taxed, if households with relatively low savings are represented more than proportionally to their size in the political objective function. A less than proportional political representation of these households leads to a capital subsidy. More precisely, as the expression below shows, capital is taxed (subsidized), if aggregate savings of the representative members of the different interest groups  $j=1\dots m$ , weighted with the relative political weight  $\omega_{rj}$ , are smaller (larger) than aggregate savings weighted with the relative size  $n_{rj}$  of the interest groups. For an equal degree of uncertainty concerning the preferences of all interest groups' representative members, and a constant marginal utility of future consumption, the relative political weight of all interest groups equals their relative

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<sup>18</sup> In a static game like this, stability has no real meaning, because the equilibrium is reached immediately and not - as the notion of stability implies - in a dynamic process where actors behave myopically. However, the assumption of stability is necessary to obtain "plausible" comparative static results in the following analysis.

size. The capital tax rate then takes the value of zero. A declining marginal utility of future consumption works in the direction of a higher capital tax rate.

$$t > (\leq) 0 \text{ if and only if } \sum_j \omega_j s_j < (\geq) \sum_j n_j s_j$$

$$\text{with } \omega_{rj} = \frac{\omega_j}{\sum_j \omega_j}, n_{rj} = \frac{n_j}{n}, \text{ and } U_{j2}(\cdot) = \text{const.}$$

The first order condition (16) is the central equation for studying the effects of tax competition on equilibrium policy. Implicit derivation of this equation first shows how the number of competing countries influences the capital tax rate:

$$\frac{dt}{dN} = -\frac{x_N}{x_t} \quad (18)$$

The expression  $x_t$  measures the effects on  $x$  of a marginal increase of the capital tax rate that is carried out in all countries symmetrically:

$$x_t = a + [N-1]b, \quad (19)$$

$$\text{with } a \equiv \frac{d^2 Z^1(t^1, t^{-1})}{[dt^1]^2} < 0 \text{ and } b \equiv \frac{d^2 Z^1(t^1, t^{-1})}{dt^1 dt^{-1}}.$$

Stability of the equilibrium implies  $a \pm [N-1]b < 0$  (see Dixit, 1986). The term  $x_t$  is therefore negative. The following equation gives the value of  $x_N$ :

$$x_N = \sum_j \omega_j U_{j2} \left\{ \left[ s_j - \frac{K}{n} \right] + \frac{t}{F_{11}n} \right\} \left[ -\frac{\Psi}{N^2} \right],$$

$$\Rightarrow x_N = \sum_j \omega_j U_{j2} \frac{t}{F_{11}nN} \quad (20)$$

A rising number of countries decreases a positive capital tax rate and increases a negative one. Capital mobility thus limits redistribution between households differing with respect to their capital endowment: In a closed country there is more redistributive capital taxation than in an open country and in an open country redistributive capital taxation declines continuously with a rising number of countries. Proposition 1 summarizes this result:

**Proposition 1:** *Assume that (i) the capital tax rate maximizes equation (15) for all countries, that (ii) utility is separable with respect to present and future consumption and exhibits constant absolute risk aversion, and that (iii) the tax competition equilibrium is stable and symmetric. Then the absolute value of the capital tax rate decreases with a rising number of countries.*

Persson, Tabellini (1992) derive a similar result concerning redistributive capital taxes and capital mobility: They investigate capital taxation in a 2-period, 2-country model where capital investments abroad cause strictly convex mobility costs. In their model, tax-competition intensifies as marginal mobility costs decline. In a symmetric equilibrium, this leads to a decreasing absolute value of capital tax rates - comparable to the results derived above. However, Persson, Tabellini (1992) employ a simpler economic framework where capital is used as the only input in a linear storage technology. Furthermore, the political part of their model differs substantially from the one formulated here, since redistributive activity is not explained by the pressure of certain interest groups in the political contest. Instead, in their model the elected policymaker chooses the capital tax to maximize his own income that consists of capital income and public transfers - comparable to the income of any other household.

