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RESIDENCE-BASED CAPITAL TAXATION:
WHY INFORMATION IS VOLUNTARILY
EXCHANGED AND
WHY IT IS NOT

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Abstract

The issue of capital tax competition in source-based capital taxes is viewed to be unproblematic if residence-based capital taxation exists. The sustainability, however, of residence-based capital taxation depends on the co-operation of source countries to assist in collecting tax revenues that benefit the residence country. We analyze conditions under which information about foreign savings are voluntarily exchanged. It turns out that information is voluntarily exchanged if the wage structure of the economy is not influenced by the size of the financial sector resulting in an efficient allocation with decentralized tax policies. In contrast, strategic incentives to withhold information may exist if the size of the financial sector has a positive impact on the wage structure of an economy.

Keywords: Tax competition, information exchange

JEL Classification: F42, F20, H21

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1 Introduction

The taxation of capital income has become particularly challenging in the past two decades. A trend towards increased international capital mobility has made the allocation of capital endogenous to national tax systems and raised concerns worldwide about the sustainability of capital income taxation. The United States (US), for example, already abolished its withholding tax on interest paid to foreigners in 1984 because of the existence of neighboring tax havens [Slemrod (1990)]. Similar pressures exist in the European Union (EU), where several attempts to introduce a minimum level of capital income taxation failed to receive the required consensus. Nevertheless, the European Commission (1998) brought forward a new proposal suggesting that member states should exchange information on bank accounts held by citizens to effectively enforce the residence principle. Recently, US tax authorities were successfully pressuring Luxembourg banks to establish a system of information exchange by threatening economic sanctions.

It is a core result of the literature on international capital taxation that the second-best allocation can be decentralized if residence-based capital taxes are enforceable [Bucovetsky and Wilson (1991), Razin and Sadka (1991)].¹ The residence principle, however, relies on the implementation of an information-exchange system and hence on the cooperation of source countries to assist in collecting revenues that benefit the residence country [c.f. Alworth (1998)]. The argument suggests that international harmonization of source-based capital taxation has substance because the alternative, residence-based capital taxation, is administratively infeasible [c.f. Tanzi (1995)].

The present paper analyzes the incentives of governments to use information transmission as a strategic variable within a tax-competition framework with wage taxation and a source-based capital tax, aside from a residence-based capital tax. It turns out from the analytical discussion that governments voluntarily provide information about foreign capital income to effectively enforce residence-based capital

¹In a recent paper Keen and Wildasin (2000) identify the conditions under which production efficiency and hence residence-based capital taxation is desirable in international capital taxation, even in the presence of international distributional considerations.

taxation in a large number of cases. The conclusion of Bacchetta and Espinosa (1995, Sec. 4), that incentives to voluntarily transmit information may exist in the absence of a source-based tax on capital, is established as a special case in our model.² If source-based capital taxes on domestic capital investments are available, however, governments continue to provide information, resulting in an efficient use of taxes on capital income and wage income. Thus, the conclusion that governments have the necessary incentives to provide information in a tax competition environment continues to hold if taxes on domestic capital investments exist.

At first glance, the result of efficient information provision in the presence of source-based capital taxation may appear to conflict with the results of Bacchetta and Espinosa (1995, Sec. 5.6) that strategic incentives to withhold information exist at the national level when source-based capital taxes on domestic investment are available. In the present paper, countries endogenously determine wage and capital taxation. Hence, an equilibrium with production efficiency is in principle feasible. The apparent contrast in results is resolved by observing that (i) source-based capital taxes are set exogenously in Bacchetta and Espinosa; (ii) they consider two countries where households in one country can only acquire foreign assets on the firm level in a second country. In our model, the tax policy for countries is determined endogenously and the assumption of an absent financial sector is not shared in this paper.

To pinpoint the first argument responsible for efficient exchange of information, we endogenize the tax policy for countries in the model where source- and residence-based taxes on capital income are available in addition to wage taxation, but not lump-sum taxation. Governments, however, do not employ a source-based capital tax in the presence of a tax on labor, independent of the effective level of residence-based capital taxation. Hence, it turns out that information exchange does not result in adverse tax-base effects of the source-based tax on capital. As a consequence,

²Huizinga and Nielsen (2000) consider a framework in which governments treat as a cost the decrease in bank profits resulting from the reduction in the level of domestic portfolio investment when information is exchanged. Basically, it is shown that information might be exchanged in a repeated game setting in which countries trade the gains from a tax on bank profits against the future costs of non-cooperation.

the equilibrium behavior of governments is efficient and information is voluntarily exchanged.

The second argument follows from the Diamond and Dybvig (1983) conclusion that a developed financial system allows for a convenient processing of information, it facilitates the intertemporal allocation of consumption by asset transformation and guarantees an efficient allocation of savings to the most productive use in firms. The reasoning suggests that an efficient banking system is widely used by households to allocate their savings to the most profitable portfolio investment. This modeling of the institutional structure has a clear impact on the strategic role of information. Whereas governments collect the information about residents' portfolio investments on the firm level in the absence of a financial sector, it is the financial sector that holds the information about individual savings in addition to the individuals. In the real world it is possible for individuals to avoid taxes by shifting their financial accounts to a foreign country, which would not be possible in the presence of information clearing. As a consequence, any exchange of information may influence the allocation of financial capital. Notice, however, that information policy has no direct effect on national welfare since investment decisions in real capital are only affected through the general-equilibrium effects of tax policy in the presence of a working financial market, which are absent if the countries are small. Information can thus be expected to be voluntarily exchanged because countries do not gain directly from a change in information policy.

Our overall conclusion from the two independent arguments hence is that information is not a strategic variable for governments in a tax competition model. The identification of the general mechanism that may lead to the strategic withholding of information points to the direction for possible extensions of the basic model: in order to find a rational explanation for information withholding we have to identify mechanisms that cause direct welfare or tax-base effects. An obvious extension of the analysis to explain the behavior of countries is to allow for structural effects caused by in-flows of financial capital on the countries' labor markets. Assuming that the relative size of the financial sector is sufficiently large in countries like Luxembourg, Liechtenstein or Switzerland and depends on the amount of financial

capital invested, the information policy has a direct effect on welfare as well as a direct effect on the tax bases due to the change in the wage structure. As we will show, this effect may give a rational explanation for the strategic use of information policies.

Our clarification of the potential sources of strategic incentives to withhold information is important for two reasons: first, it is crucial for the determination of circumstances under which we can expect that the implementation of a residence-based tax on capital will be problematic. Second, the structure of possible solutions for the information problem (e.g. incentive-compatible information-clearing mechanisms) will most likely depend on the cause of the imperfection.

