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Abstract

We analyze tax competition between large and asymmetric countries and derive conditions under which countries assist foreign authorities in collecting tax revenues via information exchange. It turns out that voluntary exchange of information is a Nash equilibrium between asymmetric countries, resulting in an efficient use of taxes by governments. However, this equilibrium is not unique and the structure of the resulting equilibrium–selection problem depends on the relative size of countries. Our model gives an explanation for the empirical observation that especially smaller countries are reluctant to co–ordinate on the full–information equilibrium, whereas countries of similar size can solve the information problem.

Keywords: asymmetric tax competition, information exchange

JEL classification: F42; F20; H21

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1 Introduction

Globalization and the removal of barriers to the free movement of capital have promoted economic development, yet at the same time they have increased the scope for tax avoidance and tax evasion. The fears that taxes on mobile capital are not sustainable are particularly strong in the European Union, where many of the obstacles to capital market integration have been eliminated as part of the internal market program and transaction costs of foreign investment are further reduced in the monetary union. Inspired by the example of the United States where a system of information exchange between states is in place, the European Commission recently proposed a council directive intended to establish a comprehensive system of information exchange on interest payments paid to individuals in Europe. The purpose is to make residence-based taxation of savings income sustainable.

The objective of this paper is to explore whether such agreements are politically feasible in an economic union in the sense that voluntary exchange of information (*i*) is a Nash equilibrium and (*ii*) leads to a Pareto improvement in each country compared to a situation without information exchange. Whenever a country is large, a shortfall of domestic savings drives up the world interest rate and ‘crowds out’ domestic investment, even under the assumption used in most work on international tax competition that portfolio investment is made through a financial market on which a single rate of return can be obtained.¹ Conflicts of interests may then arise because each country will be tempted to set its policy so as to take advantage of market power, at least so long as it can ignore any threat of retaliation by other countries. Several authors have focused on country size as one determinant of diverging interests (Bucovetsky 1991, Wilson 1991, Kanbur and Keen 1993). A central result, obtained for both capital and commodity taxation, is that the smaller

¹The present paper also assumes perfect capital-market integration, which seems to be reasonable in Europe after the establishment of the monetary union. The tests by Bayoumi and Rose (1993) (for the United Kingdom), Sinn (1992) (for the United States on 1950s data) and Helliwell and McKittrick (1999) (for the Canadian provinces) show that savings and investment are uncorrelated within jurisdictions, suggesting that exchange rate variability may be the cause for the high savings-investment correlations across countries found by Feldstein and Horioka (1980) in the post-1973 period. Feldstein (1994) concludes ‘A monetary union would cause member countries to lose their ability to use financial policies to affect domestic investment rates [...]’.

of two countries has the higher per capita utility in the Nash equilibrium because it perceives a higher tax base elasticity and undercuts its larger trading partner.

We introduce differences in country size in an adapted version of Bucovetsky and Wilson's (1991) model, where savings and labor supply decisions are endogenous. The level of information exchange as well as tax rates are strategic variables in the model; and governments use a source tax on the capital invested, wage taxation and a residence-based tax on savings to pay for the costs of national public goods.² Since we allow countries to possess market power, the home supply of capital and labor should react to changes in the home country's information policy – foreign investors tend to increase savings when the information policy of the home government is relaxed. The above observations seem to suggest that it is profitable for each country to reduce the level of information exchange unilaterally, since the tendency of the world interest rate to decrease will increase both output and the income of the immobile factor labor in the home country. Thus, the standard 'race to the bottom' intuition would suggest that the result is to restrict information exchange and to strategically reduce tax rates on capital income. However, there has been no formal analysis of this issue in the previous literature. Contrary to conventional wisdom, we show that governments will adjust taxes as to exactly offset the general equilibrium effects of a variation in information exchange, even when countries differ in size. There exists a Nash equilibrium where governments have no incentive to use information strategically.

Moreover, the model also yields the conclusion of Bucovetsky (1991) and Wilson (1991) that there exists a Nash equilibrium where countries choose not to provide information. Then, the larger of two countries always has a comparative disadvantage and the globally efficient allocation is not an equilibrium. In line with Binmore (1998) and Cooter (2000) we will call a problem structure where the globally efficient solution is not an equilibrium a *co-operation problem*. A problem structure where the globally efficient solution is an equilibrium but this equilibrium is not unique will be called *co-ordination problem* in the following. The distinction between co-operation and co-ordination changes the perception of the problem. Co-ordination

²We abstain from analyzing taxes on savings other than on a residence basis. In a companion paper, Eggert, Kolmar and Tulkens (2001) focus on the interaction between residence and source-based taxes on income from savings. One core result is that governments are not able to collect tax revenue from source-based taxation of savings with perfect capital mobility.

problems differ from co-operation problems with respect to their political consequences. Technically, co-operation problems can only be solved by a change in the institutional structure that makes the Pareto-optimum an equilibrium.³ The resulting mechanism-design problem implies the strengthening of a centralized authority. Co-operation rules have to be promulgated and deviations from these rules have to be sufficiently and credibly punished by a central authority.

The need for institutional change is weaker for co-ordination problems because the efficient policies are an equilibrium, even in the absence of a supra-national authority. Then, the equilibrium-selection problem can, for example, be solved by the creation of a round table. We show that the structure of the equilibrium–selection problem depends on the relative size of the countries. The results suggest that the creation of a round table is sufficient when countries are rather homogeneous, but it is not when countries are heterogeneous. The reason is that an infinitely small country would lose from a co-ordination on the full-information equilibrium. However, the equilibrium with full exchange of information will still dominate the equilibrium where governments choose not to provide information according to the potential Pareto criterion, implying that a large country can compensate a smaller country by a voluntary transfer of resources.

Our results provide a possible explanation for two empirical puzzle why especially small countries like Luxembourg or Switzerland are reluctant to the introduction of an information-exchange system. The larger country does not voluntarily grant the transfer payments which are necessary to make the potential Pareto improvement an actual Pareto improvement once the new equilibrium is reached. Hence, whether it is possible to solve the equilibrium-selection problem or not depends on the credibility of the larger country’s transfer payments, which are only sustainable if a central authority credibly enforces information exchange.