Equation (16) not only shows how capital mobility and tax competition affect the degree of redistributive capital taxation, it also determines the influence of lobbying on capital taxes in equilibrium. In this paper it is assumed that lobbying of interest groups affects equilibrium tax policy through its effects on the welfare weights in the political objective function (15). Through lobbying, each interest group can

increase the weight of its members in the political objective function.<sup>19</sup> An increasing weight of a single interest group in one country has the following effects on capital taxes in equilibrium.<sup>20</sup>

$$\frac{dt^1}{d\omega_k^1} = -\frac{a + [N-2]b}{[a + [N-1]b][a-b]} x_{\omega_k}, \quad (21)$$

$$\frac{dt^{-1}}{d\omega_k^1} = \frac{b}{[a + [N-1]b][a-b]} x_{\omega_k}. \quad (22)$$

The stability condition  $a \pm [N-1]b < 0$  and the condition  $a < 0$  together imply that  $a + [N-1]b < 0$ ,  $a - b < 0$ , and  $a + [N-2]b < 0$ . An increasing weight of interest group  $k$  then will increase domestic fiscal burden, if and only if it increases  $x$ . The sign of  $b$  determines the foreign reaction on a changing fiscal burden in the domestic economy. For a positive  $b$ , domestic and foreign fiscal policies are strategic complements. An increasing domestic fiscal burden then leads to an increasing fiscal burden abroad, though the foreign tax rate rises by a smaller amount than the domestic tax rate. The impact of the weight of an interest group  $k$  on the first order condition is given by the following equation:

$$x_{\omega_k} = U_{k2} \left\{ \left[ s_k - \frac{K}{n} \right] \frac{\Psi}{N} + \frac{t}{F_{11}n} \left[ 1 + \frac{\Psi}{N} \right] \right\}. \quad (23)$$

Inserting equation (17) gives the following expression:

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<sup>19</sup> Section 3 considers the influence of lobbying on political decision-making in more detail.

<sup>20</sup> These equations are derived in appendix b.

$$x_{\omega_k} = \frac{U_{k_2} \left\{ \sum_j \omega_j U_{j_2} [s_k - s_j] \right\}}{\sum_j \omega_j U_{j_2}} \frac{\Psi}{N}, \quad (24)$$

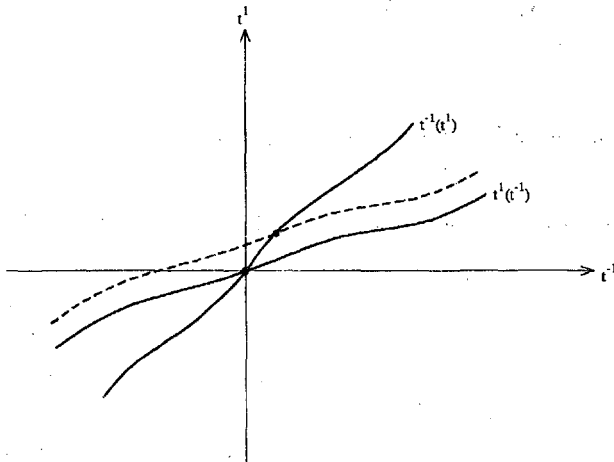
$\Rightarrow$

$$x_{\omega_k} > (\leq) 0, \text{ if and only if } \sum_j \omega_j U_{j_2} s_k < (\geq) \sum_j \omega_j U_{j_2} s_j.$$

For an interpretation of this result, assume that initially all households are weighted equally in the respective political objective function of every country and that marginal utility of future consumption is constant. In this initial equilibrium, the capital tax rate takes the value of zero in all countries. Then the domestic tax rate rises with an increasing weight of an interest group whose members save less than the average. Figure 1 depicts this for the case of two countries. With the special assumptions made above, the second order condition and the stability condition are both satisfied and domestic and foreign tax rates are strategic complements (see appendix c). An increasing weight of a capital poor interest group moves up the reaction function of the representative domestic party. The domestic capital tax rate rises and this causes also a rising capital tax rate abroad. Since the change of the domestic capital tax rate exceeds that of the capital tax rate abroad, the political influence of the capital poor interest group leads to capital outflows.

