Double Taxation, Tax Credits and the Information Exchange Puzzle

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June, 2003

Abstract

This paper analyzes the choice of taxes and international information exchange by governments in a capital tax competition model. We explain situations where countries can choose tax rates on tax savings income and exchange information about the domestic savings of foreigners, implying that the decentralized equilibrium is efficient. However, we also identify situations with adverse welfare properties in which information exchange is compatible with zero taxes on capital income. The model helps to identify the linkage between voluntary information exchange and the choice of tax rates. It is shown that the recent development in information exchange treaties may not be useful to overcome the inefficiencies caused by decentralized tax setting.

Keywords: withholding tax, tax credit, international tax competition, information exchange

JEL classification: H 77, H 87, F 42

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1 Introduction

Asymmetric information between national governments about the world-wide capital income of residents limits the availability of residence-based taxes on capital income. The sustainability of residence-based taxation, however, is frequently seen as a major prerequisite to ensure that decentralized tax setting does not cause spillover effects between tax authorities.[1] Residence-based capital taxation can either be implemented without granting a credit for the foreign tax payments of residents or through a tax credit system, which avoids the double taxation of income. This paper analyzes the choice of tax rates and information exchange by fiscal authorities in both tax regimes.

Reflecting the considerations on spillover effects of decentralized taxation in the absence of a tax on world wide savings income, it is not surprising that the exchange of information about the financial investment of domestic investors between fiscal authorities is a focus of recent economic debates. Prominent recent examples are the OECD (2002) initiative and the proposal of the European Commission (2001). At least the European proposal seems to receive much more support among member states than previously thought. On the council meeting in January 2003, European governments have agreed to exchange information with other member states on the bank details of non-resident investors after almost 13 years of diplomatic wrangling on the savings tax issue.[2] The present paper identifies economic mechanisms that can explain the existence of these types of fiscal coordination, and we analyze whether countries choose to design such measures to reduce the misallocations resulting from decentralized decision making.

Any approach to regulation in international taxation must be concerned with ef-

[1] Seminal papers which address this issue formally are Razin and Sadka (1991) and Bucovetsky and Wilson (1991).

[2] The agreement also includes Austria, Belgium and Luxembourg and the large and secretive Swiss banking market. The agreement will in addition cover offshore centers such as the Channel Islands and Isle of Man and UK dependencies in the Caribbean. Luxembourg, Austria and Belgium and Switzerland are allowed to retain banking secrecy in return for imposing a high source tax on non resident investors using their banking facilities. The tax will initially start at 15 per cent but could rise to 35 per cent on non resident savings by 2010. Full agreement with other EU states in the exchange of information is expected by this time, providing Switzerland, which has proved fiercely protective of its banking secrecy arrangements, fully complies with the existing agreement by then.

fects of international tax agreements on equilibrium in international markets. We can distinguish two types of approaches, which differ in their perception of a country's sovereignty. (*i*) Sovereignty of countries can assumed to be imperfect in some crucial aspects by a centralized agency. Given this outside enforcer exists model analysis can be used to design a supra-country fiscal system which helps overcome a Prisoners' dilemma problem by ensuring cooperation through central intervention. (*ii*) In contrast, the complexities of an approach which takes as given that countries are sovereign stem from the fact that, for tax agreements to be justified, economic structures must be identified that make regulation an equilibrium policy which is compatible with full sovereignty. Since we often also observe seemingly unregulated policies, the second approach entails that countries solve an equilibrium selection problem. The primary purpose of international (regulatory) agreements is to solve an equilibrium selection problem, or, in other words, a coordination problem.

The assumption of imperfect sovereignty of countries in tax matters implies that participation in tax harmonization or in information exchange matters need not to be voluntary. Here, international organizations are treated as outside enforcement agencies. This dramatically increases the range of possible policy recommendations in situations where the taxing problem has a Prisoners' dilemma structure precisely because the participation constraint is irrelevant. Whether this approach delivers valuable conclusions or not depends on the relevant economic environment. The approach is perhaps less suited if tax agreements between sovereign countries are analyzed, but it may be well suited to analyze the behavior of jurisdictions or states within a country in order to discuss tax mechanisms that allow to implement the efficient allocation (Wildasin, 1989; Ligthart and Keen, 2003). Whether this approach is reasonable for the analysis of member states in an economic unions foremost depends on the degree of economic and political integration between the members.

Sovereignty implies that any tax initiative launched in the international policy arena can only expected to be successfully implemented if it will receive unanimous support in all countries (Bordignon and Brusco, 2001; Boadway, 2001). In view of the lack of mechanisms to enforce contracts between countries, any measure of tax harmonization must be self enforcing. A technique to treat information exchange agreements as being contained in the set of self enforcing tax strategies is to embed

the model in a game with repeated interaction as in Huizinga and Nielsen (2003). The main focus in their paper is on the welfare properties of equilibria in which tax authorities choose different tax strategies dependent on the importance of bank profits and on the marginal cost of public funds. Bacchetta and Espinosa (1995, 2000) characterize punishment strategies and reciprocity norms that are sufficient to guarantee the exchange of information in a model where fiscal authorities cannot differentiate between savings and investment. Eggert and Kolmar (2003) use an optimal taxation framework with a differentiated set of taxes to characterize tax rates and information exchange in decentralized equilibria. A main finding is that competition in tax rates credibly ties the hands of fiscal authorities so that they have no incentive to engage in information competition. Then, tax and information exchange treaties are self enforcing.

What is missing in the literature so far is an explanation for the empirical observation that most countries choose to implement residence-based capital income taxation by crediting the foreign tax due of residents against the domestic tax. This observation creates an intellectual puzzle since it is by no means obvious why the potential transfer of tax revenue to the country of the income's source should be beneficial for the country of the investor's residency. The potential outflow of tax revenue could be avoided by implementing a system of double taxation. Furthermore, it is interesting to analyze the resulting allocation and welfare effects in the decentralized case when the choice of the tax system interacts with the strategic use of information exchange. Accordingly, this paper analyzes the government choice of fiscal instruments in two central scenarios. In the first, the authority in each country does not credit the foreign tax payments of residents against the domestic tax liability. It turns out in this scenario that the choice of fiscal policy is inefficient because of a Prisoner's dilemma problem, even though information exchange is an equilibrium. In the second scenario it is assumed that fiscal authorities have implemented a tax credit system. Then, the choice of tax rates and information exchange is efficient under the assumption that household investors have a bias for international investment, which is a plausible scenario in a well integrated economic union. However, there also exists an equilibrium in the same environment in which countries choose not to provide information and are worse off compared to the equilibrium which foresees information exchange. The

existence of the second equilibrium implies that countries will find it profitable to support an institution that coordinates tax policy towards the Pareto efficient equilibrium with information exchange. If, in contrast, household investors have a home bias, then the tax problem again has the structure of a Prisoner's dilemma, even under the tax credits system. However, the allocation in this case is identical to the allocation that is obtained under a system of double taxation. This is consistent with the empirical observation that countries choose to implement a tax credit system and dismiss the alternative, the double taxation of savings income.

The paper proceeds as follows. After introducing the model in section 2, we examine the outcome of tax competition in scenarios which differ in the domestic treatment of foreign taxes in section 3. Section 4 concludes.