The plan of the paper is as follows. After introducing the model in Section 2, we examine the outcome of tax competition in information transmission without structural effects in Section 3. This assumption is relaxed in Section 4. Section 5 contains our concluding remarks.

2 The model

Consider a two-period tax competition model in which two small countries $i = 1, 2$ are linked through the international capital market. The total population is N individuals and hence $N_1 + N_2 = N$ is the population distribution between countries. Residents within each country differ in their qualification level q . Let q be distributed on $[\underline{q}, \bar{q}]$ according to the strictly monotonous distribution function $\Phi : [\underline{q}, \bar{q}] \rightarrow [0, 1]$ and let us denote the density function by $\phi(q, a_i)$, where we introduce the parameter $a_i > 0$ to characterize the distribution. This parameter is exogenous in section 3 whereas it will be endogenized in section 4. Let us assume that the distribution function fulfills first-order stochastic dominance, $\Phi(q, \tilde{a}) > \Phi(q, \hat{a})$ if $\tilde{a} < \hat{a}$. The size of each qualification group is given by $N_i \phi(q, a_i)$.

The time structure of the model is as follows. Governments choose future tax rates non-co-operatively at the beginning of the first period and consumers receive an endowment e which then can either be consumed or invested. Once the second period arrives, consumers make a labor supply decision and firms produce from

labor and capital. As well in the second period, governments provide a national public good.

In contrast to previous work our analysis focuses on the interactions between the strategic use of information transmission and a residence-based tax on capital income t_i^r , and how this form of capital taxation interacts with a tax on domestic real investment t_i^s and a tax on wage income t_i^w . Formulating our discussion in terms of *ad valorem* taxation, the three taxes introduce the following wedges:

$$\begin{aligned}
 \rho_i &= (1 - t_i^r) R && \text{wedge created by the residence-based tax on the proportion} \\
 &&& \text{of savings income that can be monitored} \\
 r_i &= (1 + t_i^s) R && \text{wedge created by the source-based tax on domestic capital} \quad (1) \\
 &&& \text{investment} \\
 \omega_i &= (1 - t_i^w) w && \text{wedge created by the wage tax}
 \end{aligned}$$

where R denotes the world return to capital, w the gross wage rate, ρ_i the net-of-taxes rate of interest on individual savings, r_i the gross rate of return for firms, and ω_i the net-of-taxes wage rate for an individual.

Production takes place under conditions of perfect competition with a constant-returns-to-scale production function $f(k_i, q l_i^d)$, which relates output of the consumption good to the level of (real) capital investment k_i and the level of effective labor employed, $q l_i^d$, where l_i^d denotes the level of labor demand of qualification q . Using the tax definitions (1) we can write the zero profit condition as $f(k_i, q l_i^d) - w l_i^d - r_i k_i = 0$, from which we obtain the first-order conditions for profit maximization

$$f_k(k_i, q l_i^d) = r_i \quad \text{and} \quad q f_l(k_i, q l_i^d) = w. \quad (2)$$

Capital's marginal productivity should be equalized between countries to obtain production efficiency. Capital-market arbitrage of investors, however, requires the net productivity of capital R to be equalized internationally. Hence, tax policy has to consider the trade-off between production efficiency and consumption efficiency.

The latter requires R to be equal to the marginal rate of time preference. The condition on the right hand side in (2) shows that individuals with different qualifications receive different effective wages. The distribution of qualifications $\phi(q, a_i)$ is, therefore, a measure for the wage structure of the economy. By the assumption of first-order stochastic dominance countries with a larger value of a have a higher average qualification than countries with a smaller value of a . Hence, the value of a determines the sum of wage payments $\int_q q f_l(k_i, q l_i^d) \phi(q, a_i) dq$ and the level of total production $\int_q f(k_i, q l_i^d) \phi(q, a_i) dq$. Differentiating the zero-profit condition and using (2) gives the slope of the factor-price frontier for a given qualification level q for changes in the gross return to capital as

$$w_r = -\frac{k_i}{l_i^d} < 0 \quad \text{and} \quad w_{rr} = -\frac{\partial(k_i/l_i^d)}{\partial r_i} > 0. \quad (3)$$

Residents maximize lifetime utility subject to both period's budget constraints. The utility function is assumed to be well-behaved and, for analytical convenience, separable with respect to the public good,

$$v_i(c_1, c_2, l) + u_i(g), \quad (4)$$

where variables c_1, c_2 denote private consumption in the first and second period, l is labor supply, and g is the level of public good provision. Normalizing the price of the consumption good to unity it is straightforward to form the budget constraint of a consumer of type q in the first period as

$$c_{i1} = e - s_i^i - s_i^j \quad i \neq j, \quad (5)$$

where s_i^i is the level of savings residents invest at home and s_i^j denotes savings that are invested abroad. In the second period consumers receive wage income and the principal plus interest income.

Individual savings are determined by the individual qualification, which is private information and not directly observable for the government. In collecting tax revenue the government has to utilize the information about the foreign portfolio investment of residents that is either given by residents themselves or by the banking system. Assume in the following that the legal system is such that a government in

country i (j) can force banks in country i (j) to truthfully report all savings, but not banks in country j (i). Hence, the government has to rely on the information given by tax authorities in the competing country to enforce the residence-based tax on worldwide capital income. If this information is incomplete capital income is composed of declared and taxed income and undeclared and untaxed income depending on the information policies of the national authorities. Then, portfolio investments in the home country s_i^i are subject to taxation, whereas only that part of foreign portfolio investments of domestic residents that is declared by the foreign authority has to be taxed. In order to provide a tractable framework which incorporates endogenous factor supply of residents and the information problem we adopt the convention used in Bacchetta and Espinosa (1995) and assume that the foreign tax authority reports a fraction λ_j of foreign investments. The second-period budget constraint is

$$c_{i2} = \omega_i l_i + (1 + \rho_i) (s_i^i + \lambda_j s_i^j) + (1 + R)(1 - \lambda_j) s_i^j. \quad (6)$$

Residents choose the level of s_i^i , s_i^j and l_i for a given level of public goods in order to maximize utility (4) subject to the budget constraints (5) and (6).