**Proposition 2:** *Given the assumptions of Proposition 1, an increasing weight of an interest group in the political objective function leads to an increasing domestic capital tax rate, if and only if the aggregate difference is negative between per-capita savings of the interest group's representative member and of the representative members of all other interest groups - weighted with marginal utility and the political weights of the respective interest groups.*

Figure 1 - Reaction Functions and the Influence of Interest Groups



### 3. Endogenous Lobbying and Tax Competition

International capital mobility not only affects the capital tax rate for a given lobbying influence of the interest groups but it may also have consequences for the lobbying process itself. The proceeding section has shown that redistributational capital taxes or subsidies decline as the intensity of tax competition rises. In addition, the weight of an interest group in the political objective function has a lower marginal impact on the first order condition of the representative party. This section investigates, whether this also leads to declining lobbying activities of the interest groups. It therefore considers an entirely new aspect concerning the welfare effects of international capital tax competition: As tax competition limits the ability of governments to redistribute between households with differing capital endow-

ments, it may even increase welfare of all households, since it partly keeps them from investing resources for lobbying by interest groups.

This paper considers lobbying as a process of information transmission: The political weight of an interest group  $j$  depends negatively on the range of the parties' uncertainty  $\phi_j$  concerning the political preferences of the households in this group. All interest groups are assumed to possess perfect knowledge about the political preferences of their members. Therefore, the interest groups have an incentive to transmit their private knowledge through lobbying activities to the parties and thereby increase their respective weight in the political objective function. The transmission of information is assumed to be costly with a differentiable cost function  $c(\phi_j)$ , that is monotonically decreasing in  $\phi_j$ ,  $j=1\dots m$ . In an interior equilibrium, each interest group in each country devotes resources in the lobbying process up to the point where the marginal benefit for its representative household of decreasing  $\phi_j$  equals the household's share of the marginal costs of lobbying. Both, marginal benefit and marginal cost are measured in utility terms. For the remainder of this paper, it is assumed that the utility of the households is linear with respect to future consumption. Then a changing capital tax rate or changing lobbying costs will not affect the marginal utility of future consumption,  $U_{j2}$ , of all representative households. The first order conditions can be represented as follows with  $-\frac{dB_j^i}{d\phi_j}$  as the marginal benefit of decreasing the domestic parties' uncertainty:

sented as follows with  $-\frac{dB_j^i}{d\phi_j}$  as the marginal benefit of decreasing the domestic parties' uncertainty:

$$-\frac{dB_j^i}{d\phi_j} = -\frac{U_{j2}}{n_j} \frac{dc_j^i}{d\phi_j}, \quad i=1\dots N, j=1\dots m. \quad (25)$$

The second order condition and the condition for stability of the lobbying equilibrium are assumed to be satisfied. Capital mobility and the intensity of tax competition affect lobbying through their impact on the marginal benefit of lobbying. The

following equation represents the marginal benefit for a representative household of domestic interest group  $k$ :

$$-\frac{dB_k^1}{d\phi_k^1} = -\left[ \frac{dU_k^1}{dt^1} \frac{dt^1}{d\omega_k^1} + [N-1] \frac{dU_k^1}{dt^{-1}} \frac{dt^{-1}}{d\omega_k^1} \right] \frac{d\omega_k^1}{d\phi_k^1}, \quad (26)$$

As equation (26) shows, the interest groups not only obey the impact of their activities on domestic capital taxes in an open economy but also on capital taxes abroad. The relations between an increasing political weight and the capital tax rate at home and abroad are given by equations (21) and (22) of the proceeding section. The following equations (27) and (28) show how an increasing capital tax rate at home and abroad affects the welfare of the representative household of interest group  $k$ :

$$\frac{dU_k^1}{dt^1} = U_{k2} \left\{ \left[ s_k - \frac{K}{n} \right] \frac{\Psi}{N} + \frac{t}{F_{11}n} \left[ 1 + \frac{\Psi}{N} \right] \right\} = x_{\omega_k}, \quad (27)$$

$$\frac{dU_k^1}{dt^{-1}} = U_{k2} \left\{ \left[ s_k - \frac{K}{n} \right] \frac{\Psi}{N} + \frac{t}{F_{11}n} \frac{\Psi}{N} \right\}. \quad (28)$$