2 The model

Consider a two-period model of a one shot capital tax competition game between N countries, federal states or jurisdictions, indexed by $i = 1, \ldots, N$.[3] Each of the identical jurisdictions is populated by a large number of individuals, and it is assumed that individuals collectively can coordinate on an equilibrium in which there exists a regional government or tax authority. The single purpose of this authority is to provide a local public good. Individuals in state, say, i are physically immobile between jurisdictions but have access to an international market for portfolio capital. They may either invest their savings (financial capital) at home, s_i^i, using financial intermediaries at home, or abroad, $s_i^j, i \neq j$, using financial intermediaries located in the foreign countries. Capital market clearing requires that the world return to capital is such that supply equals demand

$$\sum_{i=1}^{N} \sum_{j=1}^{N} s_i^j = \sum_{i=1}^{N} k_i, \tag{1}$$

where variable k_i in (1) denotes real investment of firms in country i. To exclude any possibility for fiscal authorities to use the system of income taxation to manipulate the world interest rate R it is assumed throughout the paper that states are small on

[3] We will use the terms countries, federal states and jurisdictions as synonyms at the outset, but assign different economic environments to these terms later on.

the capital market in the sense that fiscal authorities ignore the effects of their own policy choices on the world interest rate.

Governments The fiscal authority in state, say, i uses a withholding tax on domestic interest income of foreigners, τ_i^f, a source-based tax on domestic real investment, τ_i^s, a tax on wage income, τ_i^w, and a residence-based tax on the overall capital income of residents, τ_i^r, or subsets of these taxes, to cover the costs of public good provision. The residence based capital income tax can take one of two forms, which differ in the tax treatment of foreign source income. In the first case the domestic tax is levied on the gross foreign source income. In the second case domestic tax authorities credit foreign tax liabilities against the domestic tax. The availability of the credit is limited to the domestic tax to retain the jurisdiction to tax savings income at the domestic rate.

To focus on the taxing problem in the presence of international capital mobility we assume that states cannot determine the foreign source income of own residents. To determine the tax due of its own residents under a residence based system of capital income taxation, state i therefore has to rely on the information that is given by the foreign tax authorities. We denote by $\lambda_j \in \{0, 1\}$ the fraction of savings i-residents invested in state j that state j chooses to report to state i. Taxes are proportional, each in $[0, 1]$, and link the gross and net prices for labor and capital through the tax definitions

$$
\begin{aligned}
\varrho_i^i &= R[1-\tau_i^r] && \text{net return } i\text{-residents obtain from investment in country } i,\\
\varrho_i^j &= R[1-\lambda_j\tau_i^r][1-\tau_j^f] && \text{net return } i\text{-residents obtain from investment in country } j,\\
& && \textit{double taxation},\\
\varrho_i^j &= R\lambda_j[1-\max(\tau_i^r,\tau_j^f)] && \text{net return } i\text{-residents obtain from investment in country } i,\\
&\quad + R[1-\lambda_j][1-\tau_j^f] && \textit{tax credit},\\
r_i &= R[1+\tau_i^s] && \text{gross return to physical investment in country } i,\\
\omega_i &= w_i[1-\tau_i^w] && \text{wage rate in country } i,
\end{aligned}
\tag{2}
$$

where w_i is the gross wage, which can be observed by fiscal authorities in each state.

Firms Firms in state, say, i take as given $\{w_i, r_i\}$ and rent capital k_i and labor l_i from individuals to produce a universal consumption good, which we will use as the numeraire. The technology $f(k_i, l_i)$ has the standard properties of decreasing marginal returns. Both factors are essential in the sense that $\lim_{k_i \to 0} f(k_i, l_i) = 0$ and $\lim_{l_i \to 0} f(k_i, l_i) = 0$. Firms maximize profits $\pi_i := \max_{k_i, l_i} [f(k_i, l_i) - r_i k_i - w_i l_i]$. Using the familiar first-order conditions from profit maximization we get the standard result that inputs should be employed until the marginal product of the last unit is equal to its rental price. Throughout the analysis we will use a constant returns to scale assumption which implies that $\pi_i = 0$ in any equilibrium. While the size of an individual firm is indeterminate due to technology, we may use the envelope theorem to obtain the slope of the factor price frontier to obtain the profit maximizing capital-labor ratio

$$\frac{\partial w_i}{\partial r_i} = -\frac{k_i}{l_i} \qquad\qquad \frac{\partial^2 w_i}{\partial r_i^2} > 0. \tag{3}$$

Individuals Each individual in state, say, i takes as given $\{\omega_i, \varrho_i^i, \varrho_i^j\}$. Each has a consumption-savings decision in the first period and chooses labor supply in the second. In the first period, the individual is endowed with e_i units of capital out of which $c_i^1 \leq e_i - s_i$ is consumed, where total savings are either invested domestically or abroad. Hence, $s_i = s_i^i + s_i^j$ using the notation introduced above.[4] In the second period, the individual consumes

$$c_i^2 \leq \omega_i l_i + [1 + \varrho_i^i] s_i^i + [1 + \varrho_i^j] s_i^j.$$

Since the individual's budget constraints will bind with equality an individual solves the problem

$$\begin{aligned} \max_{s_i^i, s_i^j, l_i} \quad & u(c_i^1, c_i^2, l_i) + \tilde{u}(g_i) \qquad \text{subject to} \\ & c_i^1 = e_i - s_i^i - s_i^j \\ & c_i^2 = \omega_i l_i + [1 + \varrho_i^i] s_i^i + [1 + \varrho_i^j] s_i^j \end{aligned} \tag{4}$$

where g_i is per capita government spending. Utilities $u(c_i^1, c_i^2, l_i)$ and $\tilde{u}(g_i)$ are strictly monotone, concave, and smooth. We assume that the public good is essential in

[4] To establish a case for taxing capital income we will assume throughout the analysis that e_i is sufficiently large such that $s_i > 0$.

the sense that $\lim_{g_i \to 0} \tilde{u}(g_i) = \infty$. From the first-order conditions follows directly that individuals do invest at home when $\varrho_i^i < \varrho_i^j$. Hence, individuals invest abroad whenever $\varrho_i^i > \varrho_i^j$. In the case of indifference, we can distinguish two cases which are equally logically consistent since they are both compatible with the policy choices of the fiscal authority. In the first case:

Lemma 1

$$(a) \;\; \textit{If } \varrho_i^i > \varrho_i^j \quad \Rightarrow \quad s_i = s_i^i \wedge s_i^j = 0,$$

$$(b) \;\; \textit{If } \varrho_i^i \leq \varrho_i^j \quad \Rightarrow \quad s_i = s_i^j \wedge s_i^i = 0.$$

The first case hence characterizes a situation in which individuals prefer to invest abroad in the case of indifference. The explanation for a slight preference for outside investment is exogenous to the model. One interpretation for a slight preference for foreign investments might stem from convention, resulting from the fact that people did make bad experiences in the past when they were investing at home.[5] Another explanation might be that residents of each state simply invest in foreign affiliates of domestic banks because these affiliates are able to attract customers claiming that information about the income arising from these transactions is not shared between states.[6] We will henceforth refer to this scenario as foreign bias which is a plausible case when capital market integration is perfect. In the second case

Lemma 2

$$(a) \;\; \textit{If } \varrho_i^i \geq \varrho_i^j \quad \Rightarrow \quad s_i = s_i^i \wedge s_i^j = 0,$$

$$(b) \;\; \textit{If } \varrho_i^i < \varrho_i^j \quad \Rightarrow \quad s_i = s_i^j \wedge s_i^i = 0.$$

[5]Expropriation was experienced during the second world war in Austria and Germany. These countries set down banking secrecy in their constitutions. However, the current policy debate about international information exchange brings about the fear that banking secrecy rules will become slack in future.

[6]The assumption is plausible by casual empiricism. The Deutsche Bundesbank (1994) estimated that the *announcement* of a 10% withholding in Germany tax caused a capital outflow of 99.5 bill. DM in 1989. The by far largest part of it was channeled through affiliates of German banks located in Luxembourg. Most savers decided not to return their savings, even though the tax never became effective.

Lemma 2 characterizes a situation in which individuals have a preference to invest at home. The interpretation is that financial markets are regulated, or that banks are unable to effectively compete for customers abroad.