Our result that the smaller of two otherwise identical countries is more reluctant to establish an exchange-of-information system is akin to the conjecture of Bacchetta and Espinosa (1995, p. 117) in their conclusions and to the results in Bacchetta and Espinosa (2000) and Huizinga and Nielsen (2001), except for the point that the persistence of an equilibrium where countries choose to withhold information is obtained in the presence of perfect capital mobility when the level of portfolio capital

³E.g. by implementing Pigouvian subsidies as in Wildasin (1988) or (implicit) transfer payments through tax provisions as in Homburg (1999) and Keen and Wildasin (2000).

invested domestically cannot explain private income or tax revenue. Huizinga and Nielsen (2001) characterize information exchange equilibria (among many others) when profit income of domestic banks accrues to domestic residents. Bacchetta and Espinosa (2000) focus on the trade-off between tax base effects and tax-export effects. In contrast to both papers, we do not assume that the information-exchange policy of a country has a direct effect on the budget of residents or the public. Instead, we obtain our results in a setting where fiscal policy is able to manipulate world prices. The results we obtain are, thus, complementary to the existing arguments.

The plan of the paper is as follows. After the model description in Section 2, we examine Nash equilibria with information exchange in Section 3. Tax competition without information exchange is then investigated in Section 4. Section 5 gives our concluding remarks.

2 The model

Our analysis employs the two-period model of asymmetric capital tax competition from Bucovetsky and Wilson (1991), adapted to incorporate both country specific asymmetries in the tradition of Bucovetsky (1991), Wilson (1991) and strategic use of information exchange policies. Consider two countries, i, j , which are linked through international capital mobility. Countries are identical in per-capita endowments, technologies and preferences, but not in population size. Each of the two countries has a fixed number of internationally immobile consumers.

Let us denote world population by $N = N_i + N_j$. Then, $n_i = N_i/N$ gives the relative population size of country i with $n_i = 1 - n_j$. Individuals in each country supply labor and capital. The time structure of the model is as follows. At the beginning of a first period governments choose and credibly commit to future tax rates non-cooperatively, and consumers receive an endowment. The endowment can either be consumed or invested. In a second period, consumers make their labor supply decision and firms produce using labor and capital as inputs.

Governments, institutions and the structure of information: Individuals in country i can invest their savings in either the country of residence or abroad. The

national authority (government in the following) in each country uses a residence-based tax on capital income, t_i^r , a source-based tax on domestic real investment, t_i^s , and a tax on wage income, t_i^w , to meet a public budget constraint. Let us denote by R, w_i the world return on capital and the gross wage rate, respectively. It is convenient to denote by r_i the gross rate of return for a firm, by ρ_i the net of tax rate of interest on individual savings and the net of tax wage rate in country i by ω_i . With this convention the three taxes can alternatively be expressed in terms of wedges:

$$\begin{aligned}
 t_i^s &= r_i - R && \text{source-based capital tax,} \\
 t_i^r &= R - \rho_i && \text{residence-based capital tax,} \\
 t_i^w &= w_i - \omega_i && \text{wage tax.}
 \end{aligned} \tag{1}$$

In order to enforce the different tax instruments each government needs information about wage incomes, savings, and capital investments. We assume that the legal system is such that a government in country i can verify the capital stock invested, the wage income earned, and the savings invested in country i , but not the savings invested in country j . Hence, the wage tax as well as the source-based capital tax can be perfectly enforced without the help of the foreign country, whereas the residence-based tax on savings can only be enforced if the foreign country j truthfully reports the amount of savings residents of country i invest in country j .⁴ If reporting is incomplete, capital income is composed of taxed and untaxed income. In order to provide a tractable framework which incorporates endogenous factor supply of residents and the information problem we assume that governments strategically decide about the fraction $\lambda_i \in [0, 1]$ of foreign savings they report.

Firms: Firms in both countries produce a homogeneous consumption good whose price is normalized to unity. In order to have a clear notation, let us denote functional arguments by parentheses in the following. The production function $f(k_i, l_i^d)$ exhibits constant returns to scale and relates per-capita output of the consumption good to the per-capita level of (real) capital investment, k_i , and per capita labor

⁴We neglect the costs of the collection of information about individuals' savings decisions by tax authorities. It is important to note, however, that once this information is collected the marginal costs of information provision are almost equal to zero, as for most data bases. More importantly there is no cost differential between the provision of information to a foreign or a domestic tax authority.

employed, l_i^d .⁵ Using the tax definitions (1), the zero-profit condition of a firm in country i is $f(k_i, l_i^d) - w_i l_i^d - r_i k_i = 0$, from which we obtain the following first-order conditions for profit maximization

$$f_{k_i}(k_i, l_i^d) = r_i \quad \text{and} \quad f_{l_i^d}(k_i, l_i^d) = w_i, \quad (2)$$

where we denote derivatives by subscripts. Differentiating the zero-profit condition and using (2) gives the slope of the factor-price frontier for changes in the gross return to capital as

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

Households: In the two-period model, consumers receive an endowment e_i and determine savings in the first and labor supply in the second period to maximize lifetime utility subject to their budget constraints. Denote by c_{i1}, c_{i2} per-capita private consumption in the first and second period, by l_i labor supply, and by g_i the consumption level of a publicly provided (private) good of a consumer in country i . The utility function $u(c_{i1}, c_{i2}, l_i) + \tilde{u}(g_i)$ is assumed to be twice continuously differentiable and strictly quasi-concave. The first-period budget constraint of a consumer in country i can be written as

$$c_{i1} = e_i - s_i^i - s_i^j \quad i \neq j, \quad (4)$$

where s_i^i gives the level of savings residents invest domestically and s_i^j denotes savings that are invested abroad. In the second period consumers receive wage income and the principal plus interest income. Using the tax definitions (1), the second-period budget constraint is

$$c_{i2} = \omega_i l_i + [1 + \rho_i] [s_i^i + \lambda_j s_i^j] + [1 + R] [1 - \lambda_j] s_i^j. \quad (5)$$

The first term on the right-hand in (5) is net labor income. The second and third term denote the effective return on savings. It is composed of domestic and taxed savings, s_i^i , and savings that are invested in the foreign country, s_i^j , of which a

⁵To derive this per capita formulation, let $F(K_i, L_i^d)$ denote the production function in levels. Dividing through by the population size of country i and using small letters for per capita terms gives $f(k_i, l_i^d)$.

fraction λ_j is taxed and a fraction $[1 - \lambda_j]$ is not taxed. Inserting (4) and (5) into the utility function gives the objective function of a resident in country i as

$$u \left(e - s_i^i - s_i^j, \omega_i l_i + [1 + \rho_i] [s_i^i + \lambda_j s_i^j] + [1 + R] [1 - \lambda_j] s_i^j, l_i \right) + \tilde{u}(g_i). \quad (6)$$