In the following, the paper only considers those cases where the respective capital endowment of the representative household is distributed symmetrically between the interest groups. Symmetrical distribution of the capital endowment means that for each interest group whose representative member owns a capital endowment above the average, there exists another interest group of the same size with a representative member owning a capital endowment below the average. The distance between its representative member's endowment and average endowment is the same for both interest groups. In addition, the linear utility of future consumption implies that savings are distributed exactly in the same way across the households



as exogenous capital endowment,<sup>21</sup> and that the marginal utility of future consumption takes the same value for all households. The following analysis will show that the equilibrium lobbying outlays of interest groups can be ordered in pairs in the same way as the distance between capital endowment and average capital endowment. Governments then have no incentive to raise a redistributive capital tax or subsidy and as equation (17) implies, the capital tax rate declines to zero irrespective of the number of countries. However, for every interest group, there remains an incentive to influence policy through lobbying, so that its lobbying outlays are strictly positive. Lobbying becomes a prisoners' dilemma situation for the interest groups: Each interest group devotes resources to influence policy, but because all interest groups do this in a symmetrical pattern, lobbying has no effects at all on equilibrium policy.

For  $t=0$  both equations (27) and (28) coincide and a changing capital tax rate affects the utility of a representative household  $k$  irrespective of the country in which the household resides. A household with a capital endowment below the average thus benefits from increasing capital taxes raised in any foreign country in the same way as from increasing domestic capital taxes.

For a constant marginal utility of future consumption and a symmetrically distributed capital endowment, both stability conditions for the tax competition equilibrium are satisfied (see appendix c). The domestic capital tax rate thus increases with a rising weight of an interest group representing capital poor households and decreases with a rising weight of an interest group representing capital abundant households. Inserting equations (21), (22), (27) and (28) in equation (26) leads to the following expression for the marginal benefit of lobbying:

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<sup>21</sup> Equation (5) shows that, with a linear utility of future consumption, all households consume the same amount in the first period. Differences in their capital endowments are fully reflected in differences in their savings.

$$\frac{dB_k^1}{d\phi_k^1} = \frac{[x_{\omega_k}]^2}{x_t} \frac{d\omega_k^1}{d\phi_k^1} \quad (29)$$

The following equation determines  $x_t$  for a constant marginal utility of future consumption and for  $t = 0$ :

$$x_t = \sum_j \omega_j U_{j2} \frac{1 + \frac{\psi}{N}}{F_{11} n} \quad (30)$$

Equation (29) thus can be rewritten to obtain the following expression:

$$\frac{dB_k^1}{d\phi_k^1} = \frac{[U_{k2}]^2 \left[ s_k - \frac{K}{n} \right]^2 F_{11} n}{\sum_j \omega_j U_{j2}} \frac{\psi^2}{[N^2 + \psi N]} \frac{d\omega_k^1}{d\phi_k^1} \quad (31)$$

Equation (31) implies that the marginal benefit of lobbying does not directly depend on the capital endowment of its representative household but only on the distance between that capital endowment and average capital endowment. The marginal benefits of lobbying thus can be ordered in pairs according to the distance between the capital endowment of its representative member and average capital endowment. The impact of tax competition on the marginal benefit of lobbying is given by the following equation. This equation shows how an increasing number of countries affects the marginal benefit of lobbying:<sup>22</sup>

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<sup>22</sup> Because  $t = 0$  irrespective of  $N$ , an increase in  $N$  does affect neither  $t$  nor  $s_k$ ,  $K$ ,  $\psi$  nor  $F_{11}$ . Therefore, these expressions can be treated as constants.

$$\frac{d^2 B_k^1}{d\phi_k^1 dN} = \frac{[U_{k_2}]^2 \left[ s_k - \frac{K}{n} \right]^2 F_{11} n \psi^2}{\sum_j \omega_j U_{j_2}} \frac{2N + \psi}{[N^2 + \psi N]^2} \frac{d\omega_k^1}{d\phi_k^1} < 0. \quad (32)$$

The marginal benefit of lobbying decreases continuously with an increasing number of countries  $N$ . Lobbying becomes less attractive for every interest group as the number of countries rises, and - as equation (25) implies - lobbying outlays decrease.