Policy The fiscal authority in state, say, i chooses taxes defined in (2) at the beginning of the first period (and can credibly commit to this choice within the time horizon of the model) to finance per capita government spending g_i in the second period. For convenience let us denote by x_i the vector of tax policies $\{\tau_i^r, \tau_i^s, \tau_i^f, \tau_i^w, \lambda_i\}$ and by z_i the vector of state i's choice variables that enter the decisions of i-residents $\{\tau_i^r, \tau_i^s, \tau_i^w, w_i, R\}$. Notice that z_i does not include $\{\lambda_i, t_i^f\}$ since these variables only enter the budget restriction of residents in state j. The solution of (4) gives rise to functions $l_i(z_i) > 0$, $s_i^i(z_i) \geq 0$ and $s_i^j(z_i) \geq 0$, which may be inserted into the direct utility function to obtain the indirect utility function

$$v_i(z_i, \lambda_j, \tau_j^f) := \max_{s_i^i, s_i^j, l_i} u\left(e_i - s_i^i - s_i^j, \omega_i l_i + [1 + \varrho_i^i] s_i^i + [1 + \varrho_i^j] s_i^j, l_i\right) \tag{5}$$

The fiscal authority chooses x_i to maximize the utility of residents subject to the market clearing condition for the regional labor markets, the capital market clearing condition, and the first-order conditions of individuals and firms. From (2) the per capita revenue correspondence of state, say, i reads as

$$g_i \leq \tau_i^w w_i l_i + \tau_i^s R k_i + \tau_i^r R s_i^i + \vartheta_i \lambda_j R s_i^j + \tau_i^f R s_j^i, \tag{6}$$

where the variable ϑ_i captures the development of tax revenues under the two systems of capital income taxation: (a) in the case of double taxation we define $\vartheta_i := \tau_i^r$, and, (b), under the tax credit system $\vartheta_i := \max(\tau_i^r - \tau_j^f, 0)$. An equilibrium is a vector of policies z_i^* such that

$$\{z_i^*, \lambda_i^*, \tau_i^{f*}\} \in \arg\max v_i(z_i, \lambda_j^*, \tau_j^{f*}) \quad \text{s.t.} \quad g_i \leq \tau_i^w w_i l_i + \tau_i^s R k_i + \tau_i^r R s_i^i + \vartheta_i \lambda_j R s_i^j + \tau_i^f R s_j^i$$

Since (6) holds with strict equality, we may now use (3) to write welfare in state, say, i as

$$\mathcal{L}_i(x_i, g_i) := v(z_i) + \tilde{u}\left(l_i\left[\tau_i^w w_i - \tau_i^s R \frac{\partial w_i}{\partial r_i}\right] + \tau_i^r R s_i^i + \vartheta_i \lambda_j R s_i^j + \tau_i^f R s_j^i\right). \tag{7}$$

We may now derive the effects of a change in the tax and information policy on welfare as:

$$\frac{\partial \mathcal{L}_i}{\partial \tau} = \frac{\partial v_i}{\partial \tau} + \frac{\partial \tilde{u}}{\partial g_i}\frac{\partial g_i}{\partial \tau} \quad \forall \tau \in x_i. \tag{8}$$

Notice that partial derivatives may characterize discrete responses of tax revenue. Using (2) in (5) it is readily seen that

$$\frac{\partial v_i}{\partial \tau_i^f} = \frac{\partial v_i}{\partial \lambda_i} = 0. \tag{9}$$

3 Fiscal policy

In the following we will first discuss a benchmark case which characterizes second best tax rules. Then we contrast the benchmark tax system with the choice of the information exchange parameter and tax rates in two different tax scenarios. In the first scenario, the fiscal authority does not credit foreign tax payments of residents against the domestic capital income tax. In the second scenario, we assume that such a tax credit system is in place.

3.1 A benchmark

The assumption that states are small facilitates welfare analysis because it excludes any motive for states to use tax policy to manipulate the terms of trade. Moreover, the closed economy case is a reasonable candidate for a point on the utility possibility frontier that can be achieved by an information exchange agreement since there exists no motive for interjurisdictional trade in capital in the model apart from differences in tax rates. As a consequence, fiscal policy in each state should replicate the tax structure in a closed economy. If the tax structure in an open state does not coincide with the benchmark, then utility is reduced as a consequence of interstate competition in tax rates. The tax structure in the benchmark case is:

Result 1 *Assume that leisure and first-period consumption are Hicksian substitutes. In a closed state a welfare maximizing tax structure is* $\tau^f \in [0,1]$ *and* $(\alpha\tau^r + (1-\alpha)\tau^s)/\tau^w = [wl\frac{\partial l}{\partial \varrho} - ws\frac{\partial l}{\partial \omega}]/[Rs\frac{\partial s}{\partial \omega} - Rl\frac{\partial s}{\partial \varrho}] > 0$ *where* $\alpha \in [0,1]$.

Proof. See the appendix.

Result 1 demonstrates that both wage and capital taxation should be employed under the assumption that the labor supply and savings function are not backward bending in the aggregate. Furthermore, notice that result 1 gives multiple equilibria in taxes. The reason is that the tax bases of τ^r and τ^s are identical in a closed economy since tax bases collapse by the capital market clearing condition. Hence, τ^s and τ^r are perfect substitutes in the sense that the effects of an increase in τ^s on utility can be perfectly offset by an equal decrease in τ^r, and *vice versa*. Moreover, $t_i^f \in [0,1]$ because the tax base is zero. Any deviation from result 1 indicates that competition between states introduces an inefficiency which would not be present in the absence of tax competition.

3.2 The open economy under double taxation

The tax system we analyze first has the following structure. We continue assuming that the fiscal authority in each state can observe the level of productive capital, k_i, and the financial capital that is invested domestically by domestic residents, s_i^i, and by non residents, s_j^i. Residents of state i pay the tax τ_i^r on their i investment, and the non-resident tax in state j, τ_j^f, on their foreign source income. There are no credits given by the home authority for the non-resident tax, hence $\vartheta_i = \tau_i^r$ in (6). In addition, residents of state i are *de jure* obliged to pay the tax τ_i^r on their foreign investment. However, the foreign investment of domestic individuals is private information in the absence of inter jurisdictional information exchange agreements. Using the tax definitions (2) in lemma 1 and lemma 2 we can summarize the allocation of financial capital in lemma 3:

Lemma 3 *In the case of double taxation*

lemma 1 implies				*lemma 2 implies*			
1.a	$\tau_i^r < \eta_i^j$	$\Rightarrow$	$s_i = s_i^i \wedge s_i^j = 0$	*2.a*	$\tau_i^r \leq \eta_i^j$	$\Rightarrow$	$s_i = s_i^i \wedge s_i^j = 0$
1.b	$\tau_i^r \geq \eta_i^j$	$\Rightarrow$	$s_i = s_i^j \wedge s_i^i = 0$	*2.b*	$\tau_i^r > \eta_i^j$	$\Rightarrow$	$s_i = s_i^j \wedge s_i^i = 0$

where $\eta_i^j := \frac{\tau_j^f}{1-\lambda_j(1-\tau_j^f)}$.

The individual compares the after tax return to capital when making the investment decision, taking as given foreign and domestic taxes and the information on the foreign investment of domestic residents that possibly is revealed by the foreign tax authority. The relevant home tax is τ_i^r. This tax can take two forms. It is a residence-based tax on capital income when the tax authority in state j exchanges information about the j investments of i residents to the tax authority in country i. It is a source tax on the country i source capital income by i residents when the tax authority of country j chooses not to exchange information. The interesting implications are twofold. First, if information is exchanged by the foreign tax authority, $\lambda_j = 1$, then τ_i^r vanishes in the arbitrage conditions of individuals from lemma 3. Second, if information is not exchanged, $\lambda_j = 0$, then i residents compare the tax τ_i^r with the source tax on non residents, τ_j^f.