Residents choose the level of s_i^i , s_i^j and l_i , taking as given the level of the publicly provided good, in order to maximize utility. Let us assume that e_i 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 $s_i^j \geq 0$. The first-order conditions of the individual maximization problem can be written as follows:

$$(s_i^i) : \quad 1 + \rho_i \leq \frac{u_{c1}}{u_{c2}}, \quad (7a)$$

$$(s_i^j) : \quad \lambda_j [1 + \rho_i] + [1 - \lambda_j] [1 + R] \leq \frac{u_{c1}}{u_{c2}}, \quad (7b)$$

$$(l_i) : \quad -\omega_i = \frac{u_l}{u_{c2}}. \quad (7c)$$

The interpretation of the first-order condition (7a) is that the marginal rate of substitution between second- and first-period consumption, u_{c1}/u_{c2} , should be equal to the net interest factor if a household decides to invest domestically. When, however, savings are invested abroad then the household additionally takes into account the undeclared part of capital income (7b). Condition (7c) states that the marginal rate of substitution between consumption and leisure equals the net wage rate. A short inspection of (7) 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 when $t_i^r > 0$ and $\lambda_j < 1$. Let us assume for convenience that this property holds as well for the case of indifference. These observations 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 $\lambda_j [1 + \rho_i] + [1 - \lambda_j] [1 + R] = u_{c1}/u_{c2}$.*

To pinpoint the problem of information exchange in international taxation Lemma 1 shows that consumers prefer to invest abroad in order to avoid taxation. Ensuring that tax bases are highly intertwined between countries makes the problem of information exchange most severe. The solution of the household optimization problem gives rise to the savings function and to the labor supply function denoted as

$$s_i^j(\omega_i, \rho_i, R, \lambda_j) = e - c_{i1}(\omega_i, \rho_i, R, \lambda_j) \quad \text{and} \quad l_i(\omega_i, \rho_i, R, \lambda_j). \quad (8)$$

We may then insert (8) into the direct utility function to obtain the indirect utility function $\tilde{v} := v(\omega_i, \rho_i, R, \lambda_j) + \tilde{u}(g_i)$.

Market equilibrium: Using the taxes introduced in (1) we can define a market equilibrium for a given tax and information policy as a vector of $\{\omega_i, \rho_i, r_i, \lambda_i, g_i\}$ and $\{\omega_j, \rho_j, r_j, \lambda_j, g_j\}$ such that firms maximize profits, households maximize utility,

(i) labor markets clear,

$$l_i^d = l_i \quad \text{and} \quad l_j^d = l_j, \quad (9)$$

(ii) the capital market clears,

$$n_i [k_i - s_i^i - s_i^j] + n_j [k_j - s_j^j - s_j^i] = 0, \quad n_i + n_j = 1, \quad (10)$$

(iii) and the market for the consumption good clears,

$$n_i [c_{i2} - f_i(k_i, l_i^d)] + n_j [c_{j2} - f_j(k_j, l_j^d)] = 0, \quad n_i + n_j = 1. \quad (11)$$

Denoting savings of a resident in country i by $s_i = s_i^i + s_i^j$ we can rewrite capital market-clearing (10) as

$$n_i [k_i - s_i] + n_j [k_j - s_j] = n_i m_i + n_j m_j = 0, \quad n_i + n_j = 1, \quad (12)$$

where the difference between national investment and national savings in (12) is measured by the capital-account balance, $m_i := k_i - s_i$. It follows from Walras' law that we can restrict attention to market-clearing conditions (i), (ii) and leave the market-clearing condition for the consumption good (iii) implicitly satisfied.

Political equilibrium: Denote by $x = \{x_i, x_j\} = \{t_i^r, t_i^s, t_i^w, \lambda_i, g_i, t_j^r, t_j^s, t_j^w, \lambda_j, g_j\}$ the vector of policy instruments for both countries. At the beginning of period 1 the government in country i maximizes indirect utility $\tilde{v}(x)$ subject to (2), (7), (9), (10), the zero-profit condition, and a per-capita revenue requirement

$$\begin{aligned} g_i &= t_i^r [s_i^i + \lambda_j s_i^j] + t_i^w l_i + t_i^s k_i \\ &= t_i^r [s_i^i + \lambda_j s_i^j] + [t_i^w - t_i^s w_{ir}] l_i, \end{aligned} \quad (13)$$

using $\{x_i\}$ taking $\{x_j\}$ as given. Notice that we used (3) to substitute out for k_i in the last line of (13). A Nash equilibrium of this game is a vector of policies $x^N = \{x_i^N, x_j^N\}$ such that

$$\begin{aligned} \{x_i^N\} &\in \arg \max v(x_i, x_j^N) & \text{s.t.} & \quad g_i = t_i^r [s_i^i + \lambda_j^N s_i^j] + t_i^w l_i + t_i^s k_i, \\ \{x_j^N\} &\in \arg \max v(x_i^N, x_j) & \text{s.t.} & \quad g_j = t_j^r [s_j^j + \lambda_i^N s_j^i] + t_j^w l_j + t_j^s k_j. \end{aligned}$$

It proves to be useful throughout the paper to analyze tax rates for a given level of information exchange first. Then we determine the optimal information policies given these tax rates. We may now use $\tilde{v} := v(x_i) + \tilde{u}(g_i)$ and (13) to obtain the Lagrangean for the government in country i as

$$\mathcal{L}_i = v(x_i) + \tilde{u}(g_i) + \mu_i \left[t_i^r [s_i^i(x) + \lambda_j s_i^j(x)] + [t_i^w - t_i^s w_{ir}(r_i)] l_i(x) - g_i \right], \quad (14)$$

where μ_i denotes the Lagrange multiplier on the revenue constraint. An analogous Lagrangean can be formed for country j . To derive the first-order conditions recall $v_{i\omega} = \zeta_i l_i$ and $v_{i\rho} = \zeta_i s_i$ from Roy's identity, where $\zeta_i := \partial v_i / \partial e$ captures the marginal utility of private income. Then apply the tax definitions given in (1) and use the slope of the factor-price frontier (3) to obtain

$$\begin{aligned} \mathcal{L}_{t_i^w} &= -\zeta_i l_i + \mu_i \left[l_i [1 - t_i^s w_{irr} R_{t_i^w}] + \alpha_i [l_{i\rho} R_{t_i^w} + l_{i\omega} [w_{ir} R_{t_i^w} - 1]] \right. \\ &\quad \left. + t_i^r \lambda_j [s_{i\rho} R_{t_i^w} + s_{i\omega} [w_{ir} R_{t_i^w} - 1]] \right] - m_i \zeta_i R_{t_i^w} = 0, \end{aligned} \quad (15a)$$