Inserting (5) and (6) into the utility function (4) gives the objective function as

$$\nu_i \left(e - s_i^i - s_i^j, \omega_i l_i + (1 + \rho_i) (s_i^i + \lambda_j s_i^j) + (1 + R)(1 - \lambda_j) s_i^j, l_i \right) + u(g_i). \quad (7)$$

Let us assume that e is sufficiently large to ensure that consumers do not take out loans, hence s_i^i and s_i^j are non-negative, $s_i^i \geq 0$ and $s_i^j \geq 0$. Differentiating (7) with respect to s_i^i , s_i^j and l_i shows (we suppress country indices in the derivatives of the utility function)

$$(s_i^i) : \quad (1 + \rho_i) \leq \frac{\nu_{c_1}}{\nu_{c_2}}, \quad (8a)$$

$$(s_i^j) : \quad \lambda_j(1 + \rho_i) + (1 - \lambda_j)(1 + R) \leq \frac{\nu_{c_1}}{\nu_{c_2}}, \quad (8b)$$

$$(l_i) : \quad -\omega_i = \frac{\nu_l}{\nu_{c_2}}, \quad (8c)$$

where we denote derivatives of ν by subscripts. The interpretation of the first-order conditions is straightforward. Condition (8a) states that the marginal rate of time preference $\nu_1/\nu_2 - 1$ should be equal to the net interest rate if a household decides to invest at home. If savings are invested abroad the household takes into account the undeclared part of capital income (condition 8b). Condition (8c) states that the marginal rate of substitution between consumption and leisure equals the net wage rate. A short inspection of (8) reveals that the household is indifferent between investing at home or abroad if and only if $t_i^r = 0$ or $\lambda_j = 1$. From this observation it follows directly that consumers do not invest at home as long as $t_i^r > 0$ and $\lambda_j < 1$. Let us assume for convenience that this property holds as well for the case of indifference. The arguments lead to the following Lemma:

Lemma 1. *For all $t_i^r \in [0, 1]$ and $\lambda_j \in [0, 1]$, $s_i^i = 0$ and s_i^j is implicitly given by $\lambda_j(1 + \rho_i) + (1 - \lambda_j)(1 + R) = \nu_{c_1}/\nu_{c_2}$.*

Lemma (1) shows that with a residence-based tax on capital income and incomplete information exchange consumers prefer to invest abroad in order to avoid taxation. The solution of the household optimization problem gives rise to both the savings function and to the labor supply function denoted as

$$s_i^j(\omega_i, \rho_i, \lambda_j) = e - c_{i1}(\omega_i, \rho_i, \lambda_j) \quad \text{and} \quad l_i(\omega_i, \rho_i, \lambda_j). \quad (9)$$

Inserting (9) into the direct utility function gives the indirect ‘private’ utility function $v_i(\omega_i, \rho_i, \lambda_j)$.

It is useful to summarize the model set-up briefly (see Figure 1). Recall that the arbitrage condition for households derived from (8) implies that households will invest abroad as long as arbitrage opportunities on the international capital markets offer an increase in the after-tax return earned on savings income (Lemma 1). The international allocation of real capital, however, is determined through the marginal productivity condition (2) and firms invest until $f_k/(1 + t_i^s) = R = f_k/(1 + t_j^s)$ if capital is mobile internationally. Moreover, a small open economy that is perfectly integrated in world capital markets faces an infinitely elastic supply of capital and,

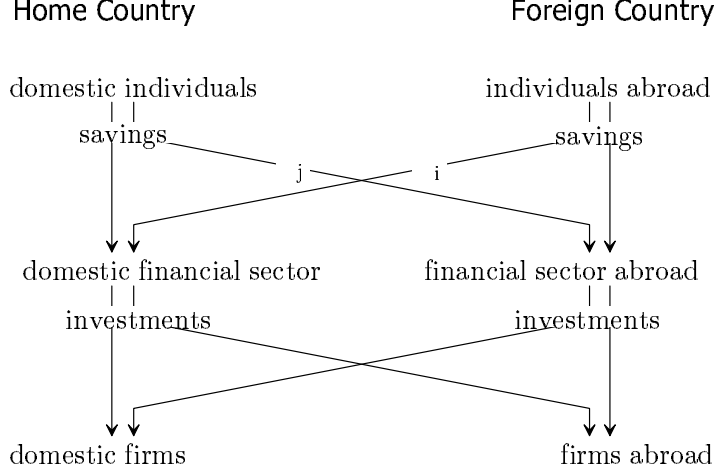


Figure 1: Institutional structure of capital taxation

hence, the international allocation of real capital investment is independent of the allocation of savings. The important implication of the institutional structure of the tax competition model that underlies the analysis is that households' and firms' decisions are separated by the existence of an efficient capital market.

In order to close the model let us introduce the market-clearing conditions. For the national labor market in each country we have for every qualification level q

$$l_i^d = N_i l_i \phi(q, a_i), \quad l_j^d = N_j l_j \phi(q, a_j). \quad (10)$$

For the international capital market to clear it must be that

$$N_i \int_q (s_i^i + s_i^j) \phi(q, a_i) dq + N_j \int_q (s_j^j + s_j^i) \phi(q, a_j) dq = \int_q k_i \phi(q, a_i) dq + \int_q k_j \phi(q, a_j) dq. \quad (11)$$

Finally, goods markets clear if

$$N_i \int_q c_{i2} \phi(q, a_i) dq + N_j \int_q c_{j2} \phi(q, a_j) dq = \int_q f(k_i, ql_i) \phi(q, a_i) dq + \int_q f(k_j, ql_j) \phi(q, a_j) dq. \quad (12)$$

For a given price of capital R , a given vector of government instruments and levels of public goods $\{t_i^r, t_i^s, t_i^w, g_i, \lambda_i, t_j^r, t_j^s, t_j^w, g_j, \lambda_j\}$ we can define an equilibrium as a price vector $\{w_i, w_j\}$ such that (10), (11), and (12) are simultaneously fulfilled and are compatible with profit and utility maximization.

Each government maximizes a utilitarian welfare function of the (indirect) utilities of residents

$$W_i = N_i \int_q v_i(t_i^r, t_i^s, t_i^w, \lambda_i, t_j^r, t_j^s, t_j^w, \lambda_j) \phi(q, a_i) dq + N_i \int_q u(g_i) \phi(q, a_i) dq \quad (13)$$

by the choice of taxes and public-good supply t_i^r, t_i^s, t_i^w, g_i and the level of information it provides to the foreign tax authority about the portfolio investment of foreign residents at home λ_i , subject to the constraint that public-good supply is equal to total tax revenues

$$g_i = N_i \int_q (t_i^r R(s_i^i + \lambda_j s_i^j) + t_i^w w l_i) \phi(q, a_i) dq + t_i^s R \int_q k_i \phi(q, a_i) dq. \quad (14)$$

It is clear from (14) that tax avoidance, because of incomplete information transmission, weakens the effective national base for residence-based taxes: λ_j measures the fraction of portfolio investments abroad that are reported by the foreign tax authority. Without any reporting ($\lambda_j = 0$) only domestic savings can be taxed. The Government has no instrument available to directly control the savings decisions of residents when foreign tax authorities withhold information.