3.2.1 Preference for outward investment

Using lemma 3.1 the possible allocations of savings can be summarized in table 1, where $\tilde{g}_i := R(\tau_i^r s_i^i + \tau_i^r \lambda_j s_i^j + \tau_i^f s_j^i)$ and $\tilde{g}_j := R(\tau_j^r s_j^j + \tau_j^r \lambda_i s_j^i + \tau_j^f s_i^j)$.

		$\tau_j^r(1-\lambda_i) \geq \tau_i^f$		$\tau_j^r(1-\lambda_i) < \tau_i^f$
$\tau_i^r(1-\lambda_j) \geq \tau_j^f$	(i)	$s_i = s_i^j,\ s_j = s_j^i$ $\tilde{g}_i = \lambda_j \tau_i^r R s_i^j + (1-\lambda_i)\tau_i^f R s_j^i$ $\tilde{g}_j = \lambda_i \tau_j^r R s_j^i + (1-\lambda_j)\tau_j^f R s_i^j$	(iii)	$s_i = s_i^j,\ s_j = s_j^j$ $\tilde{g}_i = \lambda_j \tau_i^r R s_i^j$ $\tilde{g}_j = (1-(1-\lambda_i)\lambda_j)\tau_j^r R s_j^j$ $+(1-\lambda_j)\tau_j^f R s_i^j$
$\tau_i^r(1-\lambda_j) < \tau_j^f$	(ii)	$s_i = s_i^i,\ s_j = s_j^i$ $\tilde{g}_i = (1-(1-\lambda_j)\lambda_i)\tau_i^r R s_i^i$ $+(1-\lambda_i)\tau_i^f R s_j^i$ $\tilde{g}_j = \lambda_i \tau_j^r R s_j^i$	(iv)	$s_i = s_i^i,\ s_j = s_j^j$ $\tilde{g}_i = \tau_i^r R s_i^i$ $\tilde{g}_j = \tau_j^r R s_j^j$

Table 1: Allocation of savings and tax revenue under lemma 3.1.

To determine equilibrium tax rates and information exchange assume that information is exchanged and that τ_i^r, τ_i^f and τ_j^r, τ_j^f are positive. First consider case (i) in table 1 where i-savers invest in state j and j-savers invest in state i. Tax revenues from withholding taxation are zero for all $\tau_i^f, \tau_j^f \in [0,1]$. To increase tax revenue from

withholding taxation state i chooses $\lambda_i = 0$ as long as $\tau_j^r \geq \tau_i^f > 0$ and the state is indifferent at $\tau_j^r \geq \tau_i^f = 0$. By the same argument it is profitable for state j to choose $\lambda_j = 0$ as long $\tau_i^r \geq \tau_j^f > 0$. At $\lambda_i = 0$ state j chooses $\tau_j^r < \tau_i^f$ to attract j-savers. If $\tau_i^f = 0$ such a strategy is impossible, implying that $\tau_i^f = \tau_j^f = 0$ do not induce deviations. At $\tau_i^f = \tau_j^f = 0$, however, all $\tau_i^r, \tau_j^r \in [0,1]$ are candidates for an equilibrium, as the relevant tax base – savings of residents – is zero anyway, and only $\lambda_i = \lambda_j = 0$ do not induce deviations.

In case (ii) and (iii) all savings are invested in one country. Turn first to case (ii) where all savings are invested in country i, and revenue from capital taxation is zero in state j. Country i sets $\lambda_i = 0$ since tax revenue from withholding taxation would be zero otherwise. The reason is that j-savers invest in state j if $\tau_i^f > 0$ at $\lambda_i = 1$. Country j can gain by choosing $\lambda_j = 0$ and $\tau_j^f = \tau_i^r$ if $\tau_i^r > 0$ to attract i-savers. At $\tau_i^r = 0$ such a strategy is not profitable. However, $\tau_j^f = 0$ is incompatible with the assumption that i-savers invest in state i. Moreover, at $\lambda_i = 0$ country j gains by $\tau_j^r < \tau_i^f$ as long $\tau_i^f > 0$. Hence, if $\tau_i^r = \tau_i^f = \lambda_i = 0$ country j is indifferent between all capital-tax rates and λ_j. Case (iii) is analogous to case (ii).

In case (iv) all savings are invested in the country where the investor resides. Hence, tax revenues from withholding taxation are equal to zero. Again it is profitable to reduce information exchange as long $\tau_j^r, \tau_i^r > 0$ to increase revenues from withholding taxation. At $\lambda_i = \lambda_j = 0$ state i chooses $\tau_i^f = \tau_j^r$ to attract the savings of j-residents and state j chooses $\tau_j^r < \tau_i^f$. At $\tau_i^r = \tau_j^r = 0$, however, every positive withholding tax is compatible with the allocation of savings in case (iv). Moreover, $\lambda_i, \lambda_j \in [0,1]$ since residents do not invest abroad. Countries cannot effectively tax capital income even though information exchange is an equilibrium.

Using the envelope theorem in (8), the tax rates for τ_i^s and τ_i^w are given by the conditions:

$$\frac{\partial \mathcal{L}_i}{\partial \tau_i^w} = -l_i w_i \beta_i + \frac{\partial \tilde{u}}{\partial g_i}\left[l_i w_i - \tau_i^r w_i R \frac{\partial s_i}{\partial \omega_i} - w_i \frac{\partial l_i}{\partial \omega_i}\left(\tau_i^w w_i - \tau_i^s R \frac{\partial w_i}{\partial r_i}\right)\right] = 0, \quad \text{(10a)}$$

$$\begin{aligned}\frac{\partial \mathcal{L}_i}{\partial \tau_i^s} = (1-\tau_i^w) l_i R \frac{\partial w_i}{\partial r_i}\beta_i + \frac{\partial \tilde{u}}{\partial g_i}\Bigg[\tau_i^r R^2 (1-\tau_i^w)\frac{\partial s_i}{\partial \omega_i} - (1-\tau_i^w) l_i R \frac{\partial w_i}{\partial r_i} \\ -\tau_i^s l_i R^2 \frac{\partial^2 w_i}{\partial r_i^2} + (1-\tau_i^w) R \frac{\partial l_i}{\partial \omega_i}\frac{\partial w_i}{\partial r_i}\left(\tau_i^w w_i - \tau_i^s R \frac{\partial w_i}{\partial r_i}\right)\Bigg] = 0, \quad \text{(10b)}\end{aligned}$$

where β_i is the marginal utility of income. Introducing $m_i := k_i - s_i = -l_i \partial w_i / \partial r_i - s_i$

and using this equation to substitute out s_i in (10) we form $R(1-\tau_i^w)\partial w_i/\partial r_i \partial \mathcal{L}_i/\partial \tau_i^w + w_i \partial \mathcal{L}_i/\partial \tau_i^s$ to obtain

$$-l_i R^2 \tau_i^s w_i \frac{\partial^2 w_i}{\partial r_i^2} \frac{\partial \tilde{u}}{\partial g_i} = 0 \tag{11}$$

It is clear from (11) that the small state will not use the source tax on the domestic capital, $\tau_i^s = 0$. We may now summarize results.

Result 2 *In the case of a preference for outward investment and double taxation equilibria can be characterized as follows. (1) Tax revenues from capital taxation are always equal to zero. (2) Either the residence-tax will not be levied and the withholding tax on capital income are arbitrary, the withholding tax-rates are equal to zero and the residence-tax rates are arbitrary, or one country chooses not to levy any of both taxes and the other country chooses both taxes at arbitrary rates. (3) Information exchange is an equilibrium if the residence-tax rate equals zero. (4) Countries use wage taxation to finance the public good according to* (10a).