$$\begin{aligned} \mathcal{L}_{t_i^s} &= \zeta_i l_i w_{ir} + \mu_i \left[\alpha_i [l_{i\rho} R_{t_i^s} + l_{i\omega} w_{ir} [1 + R_{t_i^s}]] - l_i [w_{ir} + t_i^s w_{irr} [1 + R_{t_i^s}]] \right. \\ &\quad \left. + t_i^r \lambda_j [s_{i\rho} R_{t_i^s} + s_{i\omega} w_{ir} [1 + R_{t_i^s}]] \right] - m_i \zeta_i R_{t_i^s} = 0, \end{aligned} \quad (15b)$$

$$\begin{aligned} \mathcal{L}_{t_i^r} &= \zeta_i l_i \lambda_j w_{ir} + \mu_i \left[\alpha_i [l_{i\rho} [R_{t_i^r} - 1] + l_{i\omega} w_{ir} R_{t_i^r}] - l_i [t_i^s w_{irr} R_{t_i^r} + w_{ir} \lambda_j] \right. \\ &\quad \left. + t_i^r \lambda_j [s_{i\rho} [R_{t_i^r} - 1] + s_{i\omega} w_{ir} R_{t_i^r}] \right] - m_i \zeta_i [R_{t_i^r} - \lambda_j] = 0, \end{aligned} \quad (15c)$$

$$\mathcal{L}_{\lambda_i} = \mu_i \left[\alpha_i [l_{i\rho} + l_{i\omega} w_{ir}] - t_i^s l_i w_{irr} + t_i^r \lambda_j [s_{i\rho} + s_{i\omega} w_{ir}] \right] R_{\lambda_i} - m_i \zeta_i R_{\lambda_i} \geq 0, \quad (15d)$$

$$\mathcal{L}_{g_i} = \tilde{u}_{g_i} - \mu_i = 0, \quad (15e)$$

where $\alpha_i = [t_i^w - t_i^s w_{ir}]$ can be interpreted as the tax burden placed on labor income. From condition (15e) follows that the government trades the marginal utility of the publicly provided good with the value of the Lagrange multiplier, which measures the marginal resource costs of public funds. The equilibrium value of μ_i is given by the solution of (15a)–(15c), which characterize government choice of taxes. Condition (15d) characterizes the optimal degree of information exchange from the

perspective of country i . Inspection of (15d) shows that information can be voluntarily exchanged if $\mathcal{L}_{\lambda_i} \geq 0$ at $\lambda_i = 1$, whereas information may not be exchanged at all if $\mathcal{L}_{\lambda_i} \leq 0$ at $\lambda_i = 0$. As a first observation we can decompose the first-order conditions (15) into tax-base and terms-of-trade effects,

$$\mathcal{L}_q = \mathcal{L}_q|_{m_i=0} + m_i \zeta_i \gamma_i(q) R_q, \quad q \in \{x_i\}, \quad (16)$$

where $\gamma_i(q)$ is a parameter depending on q , which is determined endogenously by the solution of (15). From (16), the general first-order conditions (15) can be decomposed into the first-order conditions that hold in the case of a symmetric equilibrium plus a capital-account balance effect. Recalling that we allow countries to influence equilibrium prices but assume that countries are identical except for differences in population size clarifies that each country's net capital exports are zero if government use of taxes is efficient. This property will be useful when we characterize the efficiency properties of the Nash equilibrium and the incentives for information exchange in the following sections. We will next derive the responses of the world return to capital R resulting from changes in tax and information policies. For this purpose rewrite the capital-market equilibrium condition (12) as

$$b(x) := n_i m_i(x) + [1 - n_i] m_j(x) \equiv 0, \quad 0 \leq n_i \leq 1. \quad (17)$$

The implicit-function theorem implies that

$$R_q = -\frac{b_q}{b_R} \quad q \in \{x_i\}. \quad (18)$$

Differentiating (17) with respect to t_i^w, t_i^r, t_i^s and λ_i yields

$$\begin{aligned} b_{t_i^w} &= -n_i [s_{i\omega} + l_{i\omega} w_{ir}], & b_{t_i^s} &= -w_{ir} b_{t_i^w} + n_i l_i w_{irr}, \\ b_{t_i^r} &= -n_i [s_{i\rho} + l_{i\rho} w_{ir}], & b_{\lambda_i} &= [1 - n_i] [s_{j\lambda_i} + l_{j\lambda_i} w_{jr}], \\ b_R &= b_{t_i^s} - b_{t_i^r} + [1 - n_i] [b_{t_j^s} - b_{t_j^r}]. \end{aligned} \quad (19)$$

It will prove helpful to employ compensated rather than Marshallian demand and supply functions of the individuals. Denote compensated functions by a superscript c . The derivatives of the compensated demand functions, $s_{i\rho}^c = -s_{i\lambda_j}^c$ and $l_{i\omega}^c$, are always positive. Assuming that leisure and first-period consumption are Hicksian substitutes we find that $s_{i\omega}^c$ and $l_{i\rho}^c = -l_{i\lambda_j}^c$ are both negative. We may then define

$$\phi_i := -[l_{i\rho}^c - (s_i/l_i) l_{i\omega}^c] > 0 \quad \text{and} \quad \psi_i := [s_{i\rho}^c - (s_i/l_i) s_{i\omega}^c] > 0.$$

Using these definitions and the factor–price frontier (3) we get the following Slutsky decomposition:

$$l_i l_{i\rho} - s_i l_{i\omega} = -l_i \phi_i + m_i l_{i\omega}^c, \quad (20a)$$

$$l_i s_{i\rho} - s_i s_{i\omega} = l_i \psi_i + m_i s_{i\omega}^c. \quad (20b)$$

3 The information problem

As a preliminary step we will first characterize the tax structure chosen by governments under the assumption that information is completely and voluntarily exchanged (Section 3.1). Using this tax structure, we then analyze the Nash equilibria for endogenous information policies in a second step and we show that full information exchange is in fact a Nash-equilibrium of the game (Section 3.2). However, this equilibrium need not be unique and we will therefore move on to characterize an equilibrium with no information exchange at all in Section 4.

3.1 Nationally and globally efficient tax rates

Consider the case where each government chooses the tax instruments $\{t_i^s, t_i^r, t_i^w\}$ to maximize utility of consumers, taking the vector $\{t_j^s, t_j^r, t_j^w\}$ determined by the other country and $\lambda_j = 1$ as given.

Lemma 2. *The Nash equilibrium of large countries that differ in population size has the tax structure $t_i^r \psi_i = t_i^w \phi_i$ and $t_i^s = 0$ at $\lambda_j = 1$, i.e. compensated labor and capital supply is reduced in the same proportion. This tax structure is globally efficient given the available taxes.*

Proof. See the Appendix.