**Proposition 3:** *Assume that (i) the capital tax rate maximizes equation (15) for given interest group weights and that the tax competition equilibrium is symmetric, that (ii) utility is separable with respect to present and future consumption and linear in future consumption, that (iii) all interest groups have the same lobbying cost function, that (iv) capital endowment is distributed symmetrically across all households in the respective countries, and that (v) the lobbying equilibrium is stable. Then the capital tax rate is zero irrespective of the number of countries and lobbying activities of all interest groups decline as the number of countries rises.*

So far, the impact of capital mobility on the lobbying activities has been derived under the special assumptions of a linear utility of future consumption, symmetrically distributed capital endowments and equal lobbying cost functions for all interest groups. For a large number of countries, these assumptions are not necessary to derive the negative impact of capital mobility on lobbying for capital income redistribution.<sup>23</sup> As equation (17) shows, the capital tax rate declines to zero for a sufficiently large number of countries, irrespective of the political weights of the different interest groups. In this case, lobbying completely loses its influence on the

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<sup>23</sup> This case resembles the case of a small open economy.

capital tax rate in an open economy. Since lobbying is costly at the margin, lobbying outlays will then decline to zero.

### **Concluding Remarks**

This paper has shown how tax competition caused by international capital mobility may limit redistributive activities of governments and therefore may lead to a declining amount of resources spent for lobbying by interest groups. It thus has drawn a contrasting picture to the majority of the existing literature on international tax competition and its potential welfare implications. This literature abstracts from redistributive conflicts focusing on capital taxes raised for entirely allocative purposes. In reality, capital taxes have both allocative and distributive effects, so that a combination of the results derived here and those of the models of allocative tax competition probably describes international capital tax competition most accurately. An evaluation of the needs to coordinate tax policy internationally should thus also bear the contrasting welfare implications of both kinds of models in mind.

To reduce the complexity of the problem investigated here and to isolate main driving forces of redistributive capital tax competition, the paper has focused on a symmetric tax equilibrium. An exception of the symmetry assumption has been the comparative static analysis in section 2, showing how internationally different tax rates may reflect internationally different interest group activities. As another reason for asymmetries, Bucovetsky (1991) and Wilson (1991) incorporate different population sizes of the countries in a model with allocative capital taxation. Small countries face a more elastic reaction of the capital stock on a changing tax rate and therefore raise a lower allocative capital tax rate than large countries. With an increasing elasticity of the capital reaction the marginal burden of the capital tax shifts from the mobile factor capital to the immobile factor labor. Thus, the redistributive usage of capital taxes should as well be expected to be relatively lower in small countries than in large countries. An asymmetric capital tax equilibrium may also result from the attempt of capital importing or exporting countries to influence

the interest rate in their favored direction (e.g. Hamada, 1966). Following this line of argumentation, capital importing regions raise a higher tax rate than capital exporting regions.

The paper has employed a specific approach to incorporate lobbying by interest groups in a model of political decision making in a representative democracy. It has considered lobbying as an attempt to reduce the uncertainty of political parties concerning political preferences. This specific kind of model leads to a quite general political support function as a description of equilibrium policy. Although this model has only considered one special kind of political influence by interest groups, its results can thus be transferred to other constellations where parties maximize a weighted aggregate welfare of households and interest groups influence these weights through lobbying activities.

## Appendix

### (a) The Influence of the Tax Rate on the Allocation of Capital

This appendix derives the influence of a marginal increase of the domestic capital tax rate on the international allocation of capital. The following equations have to be satisfied in the capital market equilibrium:

$$F_1(K^i, nl) - t^i = 1 + \rho, \quad (\text{A.1})$$

$$\frac{U_1 \left( v_k^i - s_k^i, s_k^i [1 + \rho] + F_2(K^i, nl)l + \frac{t^i K^i}{n} \right)}{U_2 \left( v_k^i - s_k^i, s_k^i [1 + \rho] + F_2(K^i, nl)l + \frac{t^i K^i}{n} \right)} - [1 + \rho] = 0, \quad (\text{A.2})$$