Result 2 demonstrates that states are unable to raise revenue from capital taxation in equilibrium. The argument is twofold. First, the source tax on the physical investment by firms is not levied in equilibrium because such a tax would reduce production and wages. The former distortion can be avoided by taxing wages directly. Hence, states choose not to levy the source tax on physical capital and tax wage income to avoid the loss in production efficiency. Second, states might abstain from taxing the domestic-source capital income of residents residing abroad on a source basis because any positive tax would drive out savings. The positive withholding-tax rate exactly paves the way for information exchange because the residence tax-rate is zero anyway.

3.2.2 Home bias

The next scenario to consider in this section is the environment where savers have a preference for investment in their residence country. The table 2 shows the allocations of savings and tax revenue under lemma 3.2. To determine the equilibrium tax rates and information exchange we assume that all taxes are positive and that information is exchanged. In case (i) states have an incentive not to provide information in order to increase tax revenue from withholding taxation as long the withholding tax is

		$\tau_j^r > \tau_i^f \geq 0$		$(1-\lambda_i)\tau_j^r \leq \tau_i^f$
$\tau_i^r > \tau_j^f \geq 0$	(i)	$s_i = \lambda_j(s_i^i - s_i^j) + s_i^j$	(iii)	$s_i = \lambda_j(s_i^i - s_i^j) + s_i^j$
		$s_j = \lambda_i(s_j^j - s_j^i) + s_j^i$		$s_j = s_j^j$
		$\tilde{g}_i = \lambda_j \tau_i^r R s_i^i + (1-\lambda_i)\tau_i^f R s_j^i$		$\tilde{g}_i = \lambda_j \tau_i^r R s_i^i$
		$\tilde{g}_j = \lambda_i \tau_j^r R s_j^j + (1-\lambda_j)\tau_j^f R s_i^j$		$\tilde{g}_j = \tau_j^r s_j^j + (1-\lambda_j)\tau_j^f R s_i^j$
$(1-\lambda_j)\tau_i^r \leq \tau_j^f$	(ii)	$s_i = s_i^i$	(iv)	$s_i = s_i^i$
		$s_j = \lambda_i(s_j^j - s_j^i) + s_j^i$		$s_j = s_j^j$
		$\tilde{g}_i = \tau_i^r R s_i^i + (1-\lambda_i)\tau_i^f R s_j^i$		$\tilde{g}_i = \tau_i^r R s_i^i$
		$\tilde{g}_j = \lambda_i \tau_j^r R s_j^j$		$\tilde{g}_j = \tau_j^r R s_j^j$

Table 2: Allocation of savings and tax revenue under lemma 3.2.

positive. Hence, all investors go abroad. If, say, $\tau_i^f > 0$ then state j sets $0 < \tau_j^r \leq \tau_i^f$ to attract j-residents. If $\tau_i^f = 0$, however, then such an incentive does not exist as the effect on tax revenue is absent. Every positive residence based tax is compatible with the allocation in case (i), which, however, does not become effective since investors do not invest in the country where they reside. This makes information exchange an equilibrium.

In case (ii) and (iii) all savings are invested in one country. Turn first to case (ii) where i-residents invest in state i and j-residents invest in state i if $\lambda_i = 0$, which is a profitable choice. It is profitable for state j to set $\lambda_j = 0$ to attract i-residents as long $0 < \tau_j^f < \tau_i^r$. At $\tau_i^r = 0$ such a policy is not profitable. Moreover, state j can increase tax revenue by setting $0 < \tau_j^r < \tau_i^f$ to attract j-savers as long $\tau_i^f > 0$. Hence, $\tau_i^f = 0$ does not induce deviations. However, $\tau_j^r = 0$ is not in accordance with the assumption that all savings are invested in country i. Hence, if $\tau_i^r = \tau_i^f = \lambda_i = 0$ country j is indifferent between all capital-tax rates and information exchange. Case (iii) is symmetric to case (ii).

Turn to case (iv) where all investors invest in the residence state and, thus, tax revenues from withholding taxation are zero. To increase tax revenue from withholding taxation states will choose not to provide information as long $\tau_i^r > \tau_i^f > 0$ and $\tau_j^r > \tau_j^f > 0$. For this case state, say, j may choose a tax rate $0 < \tau_j^f < \tau_i^r$ such that i-residents reallocate their savings to increase revenue from withholding taxation. If

$\tau_i^r = 0$ such a strategy is impossible and a profitable deviation does not exist. On the other hand, if $\tau_i^f > 0$, it is impossible to gain for country j by lowering τ_j^r as the tax base – s_j^j – is already subject to residence taxation or $\tau_j^r = 0$. Hence, $\tau_i^r = \tau_j^r = 0$ and $\lambda_i, \lambda_j, \tau_i^f, \tau_j^f \in [0, 1]$ are compatible with case (iv).

The rates τ_i^w and τ_i^s are given by (10), from which follows that $\tau_i^s = 0$ from (11). We summarize with:

Result 3 *Result 2 is also valid in the case of incomplete capital market integration and double taxation.*

The result suggests that information will be voluntarily exchanged under this section's assumptions on the prevailing tax system. However, positive tax rates on capital income and information exchange are mutually exclusive in equilibrium, and the argument is again twofold. First, wage taxation does dominate the source tax on physical investment as a consequence of the production efficiency lemma. Second, states compete for the domestically invested financial capital of own residents under lemma 3.2, whereas they compete for the financial capital invested abroad in the previous case under lemma 3.1. In the present case, any positive source tax on the savings income of own residents creates an incentive to undercut in the competing state. When the domestic source tax on own residents is zero such an incentive is absent and all savings are invested where the individual resides. This makes information exchange an equilibrium. Result 3 hence is similar to result 2, albeit the proofs and their economic explanations differ. This difference will become even more important when we analyze the tax credit system in the next section.

The arguments given under results 2-3 make intuitive that the decentralized equilibrium has inferior welfare properties compared to the benchmark case since:

Result 4 *A system of information exchange will not increase utility if states choose not to use the residence-based capital income tax in equilibrium.*

Proof. We prove the result by contradiction. Assuming that information is exchanged, the condition for the residence-based tax on capital is:

$$\frac{\partial \mathcal{L}_i}{\partial \tau_i^r} = -s_i R \beta_i + \frac{\partial \tilde{u}}{\partial g_i} \left[s_i R - \tau_i^r R^2 \frac{\partial s_i}{\partial \varrho_i} - R \frac{\partial l_i}{\partial \varrho_i} \left(\tau_i^w w_i - \tau_i^s R \frac{\partial w_i}{\partial r_i} \right) \right] = 0, \qquad (12)$$

where the envelope theorem has been used. We form $-R\left(m_i + l_i \partial w_i/\partial r_i\right)\partial \mathcal{L}_i/\partial \tau_i^w - l_i w_i \partial \mathcal{L}_i/\partial \tau_i^r$ using (10a) to get:

$$\frac{\tau_i^r}{\tau_i^w} = \frac{w_i}{R}\frac{s_i \frac{\partial l_i}{\partial \omega_i} - l_i \frac{\partial l_i}{\partial \varrho_i}}{l_i \frac{\partial s_i}{\partial \varrho_i} - s_i \frac{\partial s_i}{\partial \omega_i}}, \tag{13}$$

which is identical to the tax structure in result 1. ■

3.3 The open economy under tax credits

The second tax system that we analyze has a more complicated structure. Here, foreign tax payments are credited against the domestic capital tax as long the foreign capital tax does not exceed the domestic. Hence, $\vartheta_i = \max(\tau_i^r - \tau_j^f, 0)$ in (6). Using the tax definitions (2) in lemma 1 and lemma 2 allows to summarize the investment decisions by the individual as follows:

Lemma 4 *In the case of tax credits*

lemma 1 implies				*lemma 2 implies*			
1.a	$\tau_i^r < \tilde{\eta}_i^j$	$\Rightarrow$	$s_i = s_i^i \wedge s_i^j = 0$	*2.a*	$\tau_i^r \leq \tilde{\eta}_i^j$	$\Rightarrow$	$s_i = s_i^i \wedge s_i^j = 0$
1.b	$\tau_i^r \geq \tilde{\eta}_i^j$	$\Rightarrow$	$s_i = s_i^j \wedge s_i^i = 0$	*2.b*	$\tau_i^r > \tilde{\eta}_i^j$	$\Rightarrow$	$s_i = s_i^j \wedge s_i^i = 0$

where $\tilde{\eta}_i^j := \lambda_j \max(\tau_i^r, \tau_j^f) + (1 - \lambda_j)\tau_j^f$.