Only the residence-based tax on capital and the wage tax are used if information is exchanged, $t_i^r > 0$ and $t_i^w > 0$ and the presence of both taxes eliminates any tendency for governments in tax competition to distort the resource allocation. The basic argument may be outlined as follows. With complete information exchange, a government has the set of taxes available to effectively control the consumption decisions of residents. It then follows as an application of the Diamond and Mirrlees (1971) production efficiency theorem to international taxation that governments

choose not to use the specific tax on domestic capital investment, since this tax creates a production distortion. The second-best equilibrium can be reached because the tax bases of countries are not strategically linked when residence-based capital taxation is sustainable and no constraints on wage taxation exist. The above result has been emphasized in most previous work (Among the references would be Razin and Sadka (1991) and Gordon and Bovenberg (1996)). However, it would be a premature conjecture to conclude that we should not expect to observe a positive tax on capital investment in an optimal taxation framework. By extending the identical-country analysis of Bucovetsky and Wilson (1991) to asymmetric countries it can be shown that the source-based capital tax is used in the absence of the wage tax. This result is even obtained in a small open economy where governments perceive the elasticity of the source-based capital tax to be infinitely elastic. Moreover, the combined use of a source-based capital tax and a residence-based capital tax eliminates any tendency of governments to under-provide public goods in capital tax competition.⁶ We will discuss the implications of Lemma 2 and the Bucovetsky and Wilson (1991, Section 4) result in the subsequent Section.

3.2 Information policies

Having characterized the tax structure we will now turn to the question whether countries may voluntarily exchange information. Our discussion following (16) clarified that the total effect of a change in the information policy on the Lagrangean can be decomposed into the effect of information exchange on the interest factor, R_{λ_i} , and tax-base effects. A short inspection shows that there are tax-base effects in (15d) which stem from price changes, an observation that will be crucial for the determination of optimal information policies.

Proposition 1. *With large countries differing in population size there exists a Nash equilibrium in which information is completely and voluntarily exchanged.*

⁶A detailed derivation of these results is available from the authors.

Proof. We use the Slutsky equation (20) to substitute out for $s_{i\rho}, l_{i\rho}$ in the first-order condition (15d) to obtain a modified first-order condition

$$\mathcal{L}_{\lambda_i} \Big|_{\lambda_j=1} \begin{matrix} \geq \\ \leq \end{matrix} 0 \Leftrightarrow \mu_i \left[t_i^r \lambda_j [\psi_i - m_i s_{i\omega}] - l_i \frac{m_i \zeta_i}{\mu_i} + t_i^s [w_{ir} [\phi_i + m_i l_{i\omega}] - l_i^2 w_{irr}] - t_i^w [m_i l_{i\omega} + \phi_i] \right] R_{\lambda_i} \begin{matrix} \geq \\ \leq \end{matrix} 0. \quad (21)$$

Assume the other country chooses $\lambda_j = 1$. Inserting the condition for government choice of taxes (A.1b) from the Appendix in (21) shows that the terms in brackets in condition (21) vanish. Since using (A.1b) in (21) leads to $\mathcal{L}_{\lambda_i} = 0 \forall \lambda_i \in [0, 1]$, a reduction in λ_i is unprofitable for country i when the government sets taxes optimally. Full exchange of information, $\lambda_i = 1$, constitutes a Nash equilibrium as required by the Proposition. \square

Proposition 1 shows that voluntary information exchange is a Nash equilibrium. In the following we will develop the intuition for this finding in more detail. (i) First, it is not surprising that direct tax-base effects are absent in (21), since the allocation of real capital is independent of λ_i in the presence of an efficient international capital market which allocates savings to the country where the effective return is highest. (ii) Second, a decrease in λ_i leads to a change in the marginal conditions in the other country j and tends to increase foreign savings, thereby reducing the world interest rate to maintain zero profits in production.

The fact that a country can reduce the interest rate via a more relaxed information policy seems to distort the incentive of the capital importer to provide information to foreign tax authorities. This is the conventional ‘race to the bottom’ intuition that we mentioned in the beginning of the paper. However, the argument cannot be complete since, (iii) third, the government will adjust the tax structure to accommodate to the change in equilibrium prices according to condition (A.1b) in the Appendix. Hence, the second effect is exactly offset by the third. This puzzling observation is explained by observing from Lemma 2 that the government in country i , at $\lambda_j = 1$, is able to maintain the second-best optimal gap between marginal rates of substitution and marginal rates of transformation in tax competition for any information policy it may choose.

Withholding information by country i can have an effect on the excess burden of the tax system in this country only in two cases. First, if taxes are assumed to

be exogenous, which is not the case in our model. Second, if competitive forces between countries are relevant, which is also not the case, from Lemma 2, since the nationally optimal tax structure is also globally optimal (from the viewpoint of the whole world). We may then conclude that a change in, say, λ_i has no effect on welfare in country i , given the trading partner provides information, $\lambda_j = 1$. The result in Proposition 1 is more general than the above analysis suggests.

It can be shown that the Proposition continues to hold when the wage tax is absent. Then, governments will choose to employ the source-based capital tax and the residence-based capital tax. Moreover, tax competition does not cause any additional distortions in this scenario (see Bucovetsky and Wilson (1991, Section 4)). Hence, all the prerequisites described above are fulfilled and we may conclude that full exchange of information is also a Nash equilibrium when the wage tax is not available at the margin, say, because of political constraints.⁷ The case of restricted wage taxation is interesting to list here since we observe both information exchange and positive source-based capital taxes in equilibrium.

4 A co-operation or a co-ordination problem?

The above discussion suggests that under the standard assumptions made in the tax competition literature information exchange is possible in order to enforce residence-based taxation of financial capital. Governments do not treat the provision of information to other countries as a cost when a residence-based capital tax is in the set of available tax instruments, even in the presence of size asymmetries. The problem of information exchange thus has a different structure compared to the standard tax competition problem. If information exchange does not create a co-operation problem, it may either generate no problem at all (if the equilibria of the last Section are unique) or a co-ordination problem (if other equilibria exist). We will show in this Section that the latter is the case.

4.1 Tax structures

As a first observation note that no information transmission by the foreign government ($\lambda_j = 0$) is equivalent to the non-availability of the residence-based tax for the

⁷A detailed derivation is available from the authors.

domestic government ($t_i^r = 0$). We can therefore derive optimal tax structures for the case that at most the source-based tax on capital and the wage tax are available and then continue to show that (15d) is smaller or equal to zero at that point, implying that the home country will have no incentive to provide information. Let us first derive the optimal tax structures in the absence of a residence-based capital tax (i.e. for $\lambda_j = 0$).