3 Information exchange and tax structures with an exogenous distribution of qualifications

We now consider the case in which each government has a full set of tax instruments available and can impose taxes on wage income, on domestic capital investment and on the part of the worldwide capital income of residents that can be monitored, given the information obtained from the tax authority in the competing country. Government use of taxes is given by the first-order conditions of the problem specified by (13) and (14), where the public budget constraint holds with strict equality in the national optimum. Analytically we obtain the first-order conditions by differentiating with respect to $t_i^r, t_i^s, t_i^w, \lambda_i$ as

$$\frac{\partial W_i}{\partial t_i^r} = N_i \int_q \frac{dv_i}{dt_i^r} \phi(q, a_i) dq + \frac{dg_i}{dt_i^r} N_i \int_q u_{ig} \phi(q, a_i) dq = 0, \quad (15a)$$

$$\frac{\partial W_i}{\partial t_i^s} = N_i \int_q \frac{dv_i}{dt_i^s} \phi(q, a_i) dq + \frac{dg_i}{dt_i^s} N_i \int_q u_{ig} \phi(q, a_i) dq = 0, \quad (15b)$$

$$\frac{\partial W_i}{\partial t_i^w} = N_i \int_q \frac{dv_i}{dt_i^w} \phi(q, a_i) dq + \frac{dg_i}{dt_i^w} N_i \int_q u_{ig} \phi(q, a_i) dq = 0, \quad (15c)$$

$$\frac{\partial W_i}{\partial \lambda_i} = N_i \int_q \frac{dv_i}{d\lambda_i} \phi(q, a_i) dq + \frac{dg_i}{d\lambda_i} N_i \int_q u_{ig} \phi(q, a_i) dq \geq 0. \quad (15d)$$

To derive the first-order conditions notice that we do not have imposed any constraint on tax rates, hence tax rates are unbounded and first-order conditions (15a)-(15c) must hold with strict equality. The level of information exchange, however, cannot be negative and is bounded to a lower limit. Thus, a government truthfully provides information about domestic portfolio investment of foreigners to foreign tax authorities if and only if $\partial W_i / \partial \lambda_i \geq 0$ at $\lambda_i = 1$. In contrast, if $\partial W_i / \partial \lambda_i < 0 \forall \lambda_i \in [0, 1]$ we get $\lambda_i = 0$ since a reduction in the level of information exchange then increases utility.

The main result in this section is that governments do not have an incentive to withhold information. To prove this result, we first derive a preliminary result about the equilibrium rate of the source-based capital tax which directly extends the results from the tax competition literature (for example Razin and Sadka (1991)):

Proposition 1. *With small countries and asymmetric information about foreign investments, a source-based tax on capital will not be used in the presence of wage taxation.*

The proof can be found in the Appendix. The intuition for the renunciation of the use of a source-based capital tax in the presence of wage taxation is based on two arguments. The first is that each government faces a cost of the perceived capital outflow if it taxes capital to finance an additional unit of the public good. The second argument is based on the observation that internationally immobile labor bears the entire burden of the capital tax in a small open economy. Recalling the definition of taxes given in (1) and the slope of the factor-price frontier (3) clearly

illustrates that the source-based capital tax acts like an implicit tax on wages. In other words, governments choose not to use the source-based capital tax in the Nash equilibrium since the wage tax is a more direct instrument that allows the raising of tax revenues without the perceived distortion of the international capital allocation. By the same token, Proposition 1 is independent of the presence of a residence-based tax on capital, which allows a government to control the savings decision of residents.

This brings us to the issue whether competing governments provide information to effectively enforce residence-based taxation of capital income in tax competition. For this purpose evaluate $dv_i/d\lambda_i$ and $dg_i/d\lambda_i$ in (15d) to obtain

$$\frac{dv_i}{d\lambda_i} = -v_1 \frac{ds_i^j}{d\lambda_i} + v_2 \left(\omega_i \frac{dl_i}{d\lambda_i} + (1 + \rho_i) \lambda_j \frac{ds_i^j}{d\lambda_i} + (1 + R)(1 - \lambda_j) \frac{ds_i^j}{d\lambda_i} \right) + v_i \frac{dl_i}{d\lambda_i}, \quad (16)$$

$$\frac{dg_i}{d\lambda_i} = N_i \int_q \left(t_i^r R \lambda_j \frac{ds_i^j}{d\lambda_i} + t_i^w \omega_i \frac{dl_i}{d\lambda_i} \right) \phi(q, a_i) dq + t_i^s R \int_q \frac{dk_i}{d\lambda_i} \phi(q, a_i) dq. \quad (17)$$

Inspection of (16) and (17) shows that the domestic government does provide information about domestic portfolio investment of non-residents to foreign tax authorities if $\partial s_i^j / \partial \lambda_i$, $\partial l_i / \partial \lambda_i$, and $\partial k_i / \partial \lambda_i$ are equal to zero. To determine these terms let $p_i^s =: (1 - \rho_i) \lambda_j$, and ω_i denote the effective price of savings and labor, respectively. Using Roy's identity we have

$$s_i^j = - \frac{\partial v_i}{\partial p_i^s} \bigg/ \frac{\partial v_i}{\partial M}, \quad l_i = - \frac{\partial v_i}{\partial \omega_i} \bigg/ \frac{\partial v_i}{\partial M},$$

where M is full income. From the small country assumption variables w_i , ρ_i and r are not a function of λ_i . Hence, v_i is not a function of λ_i and expressions $\partial s_i^j / \partial \lambda_i$ and $\partial l_i / \partial \lambda_i$ in (16) reduce to

$$\frac{\partial s_i^j}{\partial \lambda_i} = - \frac{\frac{\partial^2 v_i}{\partial p_i^s \partial \lambda_i} \frac{\partial v_i}{\partial M} - \frac{\partial v_i}{\partial p_i^s} \frac{\partial^2 v_i}{\partial M \partial p_i^s}}{\left(\frac{\partial v_i}{\partial M} \right)^2} = 0, \quad \frac{\partial l_i}{\partial \lambda_i} = - \frac{\frac{\partial^2 v_i}{\partial \omega_i \partial \lambda_i} \frac{\partial v_i}{\partial M} - \frac{\partial v_i}{\partial \omega_i} \frac{\partial^2 v_i}{\partial M \partial \omega_i}}{\left(\frac{\partial v_i}{\partial M} \right)^2} = 0.$$