Parts 1 of lemma 4 show that the individual will not reallocate financial capital under the credit system as long the tax on residents in country i is not strictly smaller than the foreign source tax for all values of the information exchange parameter λ_j. Parts 2 of lemma 4 show that the individual will not reallocate savings as long the residence-based tax is not strictly larger than the foreign source tax at $\lambda_j = 0$. Whereas the assumptions on the savings function with respect to a home or foreign bias did not play a crucial role for the results in the preceding section that equilibrium tax revenue is zero under double taxation, the following results are able to demonstrate that this role is crucial when a tax credit system is in place. Let us first turn to the case of complete capital market integration where parts 1 of lemma 4 apply. One would expect that the fiscal authority in state i does not have any incentives to share information at all in this case since j-residents invest in state i as long the effective

tax on savings income in state j is weakly larger than the tax in state i. However, we obtain the opposite result.

3.3.1 Preference for outward investment

We use table 3 to demonstrate that the tax credit system eliminates any adverse incentives.

$\lambda_i, \lambda_j \in \{0,1\}$		$\tau_j^r \geq \tau_i^f$		$\tau_j^r < \tau_i^f$
$\tau_i^r \geq \tau_j^f$	(i)	$s_i = s_i^j,\ s_j = s_j^i$	(iii)	$s_i = s_i^j,\ s_j = s_j^j$
		$\tilde{g}_i = (\tau_i^r - \tau_j^f)Rs_i^j + \tau_i^f Rs_j^i$		$\tilde{g}_i = 0$
		$\tilde{g}_j = (\tau_j^r - \tau_i^f)Rs_i^j + \tau_j^f Rs_i^j$		$\tilde{g}_j = \tau_j^r Rs_j^j + \tau_j^f Rs_i^j$
$\tau_i^r < \tau_j^f$	(ii)	$s_i = s_i^i,\ s_j = s_j^i$	(iv)	$s_i = s_i^i,\ s_j = s_j^j$
		$\tilde{g}_i = \tau_i^r Rs_i^i + \tau_i^f Rs_j^i$		$\tilde{g}_i = \tau_i^r Rs_i^i$
		$\tilde{g}_j = 0$		$\tilde{g}_j = \tau_j^r Rs_j^j$

Table 3: Allocation of savings and tax revenue under lemma 4.1.

Interestingly, table 3 shows that the allocation of savings does not depend on the information exchange parameter λ. To explain the result observe that the tax credit system avoids the double taxation of savings income as long the credit limit is not surpassed. If it is surpassed, then i-residents invest in state i for all λ_j anyway. Hence, if state j sets $\tau_j^f > \tau_i^r$ i-residents always invest in state i and information exchange is costless for state j. On the other hand, if $\tau_j^f \leq \tau_i^r$ and information is not exchanged by state j, $\lambda_j = 0$, then i-residents invest in state j, and they also do so at $\lambda_j = 1$ because of the credit system. The argument makes intuitive that information exchange is without costs from the perspective of each state, hence $\lambda_i, \lambda_j \in \{0,1\}$. This gives rise to the following result:

Result 5 *When savers have a preference for outward investment and the tax credits system applies there exists an equilibrium in which all states provide information, $\lambda_i = \lambda_j = 1$. However, there also exists an equilibrium where fiscal authorities choose not to provide information, $\lambda_i = \lambda_j = 0$.*

Next we determine equilibrium tax rates. Assume for that purpose that $\tau_i^f = \tau_j^f = 0$ and $\tau_i^r > 0, \tau_j^r > 0$. In case (i) of table 3 country i can increase tax revenue

by choosing $\tau_i^f = \tau_j^r$. At $\tau_i^f = \tau_j^r$ a profitable deviation does not exist. By the same reasoning $\tau_j^f = \tau_i^r$. Cases (i) and (ii) are not candidates for an equilibrium since symmetric incentives are not compatible with the assumption that all savings are in just one country. In case (iv) all savings are invested where the investor resides. State i can increase tax revenue by choosing $\tau_i^f = \tau_j^r$ and state j chooses $\tau_j^f = \tau_i^r$. This choice, however, is not compatible with the assumption that all savings are invested in the state of residence. Hence, states choose the level of wage taxation and source based taxation of investment by firms according to (10). The residence tax on financial capital is set such that (12) are fulfilled. Hence, $t_i^s = 0$ from (11) and the ratio τ_i^r/τ_i^w follows (13). We summarize with:

Result 6 *Assume that savers have a preference for outward investment and lemma 1 applies. When information is exchanged the tax structure in the decentralized equilibrium is compatible to the tax structure in the benchmark of result 1.*

The intuition for the result is as follows. First notice that each state has an incentive to attract financial capital in order to increase the public budget. Suppose that $\tau_i^r < \tau_j^f$. At $\lambda_j = 0$ i-residents simply take advantage of the fact that the domestic tax is lower and invest at home. At $\lambda_j = 1$ the tax τ_i^r becomes a residence-based tax and any $\tau_j^f > \tau_i^r$ will cause i-residents to invest at home because of the credit limit. For the same reason λ_i is irrelevant for country j at $\tau_j^r < \tau_j^f$. Now suppose that $\tau_i^r \geq \tau_j^f$. Start assuming that $\lambda_j = 0$, then τ_i^r becomes a source tax. This directly implies that residents invest abroad. At $\lambda_j = 1$ the foreign tax will always be credited by the domestic tax authorities, so residents invest abroad. The discussion reveals that countries compete in source taxes in the equilibrium where information is not exchanged, akin to the argument provided for result 2. Hence:

Result 7 *Assume that savers have a preference for outward investment and lemma 1 applies. When information is not exchanged, then capital taxation does not raise tax revenue. The public good is financed using wage taxation only according to* (10a)*. A combined effort in all states to make capital income taxation sustainable would increase welfare.*

We may now summarize the main findings of this section. Results 2–5 shows that there exists equilibria in which countries choose to exchange information in the model,

next to an equilibrium where those incentives are absent. The consequences of information exchange in result 6 are, however, different to the equilibria with information exchange in results 2–4 and 7. In contrast to the latter, result 6 describes a scenario in which countries can raise tax revenue from capital income taxation.

3.3.2 Home bias

Let us now contrast the case described above with the results in an environment where the capital market is segmented. The assumption is that the borders of those segments fall short to the geographical borders. Surprisingly, incomplete capital market integration does eliminate any incentives for governments to raise revenue from capital income taxation. Observe that lemma 4.2 implies that we have to consider the allocation of savings and tax revenue in the following cases:

		$\tau_j^r > \tau_i^f$		$\tau_j^r \leq \tau_i^f$
$\tau_i^r > \tau_j^f$	(i)	$s_i = \lambda_j(s_i^i - s_i^j) + s_i^j$	(iii)	$s_i = \lambda_j(s_i^i - s_i^j) + s_i^j$
		$s_j = \lambda_i(s_j^j - s_j^i) + s_j^i$		$s_j = s_j^j$
		$\tilde{g}_i = \lambda_j \tau_i^r R s_i^i + (1-\lambda_i)\tau_i^f R s_j^i$		$\tilde{g}_i = \lambda_j \tau_i^r R s_i^i$
		$\tilde{g}_j = \lambda_i \tau_j^r R s_j^j + (1-\lambda_j)\tau_j^f R s_i^j$		$\tilde{g}_j = \tau_j^r s_j^j + (1-\lambda_j)\tau_j^f R s_i^j$
$\tau_i^r \leq \tau_j^f$	(ii)	$s_i = s_i^i$	(iv)	$s_i = s_i^i$
		$s_j = \lambda_i(s_j^j - s_j^i) + s_j^i$		$s_j = s_j^j$
		$\tilde{g}_i = \tau_i^r R s_i^i + (1-\lambda_i)\tau_i^f R s_j^i$		$\tilde{g}_i = \tau_i^r R s_i^i$
		$\tilde{g}_j = \lambda_i \tau_j^r R s_j^j$		$\tilde{g}_j = \tau_j^r R s_j^j$

Table 4: Allocation of savings and tax revenue under lemma 4.2.