Lemma 3. *If source-based capital taxation, t_i^s , and wage taxation, t_i^w , are both available, whereas residence-based capital taxes ($t_i^r = 0$) are not, the tax structure in the Nash equilibrium between countries that differ in population size is characterized by $t_i^s \mu_i [n_i w_{ir} [m_i l_{i\omega} + \phi_i] + l_i [b_R - n_i l_i w_{irr}]] = n_i [m_i \zeta_i l_i + t_i^w \mu_i [m_i l_{i\omega} + \phi_i]]$. The Nash equilibrium in both taxes t_i^s and t_i^w is inefficient.*

Proof. See the Appendix.

4.2 Information exchange

By the equivalence of no information exchange and the non-availability of a residence tax we can now answer the question whether $\lambda_i = \lambda_j = 0$ is in fact a Nash equilibrium. First, use (17) and (20) to substitute out for $s_{i\rho}$ and l_ρ in condition (15d). Use (19) to substitute out for R_{λ_i} . This allows us to write the condition for the government choice of information exchange as:

$$\mathcal{L}_{\lambda_i} \Big|_{\lambda_j=0} = \frac{1 - n_i}{l_i b_R} \left[l_i m_i \zeta_i + \mu_i t_i^s w_{irr} l_i^2 + [t_i^w - t_i^s w_{ir}] \mu_i [m_i l_{i\omega} + \phi_i] \right] R_{\lambda_i}. \quad (22)$$

To determine the incentives for a country to exchange information recall that the Lagrange multiplier $\mu_i > 0$ measures the marginal utility of the publicly provided good. Using the tax structure given in Lemma 3 to substitute out for t_i^w we obtain from (22):

$$\mathcal{L}_{\lambda_i} \Big|_{\lambda_j=0} = -\frac{1 - n_i}{n_i} [s_{j\rho} + l_{j\rho} w_{jr}] \mu_i t_i^s. \quad (23)$$

Recall $w_{jr} < 0$ and that $\rho_j = R$ in the absence of residence-based capital taxation. It is then clear that $s_{j\rho} + l_{j\rho} w_{jr} \geq 0$ when the effect of a change in the return to capital on compensated factor supply functions outweighs the income effects. Notice that this assumption is much weaker than the assumption that factor supply functions are not backward-bending. Using $\mathcal{L}_{\lambda_i} \Big|_{\lambda_j=0} \leq 0$ we may state:

Proposition 2. *Assume that $s_{j\rho} + l_{j\rho}w_{jr} \geq 0$. Then, $\lambda_i = \lambda_j = 0$ is a Nash equilibrium of the tax competition game if $t_i^s \geq 0$.*

In order to gain insight into the intuition for and implication of Proposition 2 consider the special case where the share of country j in the overall population approaches one. We then obtain from (A.3) in the Appendix that the small country i chooses not to tax capital when the residence-based tax is absent, whereas the large country j chooses to use capital taxation:

$$w_{ir} \mathcal{L}_{t_i^w} \Big|_{t_i^r=0, n_i \rightarrow 0} + \mathcal{L}_{t_i^s} \Big|_{t_i^r=0, n_i \rightarrow 0} = 0 \Leftrightarrow -l_i t_i^s w_{irr} \mu_i = 0 \Rightarrow t_i^w > 0 \wedge t_i^s = 0, \quad (24a)$$

$$w_{jr} \mathcal{L}_{t_j^w} \Big|_{t_j^r=0, n_j \rightarrow 1} + \mathcal{L}_{t_j^s} \Big|_{t_j^r=0, n_j \rightarrow 1} = 0 \Leftrightarrow t_j^s \psi_j - t_j^w \phi_j = 0 \Rightarrow t_j^w > 0 \wedge t_j^s > 0. \quad (24b)$$

We have that $t_i^s < t_j^s$ implying that *per capita* imports in the small country are $m_i > 0$ from the optimal factor–pricing condition for capital in (2). However, m_j approaches zero and the tax bases of the capital taxes t_j^s and t_j^r coincide since s_j approaches k_j in the large country j . For the small country i this implies that the utility level with full exchange of information can always be obtained. However, for $\lambda_j < 1$, this is not optimal for country i from (24), since m_i is non-zero. By a revealed-preference argument the welfare level of an infinitesimal small country must then be higher when country j does not provide information, $\lambda_j = 0$. Hence, there must be a critical level of \tilde{n}_i where the small country has the same utility in the information exchange and the no-information exchange equilibrium. In contrast it is clear that the large country under-provides the public good and at the same time loses tax revenue in the no-information exchange equilibrium. It is important to note that the critical size \tilde{n}_i defines a borderline. For all $n_i \in [\tilde{n}_i, 1 - \tilde{n}_i]$ the full-information exchange and the no-information exchange equilibria can be ranked according to the Pareto-criterion: both countries prefer to co-ordinate on the full information exchange equilibrium. This result, however, is not obtained when $n_i < \tilde{n}_i$. Then the smaller country prefers the no-information exchange equilibrium, whereas the larger country prefers the full-information exchange equilibrium. However, it is clear that equilibria can be ranked according to the potential Pareto criterion since the only systematic source of inefficiency in the model are differences in source-based capital taxation. Hence, the sum of both countries utilities with $\lambda_i = \lambda_j = 1$ is larger than the sum of utilities in cases where $\lambda_i = \lambda_j = 0$.

What are the policy implications of the results of this paper? (i) First, the equilibrium-selection problem between countries of similar size is relatively easy to solve, since countries only have to co-ordinate their expectations on the Pareto-dominant equilibrium. This finding rationalizes the empirical observation that information-exchange treaties are frequently found between sufficiently homogeneous countries.⁸

(ii) Second, the character of the equilibrium-selection problem differs when countries are sufficiently heterogeneous. Our model therefore provides an explanation for the empirical observation that the agreement on information-exchange treaties is especially difficult for countries that are very different in size.⁹

(iii) Third, the model shows that the equilibrium-selection problem between countries that differ substantially in size has a different character since the large country wins from co-ordination on the full-information exchange equilibrium, whereas a very small country loses. However, the full-information exchange equilibrium dominates the no-information exchange equilibrium according to the potential Pareto criterion implying that a Pareto-improving transfer mechanism can be implemented according to which the large country transfers resources to the small country in order to compensate for the loss in utility due to the agreement on information exchange. One explanation for the empirical persistence of the no-information exchange equilibrium can therefore be found in the lack of credible enforcement of such a transfer mechanism which may be due to a lack of an agency with sufficient power to enforce supra-lateral contracts.