An analogous argument can be applied for $\partial k_i / \partial \lambda_i$ using the conditions for profit maximization (2). Notice, moreover, that there exists a second and independent argument for the last term in (17) to vanish, since $t^s = 0$ in the Nash equilibrium from

Proposition 1. Hence, (16) and (17) are identically equal to zero.³ We summarize with Proposition 2:

Proposition 2. *With small countries and asymmetric information about foreign investments, information about foreign financial capital investments has no value for a country and therefore can completely and voluntarily be exchanged in the Nash equilibrium, irrespective of the choice of other tax instruments.*

The result has a straightforward intuition. Gross domestic product is a function of the productive factors (capital and labor) in a small open economy. Factor supply is determined by household decisions. The budget constraints of residents are, however, not affected by the information policy of the domestic government. Additionally, λ_i has no effect on the arbitrage condition of the international capital market and thus does not lead to a reallocation of real capital. This latter fact stems from the separability between the real and the financial capital allocation: an increase in reporting by the government in a small open economy has no effect on the equilibrium level of domestic investment in real capital. The reason is that the effective tax rate on financial capital (equal to the gross tax rate times the fraction of reporting) can only cause an international reallocation of real capital through the general-equilibrium price effects. These are, however, absent in a small open economy. Hence, information policy has no effect on the tax base of the source-based capital tax, even if it would be used by governments. Moreover, even in the absence of an efficient capital market, exchange of information is costless for governments in the model of this section, since small countries choose not to levy a source-based capital tax in the Nash equilibrium, given the existence of a direct tax on wage income.

It should be mentioned, however, that $\partial W_i / \partial \lambda_i$ is identically equal to zero implying that every $\lambda_i \in [0, 1]$ constitutes a Nash equilibrium. These Nash equilibria can be ranked according to the Pareto criterion: smaller values of λ_i do not affect the welfare in country i , but have a negative effect on country j 's welfare. This provides a strong argument in favor of $\lambda_i = \lambda_j = 1$ being the focal equilibrium of the game.

³A more direct way to prove this property for equation (16) is to directly use the envelope relationship $dv_i/d\lambda_i = dv_i/d\lambda_i = 0$.

We can now characterize the efficiency properties of the Nash equilibrium with a decentralized tax setting. The next Proposition shows that the allocation in the Nash equilibrium is second-best efficient, in the sense that a central planner could not improve utility by tax harmonization.

Proposition 3. *With small countries and asymmetric information about foreign investments, the Nash equilibrium between national authorities is constrained efficient even in the presence of asymmetric information if both, a residence-based tax on capital income and wage taxation, are available.*

The proof of the result can be found in the Appendix. The intuition for Proposition 3 is as follows. It follows from Proposition 1 that $t^s = 0$ in the decentralized equilibrium. This implies that no inefficiency exists stemming from tax competition. As an application of the production efficiency theorem to international capital taxation we can conclude that a tax on production is not used and the decentralized equilibrium is efficient as long as a direct tax on each margin of substitution in the utility function of residents exists. This condition is fulfilled, given the presence of residence-based capital and wage taxation.

The main finding of this section can be summarized as follows: in a small open economy with an exogenous qualification structure, information will be voluntarily exchanged because a change in the information policy has no effect on welfare. The argument is that wages and the international return to capital are fixed for a small open economy. Hence, information policy has an effect only on the amount of financial capital that is invested in the country, but the allocation of real capital and a country's factor supply is unaffected by the degree of reporting. This also implies that information policy has no tax-base effect for the reporting country. This is so because either the allocation of real capital can be separated from the allocation of savings, or, as an independent argument, because the source-based capital tax is not used by governments in the Nash equilibrium.

4 Information exchange with an endogenous distribution of qualifications

Our discussion in the previous section proved that strategic incentives to withhold information do not exist. The absence of direct and tax-base effects creates an intellectual puzzle because countries like Luxembourg and Switzerland (which have a large financial sector) seem to have an incentive to withhold information. Even if our model is not designed to be a precise picture of real-world tax policies, the observation legitimizes extensions of the basic setup in order to get a better idea about the robustness of the results. In order to do so let us consider a case in which information policy has an effect on the wage structure in a small open economy. We argue that countries might gain from the withholding of information because this strategy might improve their sectoral structure. The creation of a large financial sector with highly qualified jobs and the associated spill-over effects to other sectors of the economy may improve the labor market structure and therefore total wage income, especially in relatively small countries. This conclusion rests on the assumption that either (i) jobs in the financial sector pay wages above average, hence a positive correlation between the volume of financial capital and the number of employees working in the sector exists; or (ii) the existence of a financial sector has positive spill-over effects on other sectors of the economy, or both.

In order to formulate the idea in the easiest way possible we will henceforth assume that the qualification profile of the economy is influenced by the size of the financial sector. For our analytical discussion let parameters a_i, a_j characterize the qualification distributions, which, without implication for the following results, are assumed to be functions of the aggregate financial capital invested in the country. Combined use of the argument and Lemma 1 we have that

$$a_i = \int_q s_j^i \phi(q, a_j) dq, \quad a_j = \int_q s_i^j \phi(q, a_i) dq. \quad (18)$$

An increase in the amount of financial capital invested in the economy increases the qualification profile of the economy through the spillover effects associated with a growing financial sector.

The main result in this section is that, with an endogenous qualification profile, national authorities may have an incentive to withhold information. To prove this result it is convenient to recall that governments do not employ a source-based capital tax from Proposition 1. The argument in the previous section for the absence of a source-based capital tax in the presence of wage taxation was based on the observation that t_i^s acts like an implicit tax on wages in a small open economy but additionally distorts the international allocation of capital investment by firms, and that both taxes only interact with the residence-based capital tax through income effects. Endogenizing the distribution of qualifications does not change this logic. Analytically we can use the tax definitions given in (1) and the slope of the factor-price frontier (3) in the first-order conditions of t_i^s and t_i^w to obtain $t_i^s = 0$ in the Nash equilibrium using similar steps to those in the proof of Proposition 1.