Observing that table 4 reproduces table 2 we can state the following:

Result 8 *Result 2 is also valid in the case of a home bias and under the tax credit system.*

A discussion of result 5 and result 8 clarifies the mechanism which makes information exchange an equilibrium in this model. When capital markets are not segmented then individuals will make use of the option to choose the financial intermediary which offers the most preferable service. The bank is most likely not located in the home

jurisdiction, provided that the overall number of jurisdictions is sufficiently large. We interpreted this situation as an environment where lemma 1 applies. Voluntary information exchange is an equilibrium in this environment exactly because individuals do not reallocate their savings when the source tax on capital income in the jurisdiction where the financial capital is invested is equal to the tax levied in the jurisdiction where the individual resides. In contrast, the underlying assumption in result 8 is that the geographical borders of a jurisdiction collapse with the boundaries of the segments on the capital markets. In this case the government in each jurisdiction has an incentive to lower the tax burden placed on financial capital below the tax burden in other jurisdictions. The crediting of taxes only assures that the effective tax burdens are equalized between jurisdictions. The conflict between result 5 and result 8 is then understood from the observation that the tax credit system eliminates the incentives of individuals to reallocate their financial capital to the home jurisdiction only in the case where the capital market is fully integrated. However, fiscal authorities have an incentive to strategically use information exchange in an environment where the *equalization* of the tax burden immediately causes capital to move to the home state.

3.4 Discussion of model extensions

A core result of the previous discussion is that information exchange turns out to be an equilibrium in the present model. However, information exchange is only a necessary condition for the efficiency of decentralized tax setting. Hence, it is interesting to discuss model extensions and mechanisms that help to ensure efficient decision making by states.

First, let us discuss whether the results qualitatively depend on the assumption that wage taxation can be optimally set by states. Consider the example where the wage tax is bounded from above such that $\tau_i^w = 0$ in all states. The vector of tax policies is $x_i = \{\tau_i^r, \tau_i^s, \tau_i^f, \lambda_i\}$. The consequence is that $\partial \mathcal{L}_i / \partial \tau_i^w$ can be dropped

and (10b), (12) reduce to

$$\frac{\partial \mathcal{L}_i}{\partial \tau_i^s} = l_i R \frac{\partial w_i}{\partial r_i}\beta_i + \frac{\partial \tilde{u}}{\partial g_i}\left[\tau_i^r R^2 \frac{\partial s_i}{\partial \omega_i} - l_i R \frac{\partial w_i}{\partial r_i} - \tau_i^s l_i R^2 \frac{\partial^2 w_i}{\partial r_i^2} - R \frac{\partial l_i}{\partial \omega_i}\frac{\partial w_i}{\partial r_i}\tau_i^s R \frac{\partial w_i}{\partial r_i}\right] = 0, \tag{14a}$$

$$\frac{\partial \mathcal{L}_i}{\partial \tau_i^r} = -s_i R \beta_i + \frac{\partial \tilde{u}}{\partial g_i}\left[s_i R - \tau_i^r R^2 \frac{\partial s_i}{\partial \varrho_i} - R \frac{\partial l_i}{\partial \varrho_i}\left(\tau_i^w w_i - \tau_i^s R \frac{\partial w_i}{\partial r_i}\right)\right] = 0, \tag{14b}$$

where β_i is the marginal utility of income. We form $\partial \mathcal{L}_i/\partial \tau_i^r \partial w_i/\partial r_i - (m_i + l_i \partial w_i/\partial r_i)\partial \mathcal{L}_i/\partial \tau_i^s = 0$ using $s_i = -l_i \partial w_i/\partial r_i - m_i$ and get:

$$\frac{\tau_i^s}{\tau_i^r} = \frac{\frac{\partial w_i}{\partial r_i}\left(l \frac{\partial s_i}{\partial r_i} - s_i \frac{\partial s_i}{\partial \omega_i}\right)}{l_i s_i \frac{\partial^2 w_i}{\partial r_i^2} + \frac{\partial w_i}{\partial r_i}^2 \left(s_i \frac{\partial l_i}{\partial \omega_i} - l_i \frac{\partial l_i}{\partial r_i}\right)}. \tag{15}$$

The small state chooses to use the source tax on real investment by firms when the wage tax is not available since $0 < \tau_i^s/\tau_i^r < \infty$ from (15).[7] Of course, as is indicated by the term $(\partial w_i/\partial r_i)^2$ the absence of wage taxation causes a loss in utility compared to the case where such a tax is available. However, the loss is due to domestic imperfections and it is not caused by the mobility of capital. Also note that τ_i^s does not enter the arbitrage condition of individuals and, hence, does not affect the allocation of financial capital. Therefore we can conclude that none of the results in the previous sections changes fundamentally when the domestic tax system is imperfect in the sense that wage income cannot be taxed. The only difference is that the source tax on investment by firms is not zero in equilibrium and some tax revenue can be raised by capital taxation. But this has not effect for the incentives of states to exchange information.

So, if a zero bound on source taxation of real investment and the availability of wage taxation is not crucial for the model results, which model extension straightforwardly changes results in a relevant way? An important starting point for this discussion is to assume that states restrict their use of the source tax on the financial investment by non residents if the state receives information about the foreign capital income of own residents. If, however, information is not provided then the state 'punishes' the other state by implementing an source tax on the capital income by foreigners. Under this modification, cases (i) in tables 1–4 reduce to

[7] We maintain the assumption that leisure and first period consumption are Hicksian substitutes.

(i) in table 1	$\tilde{g}_i\|_{\lambda_j=1} = \tau_i^r Rs_i^j$	(i) in table 2	$\tilde{g}_i\|_{\lambda_j=1} = \tau_i^r Rs_i^i$
	$\tilde{g}_i\|_{\lambda_j=0} = (1-\lambda_i)\tau_i^f Rs_j^i$		$\tilde{g}_i\|_{\lambda_j=0} = (1-\lambda_j)\tau_i^f Rs_j^i$
(i) in table 3	$\tilde{g}_i\|_{\lambda_j=1} = (\tau_i^r - \tau_j^f)Rs_i^j$	(i) in table 4	$\tilde{g}_i\|_{\lambda_j=1} = \tau_i^r Rs_i^i$
	$\tilde{g}_i\|_{\lambda_j=0} = (\tau_i^r - \tau_j^f)Rs_i^j + \tau_i^f Rs_j^i$		$\tilde{g}_i\|_{\lambda_j=0} = (1-\lambda_i)\tau_i^f Rs_j^i$

Inspection of the cases taken from tables 1, 2 and 3 shows that country i has no incentive to use λ_i strategically when country j provides information. State i exchanges information and taxes the capital income of own residents according to the residence principle. Since all states act accordingly, decentralized tax setting is efficient.

However, the state has an incentive to use information exchange and tax policy strategically in the case where the other state chooses not to exchange information. Then, the logic described in results 1–4 and 8 applies, leading to the result that either taxes on capital income are equal to zero or the tax base is zero. Decentralized tax setting is inefficient here since tax revenue from residence taxation of financial capital is always zero.[8] To sum up, states are still tempted to attract world savings using information exchange and τ^f strategically to increase the public budget — but a supranational authority can help to support the Pareto efficient benchmark as the outcome with decentralized tax setting if it were to dictate a zero tax on the domestic source income of foreign investors.