⁸This is in line with the observation of Tanzi (1995, p. 85) that well-devised, cooperative measures of mutual tax assistance between tax administrators can be implemented by the resemblance between the participating countries: *‘an early example of these broad agreements and one that has influenced other attempts was the Nordic Mutual Assistance Treaty ...’* between Denmark, Finland, Iceland, Norway and Sweden. These countries can be considered to be sufficiently homogeneous (see Sørensen (2000) and Richter (2001)) and support our result that the resulting policy game has the structure of a co-ordination problem where equilibria can be Pareto ranked.

⁹An example of such a multilateral initiative is the Multilateral Convention on Mutual Administrative Assistance in Tax Matters of 1988, which came into force in 1995. This initiative, however, has not been embraced by many countries.

5 Conclusions

Our analysis has shown that asymmetric information about foreign investments does not create a co-operation problem in the standard model of asymmetric tax competition that is accepted in the literature (Among the references are Bucovetsky (1991) and Wilson (1991)). We argue that the results obtained in this model give a rational explanation for the empirical observation that smaller countries (Liechtenstein, Luxembourg, Canal Islands etc.) are reluctant to exchange information whereas sufficiently homogeneous countries may choose to exchange information. Voluntary exchange of information, which allows tax authorities to effectively implement residence-based taxation of portfolio capital, is a Nash equilibrium. The usual ‘race to the bottom’ intuition does not hold in this model even though countries can influence the international interest rate through a change of their information policy. However, complete absence of information exchange can also be sustained as an equilibrium of the game.

The structure of these results has a substantial influence on the implications regarding the scope for residence-based taxation: if a residence-based capital tax shall be implemented for a set of countries that differ only with respect to size, the under-provision of information stems from an equilibrium selection problem where countries have co-ordinated on an inefficient equilibrium.¹⁰ Such equilibria may be long lasting because they are *equilibria*; national changes in the information policy are not rational. In addition to this the no-information equilibrium is the natural one for the countries of the European Union, for example, that started to integrate their markets.

If the equilibria can be Pareto-ranked then the equilibrium selection problem can be easily solved by countries because there exist strong incentives to coordinate on bilateral information exchange. The examples of United States and the Nordic Countries provide evidence that countries may indeed succeed in implementing an exchange-of-information system without further centralization or agreements on transfer payments. The mechanisms explored indicate that higher market integration, promoted by an economic and monetary union, is not a thread to fiscal

¹⁰As an application of the Folk theorem, an even stronger argument for co-ordination on the equilibrium with information exchange would result in a repeated game under fairly weak conditions.

autonomy. Governments in rather homogeneous countries are able to overcome the informational deficits which constitute the basic reason for the inefficiency of decentralized fiscal policy.

The equilibria cannot be Pareto-ranked if size differences are large. Then, the full-information equilibrium and the no-information equilibrium can only be ranked according to the potential Pareto criterion. Hence, the introduction of a supra-national transfer mechanism is possible in principle which would guarantee the unanimous support of an information exchange system. However, the credibility of the enforcement of transfers becomes of primary importance for the unanimous support of residence-based capital taxation with mutual assistance in information exchange. The model suggests that the credibility of transfer payments is of crucial importance in order to get the support of smaller countries, which may be reluctant to exchange information since it obtains a higher welfare level in the Nash equilibrium without information exchange compared to the globally efficient equilibrium (with information exchange). Although a Diamond and Mirrlees economy is often considered as a benchmark case and has often been used in the previous literature on optimal taxation, it is clarifying to briefly discuss the robustness of our main results when assumptions are relaxed. Keen and Wildasin (2000) show that residence-based capital taxation is a measure to eliminate fiscal competition in relevant scenarios, even when countries do not have the same per-capita budget requirements. We would expect that our results carry over to these cases. The argument is that the combination of tax instruments which ensures that the nationally optimal tax structure also is globally optimal also supports a Nash equilibrium with information exchange in the present framework. Our analysis suggests, however, that it may not be possible to implement this equilibrium when countries are highly asymmetric, even in a setting where information policies have no direct effects.

Appendix

Proof of Lemma 2

Proof. To prove the first part of the Lemma we combine the first-order conditions $\mathcal{L}_{t_i^s} + w_{ir}\mathcal{L}_{t_i^w}$ and $\mathcal{L}_{t_i^r} - \mathcal{L}_{t_i^s}$ using $\lambda_j = 1$ and $m_j = -n_i/n_j m_i$ from capital market clearing (12). Employing the Slutsky equation (20) to substitute out for $s_{i\rho}, l_{i\rho}$ and use of the derivatives of R given in (18) in the resulting expression shows

$$\begin{aligned} \mathcal{L}_{t_i^s} \Big|_{\lambda_j=1} + w_{ir} \mathcal{L}_{t_i^w} \Big|_{\lambda_j=1} &= 0 \Leftrightarrow \\ t_i^w [m_i l_{i\omega} + \phi_i] &= t_i^r [\psi_i - m_i s_{i\omega}] - l_i \frac{m_i \zeta_i}{\mu_i} + t_i^s \left[w_{ir} [\phi_i + m_i l_{i\omega}] + l_i \left[\frac{b_R}{n_i} - l_i w_{irr} \right] \right], \end{aligned} \quad (\text{A.1a})$$

$$\begin{aligned} \mathcal{L}_{t_i^r} \Big|_{\lambda_j=1} - \mathcal{L}_{t_i^s} \Big|_{\lambda_j=1} &= 0 \Leftrightarrow \\ t_i^w [m_i l_{i\omega} + \phi_i] &= t_i^r [\psi_i - m_i s_{i\omega}] - l_i \frac{m_i \zeta_i}{\mu_i} + t_i^s [w_{ir} [\phi_i + m_i l_{i\omega}] - l_i^2 w_{irr}]. \end{aligned} \quad (\text{A.1b})$$

Conditions (A.1) isolate those effects of the source-based capital tax that cannot be duplicated by the wage tax, (A.1a), or the residence-based capital tax, (A.1b). Since $w_{ir} < 0$, $w_{irr} > 0$, $\psi_i > 0$ and $\phi_i > 0$ both conditions (A.1) can be simultaneously fulfilled only if $t_i^s = 0$. Hence, the government in an open economy ($n_i < 1$) chooses not to employ the source-based capital tax in the Nash equilibrium at $\lambda_j = 1$. Using $t_i^s = 0$ in either (A.1a) or (A.1b) shows that a government chooses tax rates t_i^w and t_i^r such that

$$t_i^r \psi_i = t_i^w \phi_i + m_i \left[t_i^w l_{i\omega} + t_i^r s_{i\omega} + \frac{l_i \zeta_i}{\mu_i} \right]. \quad (\text{A.2})$$