Indicating total savings in the domestic economy by $S_j^i = \int_q s_j^i \phi(q, a_j) dq$ and total savings abroad by $S_i^j = \int_q s_i^j \phi(q, a_i) dq$, the nationally optimal level of information transmission is given by the first-order condition

$$\begin{aligned} \frac{\partial W_i}{\partial \lambda_i} &= N_i \int_q \frac{dv_i}{d\lambda_i} \phi(q, a_i) dq + \frac{dg_i}{d\lambda_i} N_i \int_q u_{ig} \phi(q, a_i) dq \\ &\quad + N_i \int_q v_i \frac{\partial \phi}{\partial a_i} \frac{dS_j^i}{d\lambda_i} dq + N_i \int_q u_i \frac{\partial \phi}{\partial a_i} \frac{dS_j^i}{d\lambda_i} dq \leq 0. \end{aligned} \quad (19)$$

The critical difference between (15d) and (19) is in the last two terms of (19) and the term $dg_i/d\lambda_i$. Since portfolio capital invested at home enlarges the financial sector in the economy and alters the wage structure we have

$$\begin{aligned} \frac{dg_i}{d\lambda_i} &= N_i \int_q \left(t_i^r R \lambda_j \frac{\partial s_i^j}{\partial \lambda_i} + t_i^w \omega_i \frac{\partial l_i}{\partial \lambda_i} \right) \phi(q, a_i) dq + t_i^s R \int_q \frac{\partial k_i}{\partial \lambda_i} \phi(q, a_i) dq \\ &\quad + N_i \int_q \left(t_i^r R \lambda_j s_i^j + t_i^w w l_i + t_i^s R k_i / N_i \right) \frac{\partial \phi}{\partial a_i} \frac{dS_j^i}{d\lambda_i} dq. \end{aligned} \quad (20)$$

Using that $t_i^s = 0$ in the Nash equilibrium in the presence of wage taxation and recalling from the analysis in the previous section that the first term in (19) plus

the first two terms in (20) times the second term in (19) are identical equal to zero we can rewrite (19) as

$$\begin{aligned} \frac{\partial W_i}{\partial \lambda_i} &= N_i \frac{dS_j^i}{d\lambda_i} \int_q (v_i + u_i) \frac{\partial \phi}{\partial a_i} dq \\ &\quad + N_i^2 \frac{dS_j^i}{d\lambda_i} \int_q (t_i^r R \lambda_j s_i^j + t_i^w w l_i) \frac{\partial \phi}{\partial a_i} dq \int_q u_{ig} \phi(q, a_i) dq \leq 0. \end{aligned} \quad (21)$$

where we used the property that $dS_j^i/d\lambda_i$ is independent of q . Since the marginal utility of the public good is independent of q we can substitute out $\int_q u_{ig} \phi(q, a_i) dq$ for $u_{ig} \int_q \phi(q, a_i) dq = u_{ig}$ in (21) to obtain

$$\begin{aligned} \frac{\partial W_i}{\partial \lambda_i} &= N_i \frac{dS_j^i}{d\lambda_i} \int_q (v_i + u_i) \frac{\partial \phi}{\partial a_i} dq + N_i \frac{dS_j^i}{d\lambda_i} u_{ig} \int_q N_i (t_i^r R \lambda_j s_i^j + t_i^w w l_i) \frac{\partial \phi}{\partial a_i} dq \\ &= N_i \underbrace{\frac{dS_j^i}{d\lambda_i}}_A \underbrace{\int_q (v_i + u_i + N_i u_{ig} (t_i^r R \lambda_j s_i^j + t_i^w w l_i)) \frac{\partial \phi}{\partial a_i} dq}_B \leq 0. \end{aligned} \quad (22)$$

The total effect of a change in the information policy on welfare can be decomposed into two effects: first, the effect on domestically invested financial capital (A). Second, the effect of aggregated financial capital on the wage structure (B). Let us discuss both effects in turn.

(A): The effect of a change in the information policy on aggregate savings can be calculated as follows: using the Slutsky decomposition it follows from the individual optimization problem (7) that

$$\frac{\partial s_j^i}{\partial \lambda_i} = \frac{\partial s_j^i}{\partial p_j^i} \frac{\partial p_j^i}{\partial \lambda_i} = \left(\left. \frac{\partial s_j^i}{\partial p_j^i} \right|_H - (e - s_j^i) \frac{\partial s_j^i}{\partial M} \right) (\rho_j - R), \quad (23)$$

where $p_j^s = (1 + \rho_j)\lambda_i + (1 + R)(1 - \lambda_i)$ denotes the effective price of savings, M full income in period 2, and $\partial s_j^i / \partial p_j^i |_H$ the partial derivative of Hicksian savings function. In general, the effect on individual savings is undetermined: the substitution effect is non-negative which would imply a decrease in savings because $(\rho_j - R) \leq 0$. The income effect, however, is ambiguous depending on the structure of individual preferences. Hence, the level of savings might be decreasing or increasing if the effective return to savings increases. Aggregation over q gives

$$\frac{dS_j^i}{d\lambda_i} = (\rho_j - R) \int_q \left(\left. \frac{\partial s_j^i}{\partial p_j^i} \right|_H - (e - s_j^i) \frac{\partial s_j^i}{\partial M} \right) \phi(q, a_i) dq.$$

The aggregate savings function is decreasing in the level of reporting if the Giffen paradox that might occur on the individual level does not occur on the aggregate level. We will call this property “normality of the aggregate savings function” in the following. This assumption is much milder than the assumption of normality of the individual savings functions because it allows for the Giffen paradox on the individual level if this effect will be outweighed by aggregation.⁴

(B): The effect of a change in the information policy on the wage structure

$$\int_q (v_i + u_i + N_i u_{ig} [t_i^r R \lambda_j s_i^j + t_i^w w l_i]) \frac{\partial \phi}{\partial a_i} dq$$

can be evaluated as follows. In order to determine the sign of the above condition we have to determine the behavior of the term within brackets for different q . Because of the assumption of first-order stochastic dominance, a larger fraction of the population earns higher wages if a_i increases. This has three effects: (i) Using the Envelope Theorem and (7) as well as (2), it becomes straightforward to show that utility out of the consumption of private goods and leisure is increasing in q , $\partial v_i / \partial q = l_i (1 - t_i^w) f_l > 0$; (ii) from the separability of the utility function it follows that $\partial u / \partial q = 0$; (iii) tax revenues $T_i =: t_i^r R \lambda_j s_i^j + t_i^w w l_i$ can be either decreasing or increasing in qualification:

$$\frac{\partial T_i}{\partial q} = t_i^r R \lambda_j \frac{\partial s_i^j}{\partial q} + t_i^w w \frac{\partial l_i}{\partial q}.$$

The effect of an increase in q on labor supply is ambiguous in general and tends to reduce savings. Hence, tax revenues need not be monotonous in qualification. This implies that the change in public-good supply caused by a change in the qualification structure $N_i \int_q N_i u_{ig} T_i \partial \phi / \partial a_i dq$ can be either positive or negative.