$$\sum_{i=1}^N \sum_{k=1}^n s_k^i = \sum_{i=1}^N K^i. \quad (\text{A.3})$$

These equations determine the endogenous variables  $K^i, s_k^i$  and  $\rho$  ( $i=1 \dots N, k=1 \dots n$ ). Total differentiation of the system (A.1) – (A.3) leads to the following equations:

$$F_{11}^i dK^i - dt^i = d\rho, \quad (\text{A.4})$$

$$A_k^i ds_k^i + B_k^i \left[ F_{21}^i l + \frac{t^i}{n} \right] dK^i + [B_k^i s_k^i - 1] d\rho + B_k^i \frac{K^i}{n} dt^i = 0, \quad (\text{A.5})$$

$$\sum_{i=1}^N \sum_{k=1}^n ds_k^i = \sum_{i=1}^N dK^i. \quad (\text{A.6})$$

The terms  $A_k^i$  and  $B_k^i$  are defined as follows:<sup>24</sup>

$$A_k^i \equiv - \frac{\partial \left[ \frac{U_1(c_{gk}^i, c_{zk}^i)}{U_2(c_{gk}^i, c_{zk}^i)} \right]}{\partial c_{gk}^i} + \frac{\partial \left[ \frac{U_1(c_{gk}^i, c_{zk}^i)}{U_2(c_{gk}^i, c_{zk}^i)} \right]}{\partial c_{zk}^i} [1 + \rho], \quad (\text{A.7})$$

$$B_k^i \equiv \frac{\partial \left[ \frac{U_1(c_{gk}^i, c_{zk}^i)}{U_2(c_{gk}^i, c_{zk}^i)} \right]}{\partial c_{zk}^i} \quad (\text{A.8})$$

For all households  $k=1\dots n$ , the terms  $A_k^i$  and  $B_k^i$  are the same, because the utility function is assumed to be separable between present and future consumption and to exhibit constant absolute risk aversion.<sup>25</sup> Therefore, the index  $k$  in these terms can be dropped. To derive the effects of an increasing net fiscal burden in country 1, starting from the symmetric equilibrium, equations (A.4) – (A.6) are rewritten as follows:<sup>26</sup>

$$F_{11} dK^1 - dt^1 = d\rho, \quad (\text{A.9})$$

<sup>24</sup> The terms  $c_{gk}^i$  and  $c_{zk}^i$  denote present and future consumption of household  $k$  in country  $i$ .

<sup>25</sup> A separable utility function with constant absolute risk aversion has the following characteristics:  $U_{12} = U_{21} = 0$ ,  $U_{11}/U_1 = \text{const.}$  and  $U_{22}/U_2 = \text{const.}$

<sup>26</sup> In a symmetric equilibrium all countries choose the same tax rate. Therefore also the savings of the households, the invested capital stock and the terms  $F_{11}$ ,  $F_{12}$ ,  $A$  and  $B$  are the same in all countries. The indices  $l$  and  $-l$  then can be dropped in these terms. Moreover, the stock of aggregate savings equates the stock of investments in every country.

$$F_{11} dK^{-1} = d\rho, \quad (\text{A.10})$$

$$A \sum_{k=1}^n ds_k^1 + B[F_{21}nl + t] dK^1 + \left[ B \sum_{k=1}^n s_k - n \right] d\rho + BK dt^1 = 0, \quad (\text{A.11})$$

$$A \sum_{k=1}^n ds_k^{-1} + B[F_{21}nl + t] dK^{-1} + \left[ B \sum_{k=1}^n s_k - n \right] d\rho = 0, \quad (\text{A.12})$$

$$\sum_{k=1}^n ds_k^1 + [N-1] \sum_{k=1}^n ds_k^{-1} = dK^1 + [N-1] dK^{-1}. \quad (\text{A.13})$$

This system can be expressed in matrix-form:

$$\begin{bmatrix} F_{11} & 0 & 0 & 0 & -1 \\ 0 & F_{11} & 0 & 0 & -1 \\ B[F_{21}nl + t] & 0 & A & 0 & B \sum_k s_k - n \\ 0 & B[F_{21}nl + t] & 0 & A & B \sum_k s_k - n \\ -1 & -[N-1] & 1 & [N-1] & 0 \end{bmatrix} \begin{bmatrix} dK^1 \\ dK^{-1} \\ d \sum_k s_k^1 \\ d \sum_k s_k^{-1} \\ d\rho \end{bmatrix} = \begin{bmatrix} dt^1 \\ 0 \\ -BK dt^1 \\ 0 \\ 0 \end{bmatrix}. \quad (\text{A.14})$$