To prove the second part of the Lemma (the implications for efficiency) recall that there exist no reasons for factor movements between countries that differ in population size if taxes are set efficiently. Then, tax policy replicates the benchmark of a closed economy, $n_i = 1$ and $s_i = k_i$, where strategic incentives are absent. Observing that $t_i^s = 0$ and that t_i^r and t_i^w as given by (A.2) are independent of country size n_i shows that government use of taxes is efficient. As an implication tax policy replicates the closed economy benchmark. Using $m_i = 0$ in (A.2) proves that the government in country i chooses taxes as $t_i^r \psi_i = t_i^w \phi_i$ at $\lambda_j = 1$. This completes the proof. \square

Proof of Lemma 3

Proof. If only the source-based capital tax and the wage tax are in the set of available taxes ($t_i^r = 0$), the tax structure in the constrained Nash equilibrium is determined by first-order conditions (15a) and (15b). To prove the first part of the Lemma we form $w_r \mathcal{L}_{t_i^w} + \mathcal{L}_{t_i^s}$ using $t_i^r = 0$. We employ the Slutsky relationship (20) to substitute out for $s_{i\rho}, l_{i\rho}$ and the derivatives of R given in (18) in the resulting expression to obtain

$$w_r \mathcal{L}_{t_i^w} \Big|_{t_i^r=0} + \mathcal{L}_{t_i^s} \Big|_{t_i^r=0} = 0 \Leftrightarrow t_i^s \mu_i [n_i w_{ir} [l_{i\omega} m_i + \psi_i] + l_i [b_R - l_i n_i w_{irr}]] = n_i [l_i \zeta_i m_i + t_i^w \mu_i [l_{i\omega} m_i + \phi_i]]. \text{(A.3)}$$

To prove the second part of the Lemma (the implications for efficiency) notice that the tax structure in the Nash equilibrium given by (A.3) is a function of n_i . Using the Slutsky equation (20) and $n_i = 1, m_i = 0$ in the definition of b_R [given in (19)] shows that the tax structure (A.3) reduces to $t_i^w \phi_i = t_i^s \psi_i$ in the benchmark of a closed economy where strategic incentives are absent. \square

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**Supplement to
Information Sharing, Multiple Nash Equilibria, and Asymmetric
Capital–Tax Competition**

GLOBAL AND NATIONAL EFFICIENCY EVEN WITH A RESTRICTED SET OF TAXES

We turn to the case where each government can use both, the residence–based tax on savings as well as the source–based tax on capital, but not the wage tax. This case was first analyzed by Bucovetsky and Wilson (1991).

Lemma 4. *Assume countries can use all tax instruments except for the wage tax. The constrained Nash equilibrium of large countries that differ in population size has the following tax structure: $t_i^r \psi_i = t_i^s [w_{irr} l_i^2 - w_{ir} \phi_i]$ at $(\lambda_i = \lambda_j = 1)$. The tax structure in the Nash equilibrium is globally efficient given the available taxes.*

Proof. When both capital taxes but not the wage tax are in the set of available taxes ($t_i^w = 0$), the tax structure is determined by first–order conditions (15b) and (15c). We form $\mathcal{L}_{t_i^r} - \mathcal{L}_{t_i^s}$ using $t_i^w = 0$ and $\lambda_j = 1$. Next, we employ the Slutsky equation (20) to substitute out for $s_{i\rho}, l_{i\rho}$ and the derivatives of R given in (18) in the resulting expression to obtain

$$\begin{aligned} \mathcal{L}_{t_i^r} \Big|_{\lambda_j=1, t_i^w=0} - \mathcal{L}_{t_i^s} \Big|_{\lambda_j=1, t_i^w=0} = 0 \Leftrightarrow \\ t_i^r \psi_i = t_i^s [w_{irr} l_i^2 - w_{ir} \phi_i] + m_i \left[\frac{l_i \zeta_i}{\mu_i} + t_i^r s_{i\omega} - t_i^s l_{i\omega} w_{ir} \right]. \end{aligned} \tag{B.1}$$

Notice that this tax structure is not a function of n_i . The same arguments as in the proof of Lemma 2 show that government use of taxes is efficient. Hence, we can use $m_i = 0$ in (B.1) to determine the equilibrium tax structure as $t_i^r \psi_i = t_i^s [w_{irr} l_i^2 - w_{ir} \phi_i]$ at $\lambda_j = 1$. \square Hence, if wage taxation is constrained at the margin and fiscal authorities do not have a system of optimal commodity taxes available, both taxes on capital will be used if information is fully exchanged, $t_i^s > 0$ and $t_i^r > 0$ at $\lambda_j = 1$. Since the gross wage w_i is negatively linked to changes in the gross return to capital $r_i = R + t_i^s$ through the slope of the factor–price frontier in (3), the source–based tax on capital will be used as a substitute for the missing direct tax on wage income to control the labor supply of residents. It is natural then to analyze the case of an incomplete set of tax instruments, where labor taxation is constrained:

Proposition 3. *With large countries that differ with respect to population size and the absence of wage taxation ($t_i^w = 0$), there exists a Nash equilibrium in which information is completely and voluntarily exchanged, even in the presence of a positive source-based capital tax ($t_i^s > 0$).*

Proof. We use the Slutsky equation (20) to substitute out for $s_{i\rho}, l_{i\rho}$ in the first-order condition (15d) and obtain a modified first-order condition for the case of an absent wage tax

$$\mathcal{L}_{\lambda_i} \Big|_{t_i^w=0} = \mu \left[t_i^s [w_{irr} l_i^2 - w_{ir} \phi_i] - t_i^r \lambda_j \psi_i + m_i \left[\frac{l_i \zeta_i}{\mu_i} + t_i^r \lambda_j s_{i\omega} - t_i^s l_{i\omega} w_{ir} \right] \right] R_{\lambda_i} \gtrless 0. \quad (\text{B.2})$$

Using $\lambda_j = 1$ and inserting the tax structure given by condition (B.1) from Lemma 4 in condition (B.2) we have $\mathcal{L}_{\lambda_i} \Big|_{t_i^w=0} = 0 \forall \lambda_i \in [0, 1]$. A combined change in instruments does not change this conclusion because a reduction of λ_i does not yield any tax-base effects that could be exploited by an increase in t_i^s and the equilibrium price vector is second-best efficient. \square

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