From the above argument, the total effect of an increase in the qualification structure a_i is ambiguous. The intuition is that governments only have distorting taxes available and, hence, an improved wealth structure may have an adverse effect on factor supply that may cause an erosion of tax bases. Then, the positive effect on

⁴This property can either be fulfilled if either the utility functions or the wealth distribution fulfill some regularity conditions. See Hildenbrand (1994) for a detailed analysis of these properties.

welfare caused by an increase in disposable income erodes through reduced public-good supply.

Consider the case $B > 0$ in the following, when an improvement in the qualification structure increases welfare.

Proposition 4. *With small countries and asymmetric information about portfolio investments, countries choose not to exchange information ($\lambda_i < 1$) if aggregate savings are normal and the country wins from an improvement of the qualification structure.*

Proposition 4 demonstrates that strategic incentives to withhold information can be explained by the endogeneity of the wage structure of an economy; a capital inflow from other countries is one means to improve the sectoral structure of the economy. Also notice that condition $B > 0$ is not very restrictive. It essentially boils down to the condition that tax revenues do not decrease by too much if the qualification structure improves.

A sufficient condition for an improvement of welfare is monotonicity of $\zeta(q) =: N_i u_{ig}(v_i + u_i + (t_i^r R \lambda_j s_i^j + t_i^w w l_i))$ in q . From first-order stochastic dominance follows

$$\int_q \zeta(q) \frac{\partial \phi}{\partial a} dq > \int_q \min_q \{\zeta(q)\} \frac{\partial \phi}{\partial a} dq = \min_q \{\zeta(q)\} \int_q \frac{\partial \phi}{\partial a} dq = 0, \quad (24)$$

where the last equality in (24) holds since ϕ is a density function. Hence, we have shown that $\partial W / \partial \lambda < 0$. We summarize with Corollary 1:

Corollary 1. *With small countries and asymmetric information about foreign investments, information about foreign portfolio investments will not be voluntarily exchanged ($\lambda_i < 1$) if $\zeta(q)$ is monotonic and the aggregate savings function is normal.*

Corollary 1 demonstrates that strategic incentives to withhold information exist if the potential negative correlation between qualification and taxes paid does not compensate the increase in private-goods utility due to an increase in qualification on the individual level.

It is instructive to formulate an even stronger sufficient condition:

Corollary 2. *With small countries and asymmetric information about foreign investments, information about foreign portfolio investments will not voluntarily be exchanged if tax revenues are monotonic in qualification.*

In this case,

$$\int_q \zeta(q) \frac{\partial \phi}{\partial a} dq = \int_q (v_i + u_i) \frac{\partial \phi}{\partial a} dq + \int_q (t_i^r R \lambda_j s_i^j + t_i^w w l_i) \frac{\partial \phi}{\partial a} dq > 0 \quad (25)$$

because both, $(v_i + u_i)$ and $(t_i^r R \lambda_j s_i^j + t_i^w w l_i)$ are monotonic (see the proof of Corollary 1).

Proposition 4 together with the two corollaries have an important implication: conclusions about the importance of strategic incentives with residence-based capital taxation cannot be drawn from an inspection of the macroeconomic structure of the economies alone. It is, rather, the influence of financial capital on the composition of the sectoral structure of the economy that is of crucial importance for the evaluation of the effects. These effects cannot be evaluated without reference to the distribution of qualifications and the existing tax system.

To summarize, our analysis in this section has provided a discussion of information exchange and non-cooperative tax policy in a unifying framework. We derived conditions for a strategic use of information. Clearly, we have not found an unambiguous answer to the central question – the enforcement of residence-based capital taxation – from a model that is designed to encompass both the case in which information exchange is beneficial, in which it is almost certainly desirable, and the case in which tax revenues are increasing in the qualification structure, in which the opposite is almost certainly true. It has not been within the scope of the present analysis, however, to find any unambiguous answer to the question whether governments have the necessary incentives to provide information in tax competition. In contrast, the important point is that the question of the existence of strategic incentives to withhold information cannot be answered without recourse to the sectoral and tax structure of the economy.

5 Conclusions

In this paper we have analyzed the strategic potential for information transmission that may cause an enforcement problem in residence-based taxation of portfolio capital investments. We have shown that governments do not use information as a strategic variable in tax competition as long as country-specific policies have no influence on equilibrium prices. Moreover, it has been shown in the present analysis that this result is sustainable even when governments have a source-based capital tax on domestic investment available. The overall conclusion from our model in the first section is that governments have no incentives to set taxes or information policy strategically in the Nash equilibrium.

A comparison of our results with the results in Bacchetta and Espinosa (1995) reveals the economic mechanism. In the Bacchetta and Espinosa world, with an exogenously set source-based capital tax, information transmission has no general equilibrium effect but a tax-base effect: reducing reporting increases the stock of real capital and hence tax revenues generated through the source-based tax. In contrast, the institutional structure in our model of a small open economy makes the investment decision for financial capital and the investment decision for real capital separable. Since tax-base effects are eliminated there is no strategic room left for information policies. Hence, the existence of tax-base effects becomes the crucial factor for the evaluation of information policies in practice.

Whereas no problem of information transmission exists in a pure tax-competition framework, model extensions, however, allow to discuss mechanisms that give rise to tax-base effects. The explanations on which we have concentrated are the effects on the wage structure caused by an expansion of the financial sector that is due to strategic tax policy. It turns out that if these effects exist, information may no longer be voluntarily exchanged.

This paper attempted to provide some deeper understanding of the structure of the effects that are relevant in a world with decentralized tax setting when information is an instrument that can be used strategically. The rich set of tax instruments which governments endogenously determine in our setting, source-based taxes on

real capital, residence-based taxes on financial capital and wage taxation, depicts an institutional design that may allow us to conclude with some implications of the results for the prospects of international capital taxation. Our analysis proved that the relevant economic costs which countries like Luxembourg face cannot be attributed to a loss in real investment. In contrast, it is the welfare loss which is directly related to the lower inflow of portfolio capital that should not be underestimated. Our analysis suggests that these costs hamper any agreement to establish an exchange of information system in the absence of either economic sanctions or compensating transfer payments.