Using Cramer's rule, the following equations can be derived for the influence of a marginally increasing domestic tax rate on the domestic and foreign capital stock:

$$\frac{dK^1}{dt^1} = \frac{1}{F_{11}} + \frac{dK^{-1}}{dt^1}, \quad (\text{A.15})$$

$$\frac{dK^{-1}}{dt^1} = - \frac{A + B[F_{21}nl + t] + BK F_{11}}{NF_{11} \left\{ A + B[F_{21}nl + t] + F_{11} \left[ B \sum_k s_k - n \right] \right\}}. \quad (\text{A.16})$$

Because the production function is assumed to be linear-homogenous and because in every country the stock of savings equals the stock of invested capital, equation (A.16) simplifies to the following expression:



$$\frac{dK^{-1}}{dt^1} = -\frac{A+Bt}{NF_{11}[A+Bt-F_{11}n]} \quad (\text{A.17})$$

The term  $A+Bt$  is positive, as the following equation shows:

$$A+Bt \equiv -\frac{\partial \left[ \frac{U_1(c_{gk}^i, c_{zk}^i)}{U_2(c_{gk}^i, c_{zk}^i)} \right]}{\partial c_{gk}^i} + \frac{\partial \left[ \frac{U_1(c_{gk}^i, c_{zk}^i)}{U_2(c_{gk}^i, c_{zk}^i)} \right]}{\partial c_{zk}^i} F_1. \quad (\text{A.18})$$

The equations (A.9), (A.15) and (A.17) then can be expressed as follows:

$$\frac{d\rho}{dt^1} = \frac{\Psi}{N} < 0, \quad (\text{A.19})$$

$$\frac{dK^1}{dt^1} = \frac{1}{F_{11}} \left[ 1 + \frac{\Psi}{N} \right] < 0, \quad (\text{A.20})$$

$$\frac{dK^{-1}}{dt^1} = \frac{\Psi}{NF_{11}} > 0, \quad (\text{A.21})$$

with

$$\Psi \equiv -\frac{A+Bt}{A+Bt-F_{11}n}, \quad -1 < \Psi < 0.$$

With its property  $\Psi < 0$ , the capital market equilibrium also satisfies the condition for local dynamic stability. This condition can be expressed as follows:

$$\frac{dK^i - \sum ds_k^i}{d\rho^i} < 0, \quad i = 1, \dots, N. \quad (\text{A.22})$$

Inserting equations (A.9) and (A.11) with  $dt^1 = 0$  leads to the following stability condition for the representative country:

$$\frac{A + Bt - F_{11}n}{AF_{11}} < 0. \quad (\text{A.23})$$

This condition is satisfied.

*b) Comparative Statics*

The following comparative static analysis of the tax competition equilibrium is based on Dixit (1986) who describes the procedure of a comparative static analysis of an oligopoly equilibrium. According to the equations (15) and (16), the first order condition for the representative party in country  $i$  can be represented as follows:

$$x^i(t^i, t^{-i}, \omega_1^i, \dots, \omega_m^i) = 0. \quad (\text{A.24})$$

Total differentiation of this equation leads to the following expression:

$$adt^i + [N-1]bd t^{-i} = -x_{\omega_k}^i d\omega_k^i. \quad (\text{A.25})$$

With  $\bar{t}$  defined as  $t^i + [N-1]t^{-i}$ , equation (A.25) can be transformed as follows:

$$[a-b]dt^i + b d\bar{t} = -x_{\omega_k}^i d\omega_k^i. \quad (\text{A.26})$$

Summing up equation (A.26) over all countries  $i = 1 \dots N$  gives the following expression:

$$d\bar{t} = -\frac{\sum_{i=1}^N x_{\omega_k}^i d\omega_k^i}{a + [N-1]b} \quad (\text{A.27})$$