Appendix

Proof of Propositions 1 and 3

We will start with Proposition 1, using the results for t^r only to prepare for the proof of Proposition 3. By the Envelope theorem the marginal changes in individual indirect utilities for changes in t_i^w , t_i^s , and t_i^r are as follows:

$$\frac{\partial v_i}{\partial t_i^w} = -\nu_{c_2} w l_i, \quad \frac{\partial v_i}{\partial t_i^s} = \nu_{c_2} (1 - t_i^w) l_i R w_r, \quad \frac{\partial v_i}{\partial t_i^r} = -\nu_{c_2} R s_i^j.$$

The government budget constraint (14) can be rewritten using the slope of the factor-price frontier given in (3) and the labor-market equilibrium condition (10):

$$\begin{aligned} g_i &= N_i \int_q (t_i^r R (s_i^i + \lambda_j s_i^j) + t_i^w w l_i) \phi(q, a_i) dq - t_i^s R w_r l_i^d \\ &= N_i \int_q (t_i^r R (s_i^i + \lambda_j s_i^j) + t_i^w w l_i) \phi(q, a_i) dq - t_i^s R w_r N_i \int_q l_i \phi(q, a_i) dq \\ &= N_i \int_q (t_i^r R (s_i^i + \lambda_j s_i^j) + (t_i^w w - t_i^s R w_r) l_i) \phi(q, a_i) dq. \end{aligned} \quad (\text{A.1})$$

We can differentiate (A.1) with respect to t_i^w , t_i^s , and t_i^r . Using the tax definitions (1) we obtain

$$\begin{aligned} \frac{ds_i^j}{dt_i^s} &= (1 - t_i^w) w_r R \frac{\partial s_i^j}{\partial \omega_i}, & \frac{dl_i}{dt_i^s} &= (1 - t_i^w) w_r R \frac{\partial l_i}{\partial \omega_i}, & \frac{dw_r}{dt_i^s} &= w_{rr} R, \\ \frac{ds_i^j}{dt_i^w} &= -w \frac{\partial s_i^j}{\partial \omega_i}, & \frac{dl_i}{dt_i^w} &= -w \frac{\partial l_i}{\partial \omega_i}, \\ \frac{ds_i^j}{dt_i^r} &= -R \frac{\partial s_i^j}{\partial \rho_i}, & \frac{dl_i}{dt_i^r} &= -R \frac{\partial l_i}{\partial \rho_i}. \end{aligned}$$

Combined use of these expressions and (A.1) shows

$$\frac{\partial g_i}{\partial t_i^w} = N_i \int_q \left(-t_i^r R \lambda_j w \frac{\partial s_i^j}{\partial \omega_i} + w l_i - w (t_i^w w - t_i^s R w_r) \frac{\partial l_i}{\partial \omega_i} \right) \phi(q, a_i) dq, \quad (\text{A.2a})$$

$$\begin{aligned} \frac{\partial g_i}{\partial t_i^s} &= N_i \int_q \left(t_i^r R^2 \lambda_j (1 - t_i^w) w_r \frac{\partial s_i^j}{\partial \omega_i} + (t_i^w w - t_i^s R w_r) (1 - t_i^w) R w_r \frac{\partial l_i}{\partial \omega_i} \right. \\ &\quad \left. + (t_i^w w_r R - R w_r - t_i^s R^2 w_{rr}) l_i \right) \phi(q, a_i) dq, \end{aligned} \quad (\text{A.2b})$$

$$\frac{\partial g_i}{\partial t_i^r} = N_i \int_q \left(R \lambda_j s_i^j - t_i^r R^2 \lambda_j \frac{\partial s_i^j}{\partial \rho_i} - (t_i^w w - t_i^s R w_r) R \frac{\partial l_i}{\partial \rho_i} \right) \phi(q, a_i) dq. \quad (\text{A.2c})$$

Inserting (A.2) in (15b), (15c), and (15a) gives explicit conditions for changes in national welfare due to changes in wage and source taxes. Thus, we rewrite the first-order conditions (15) as

$$\begin{aligned}\mathcal{W}_1 &=: w_r R(1 - t_i^w) \frac{\partial W_i}{\partial t_i^w}, & \mathcal{W}_2 &=: w_r R \lambda_j \frac{\partial W_i}{\partial t_i^w}, \\ \mathcal{R} &=: w \frac{\partial W_i}{\partial t_i^r}, & \mathcal{S} &=: w \frac{\partial W_i}{\partial t_i^s}.\end{aligned}\quad (\text{A.3})$$

The necessary conditions for an optimum are given by $\partial W_i / \partial t_i^w = 0$, $\partial W_i / \partial t_i^s = 0$, and $\partial W_i / \partial t_i^r = 0$. Choose a pair $\{t_i^s, t_i^w\}$ such that these conditions are fulfilled. At that point we know that $\mathcal{W}_1 + \mathcal{S} = 0$ and $\mathcal{W}_2 + \mathcal{R} = 0$. Assume that a positive level of public good provision is required, i.e. $g_i > 0$ in equilibrium.

Proposition 1 is proved using only the first-order conditions for the wage tax and the source-based capital tax. We can combine the relevant modified first-order conditions in (A.3) to obtain

$$\mathcal{W}_1 + \mathcal{S} = - \int_q (t_i^s l_i w w_{rr} R) \phi(q, a_i) de \int_q u_{iq} \phi(e, a_i) de. \quad (\text{A.4})$$

Recalling that some tax revenue must be raised in equilibrium from the government budget constraint (14), a positive rate of the source-based capital tax $t_i^s > 0$ would imply $\mathcal{W}_1 + \mathcal{S} = 0$. Condition (A.4) can only be fulfilled if $t_i^s = 0$ is already a consequence of utility maximization because l_i, R, w , and w_{rr} are positive. Hence, we can conclude that $t_i^w > 0$ and $t_i^s = 0$ in the Nash equilibrium, which completes the proof of Proposition 1. Notice that both residence-based capital taxation and information exchange are not needed to derive the result.

To prove **Proposition 3** we use the result that countries choose to use the source-based capital tax, $t^s = 0$, from Proposition 1 and provide information from Proposition 2, $\lambda_j = 1$. It is now straightforward to combine $\mathcal{W}_2 + \mathcal{R}_2 = 0$ and solve the resulting expression for the optimal tax rates

$$t_i^r = - \frac{w \left(w_r \frac{\partial l_i}{\partial \omega_i} + \frac{\partial l_i}{\partial \rho_i} \right)}{R \left(w_r \frac{\partial s_i^j}{\partial \omega_i} + \frac{\partial s_i^j}{\partial \rho_i} \right)} t_i^w. \quad (\text{A.5})$$

In order to complete the proof of Proposition 3 note that source and residence-based capital taxes are identical in a closed economy. Hence, $t_i^s = 0$ is compatible with the

optimum of a closed economy. Market integration does not change this logic. A central planner who is restricted to use the same instruments as the national authorities but can coordinate their use can reach the optimum by restricting the set of tax instruments to only a residence based capital tax and a wage tax, which is an immediate consequence of the production-efficiency theorem. Hence, the decentralized solution is compatible with efficiency. \square

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