Inserting this expression into equation (A.26) and setting  $i=1$  and  $dt^{-1} = 0$  leads to equation (21) of section 2:<sup>27</sup>

$$\frac{dt^1}{d\omega_k^1} = -\frac{a + [N-2]b}{[a + [N-1]b][a-b]} x_{\omega_k} \quad (21)$$

Inserting equation (21) into equation (A.25) then also gives equation (22) of Section 2:

$$\frac{dt^{-1}}{d\omega_k^1} = \frac{b}{[a + [N-1]b][a-b]} x_{\omega_k} \quad (22)$$

*c) Second Order Condition, Stability and Slope of the Reaction Function*

The second order condition  $a < 0$  as well as the stability condition  $a \pm (N-1)b < 0$  are satisfied with a utility function that is linear in future consumption and a symmetrically distributed capital endowment. The reaction function of the representative parties then has a positive slope - that means  $b > 0$ .

Equation (16) of section 2 depicts the first order condition for the capital tax rate in equilibrium. It is rewritten here for country 1:

$$\frac{dZ^1(\cdot)}{dt^1} = \sum_{j=1}^m \omega_j U_{j2} \left\{ \left[ s_j^1 - \frac{K^1}{n} \right] \frac{\Psi}{N} + \frac{t^1}{F_{11} n} \left[ 1 + \frac{\Psi}{N} \right] \right\} \quad (\text{A.28})$$

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<sup>27</sup> For simplicity, the adjunct 1 is dropped in the right hand side of equation (22).

The following expression then describes the term  $a$  for a constant  $U_{j2}$  and for

$$\sum_j \omega_j \left[ s_j^1 - \frac{K^1}{n} \right] = 0:$$

$$a = \sum_j \omega_j U_{j2} \left[ \frac{ds_j^1}{dt^1} - \frac{dK^1}{dt^1} \frac{1}{n} \right] \frac{\psi}{N} + \sum_j \omega_j U_{j2} \frac{dK^1}{dt^1} \frac{1}{n}. \quad (\text{A.29})$$

For a constant  $U_{j2}$ , the influence of the world interest rate on private savings is the same for all households  $j$ . It is given by the following partial derivative of equation (5):

$$\frac{ds_j^1}{d\rho} = - \frac{U_2}{U_{11}} = \frac{1}{A}. \quad (\text{A.30})$$

Combining this equation with equation (A.19) leads to the following expression for the marginal influence of the capital tax rate on private savings:

$$\frac{ds_j^1}{dt^1} = \frac{\psi}{AN}. \quad (\text{A.31})$$

The first term in brackets in equation (A.29) then looks as follows:<sup>28</sup>

$$\frac{ds_j^1}{dt^1} - \frac{dK^1}{dt^1} \frac{1}{n} = \frac{[N-1]A}{N F_{11} n [A - F_{11} n]} > 0. \quad (\text{A.32})$$

The second order condition  $a < 0$  is thus satisfied. The first condition for stability,  $a + [N-1]b < 0$  is satisfied for  $t = 0$  as the following equation shows:

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<sup>28</sup> For a constant marginal utility of future consumption, the term  $B$  in  $\psi$  vanishes.

$$a + [N - 1]b = \sum_j \frac{\omega_j U_{j2}}{n} \frac{dK^1}{dt^1} < 0. \quad (\text{A.33})$$

The second condition for stability  $a + [N - 1]b > 0$  also holds for a constant marginal utility of future consumption and a symmetrically distributed capital endowment, since in this case the slope of the reaction function is positive ( $b > 0$ ), as the following derivation shows:

$$b = \sum_j \omega_j U_{j2} \left[ \frac{ds_j^1}{dt^{-1}} - \frac{dK^1}{dt^{-1}} \frac{1}{n} \right] \frac{\psi}{N}. \quad (\text{A.34})$$

From equations (A.10), (A.12) and (A.19) the following expression can be derived for the first term in brackets in equation (A.34):

$$\frac{ds_j^1}{dt^{-1}} - \frac{dK^1}{dt^{-1}} \frac{1}{n} = \frac{[nF_{11} - A]\psi}{ANF_{11}n}. \quad (\text{A.35})$$

This term is negative implying a positive term  $b$  and therefore also a positively sloped reaction function.

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