4 Conclusions

In this model we set up a tax competition model where jurisdictions are able to compete for mobile capital, assuming that fiscal authorities simultaneously choose information exchange and taxes on financial and real capital. We demonstrated that information exchange is an equilibrium in this game. However, information exchange turned out to be only a necessary condition for an effective level of savings taxation. The exception is the scenario where savers have a preference for outward investment and each country grants credits for the foreign taxes paid by domestic residents. In all other scenarios there exists equilibria in which countries exchange information but nevertheless are unable to raise revenue from capital income taxation. It follows from

[8] The case from table 3 is repeated here for completeness only since it is obvious that there exists an efficient equilibrium from result 6.

this argument that countries may choose to credit the foreign tax due of residents against the domestic tax liabilities.

Our results can be interpreted in at least two different ways. The starting point of the first interpretation is the perception that international institutions like the OECD and the EU Commission are not outside enforcement agencies and, consequently, cannot act against the best interest of member states. The model rationalizes outcomes where countries choose to exchange information because of the absence of a positive residence tax on savings. In this case decentralized tax setting cannot implement the efficient outcome. This is what we called the information exchange puzzle in the title of the paper. The puzzle has an interesting empirical implication. Any attempt of the EU or OECD to introduce a system of information exchange has to be judged by the willingness of states to choose a positive tax on savings income of residents. The present model suggests that there exist equilibria in the real world where taxes on worldwide savings income are zero when information is exchanged.

The starting point of the second interpretation of the model results is the perception that international institutions are outside enforcement agencies. In this view, participation of states need not be voluntary, or participation is obvious and need not to be explained within the model. The implementation of regulatory policy measures in the economic environments in which decentralized decision making causes a waste of resources are of special importance in such a 'dictatorial' regime. Of course there are many instruments a supra jurisdictional authority may use to give governments the necessary incentives to provide information. But one is straightforward from the present analysis. The tax measure which seems to be most compatible with the principle of subsidiarity — as it appears in The Treaty on European Union and The Treaty of Amsterdam — is to dictate a zero source tax on financial capital to eliminate tax base effects. This would leave the decision about other tax rates and information exchange at the regional level. States would still be able to set the remaining taxes according to their specific needs. The present model analysis suggests that they would implement residence based taxation of capital income. There are arguments for the view that the action proposed by the EU council directive goes beyond what is necessary to achieve the objective of ensuring a minimum of effective taxation of savings income.

Appendix

Proof of result 1

Proof. We characterize the closed economy case where $N = 1$, which allows to skip country-specific indices. In a closed economy $k = s$ and $\tilde{R} := R|_{N=1}$ must adjust appropriately in any equilibrium. First notice that tax revenue of τ^f is zero in a closed economy because the tax base is zero. Hence, $\tau^f \in [0, 1]$. Second, the tax base of the residence-based capital tax can perfectly be monitored by the government. Third, the tax bases of the source-based capital tax τ^s and the residence-based capital tax τ^r collapse. Hence we can set $\tau^s = 0$ without loss of generality, implying that $\tilde{R} = r$ from the definition of τ^s. Moreover, the tax problem is bounded from the assumption that all taxes are in $[0, 1]$. Clearly, $t^w = t^r = 0$ cannot be a welfare maximum under the assumption that the public good is essential. The case $t^w = t^r = 1$ can be excluded since households would neither save nor supply labor, implying that second period production is zero. Cases $t^w = 1, t^r \in [0, 1]$ and $t^r = 1, t^w \in [0, 1]$ can be excluded from the assumption that both factors of production are essential in production. We consider the case where (8) for τ^r and τ^w is equal to zero, and the resulting tax rates characterize the welfare maximum. Using the Envelope theorem on the indirect utility function, the conditions for an optimal choice of taxes are:

$$\begin{aligned}
\left.\frac{\partial \mathcal{L}}{\partial \tau^w}\right|_{N=1} &= -\left(w + \tilde{R}_{t^w}\left(\tau^w - \tau^r\right)\frac{\partial w}{\partial r}\right)\left(l\left(\beta - \frac{\partial \tilde{u}}{\partial g_i}\right) + \frac{\partial \tilde{u}}{\partial g_i}\left(\tilde{R}\frac{\partial s}{\partial \omega}\tau^r + w\frac{\partial l}{\partial \omega}\tau^w\right)\right) \\
&\quad + \frac{\frac{\partial \tilde{u}}{\partial g_i}}{l}\tilde{R}_{t^w}\left(\tau^r - 1\right)\left(\tau^w w\left(s\frac{\partial l}{\partial \omega} - l\frac{\partial l}{\partial \varrho}\right) - \tau^r R\left(l\frac{\partial s}{\partial \varrho} - s\frac{\partial s}{\partial \omega}\right)\right) = 0, \\
\left.\frac{\partial \mathcal{L}}{\partial \tau^r}\right|_{N=1} &= \left(\tilde{R} + \tilde{R}_{t^r}\left(\tau^r - \tau^w\right)\right)\frac{\partial w}{\partial r}\left(l\left(\beta - \frac{\partial \tilde{u}}{\partial g_i}\right) + \frac{\partial \tilde{u}}{\partial g_i}\left(\tilde{R}\frac{\partial s}{\partial \omega}\tau^r + w\frac{\partial l}{\partial \omega}\tau^w\right)\right) \\
&\quad + \frac{\frac{\partial \tilde{u}}{\partial g_i}}{l}\left(\tilde{R} + \tilde{R}_{t^r}\left(\tau^r - 1\right)\right)\left(\tau^w w\left(s\frac{\partial l}{\partial \omega} - l\frac{\partial l}{\partial \varrho}\right) - \tau^r R\left(l\frac{\partial s}{\partial \varrho} - s\frac{\partial s}{\partial \omega}\right)\right) = 0,
\end{aligned}$$

where β is the marginal utility of income. The derivatives $\partial\tilde{R}/\partial\tau^r$ and $\partial\tilde{R}/\partial\tau^w$ are obtained by using $s = k = -\partial w/\partial r$, where the latter equality is a consequence from the factor-price frontier (3):

$$\frac{\partial \tilde{R}}{\partial \tau^w} = w\left(\frac{\partial s}{\partial \omega} + \frac{\partial l}{\partial \omega}\frac{\partial w}{\partial r}\right)/J \qquad \frac{\partial \tilde{R}}{\partial \tau^r} = R\left[\frac{\partial s}{\partial \varrho} + \frac{\partial l}{\partial \varrho}\frac{\partial w}{\partial r}\right]/J$$

where we assume that $J \gtrless 0$. Take a pair $\{\tau^r, \tau^w\}$ such that $\partial\mathcal{L}/\partial\tau^r|_{N=1} = 0$ and $\partial\mathcal{L}/\partial\tau^w|_{N=1} = 0$. We then know – since $\partial v/\partial\varrho \neq 0$ and $\partial v/\partial\omega \neq 0$ – that

$$\left(\tilde{R} + \tilde{R}_{t^r}\left(\tau^r - \tau^w\right)\right)\frac{\partial w}{\partial r}\left.\frac{\partial\mathcal{L}}{\partial\tau^w}\right|_{N=1} + \left(w + \tilde{R}_{t^w}\left(\tau^w - \tau^r\right)\frac{\partial w}{\partial r}\right)\left.\frac{\partial\mathcal{L}}{\partial\tau^r}\right|_{N=1} = 0$$

and, by the same token,

$$\begin{aligned}\left(\tilde{R}_{t^r}\left(\tau^r - 1\right)w + \tilde{R}\left(w + \tilde{R}_{t^w}\left(\tau^w - 1\right)\frac{\partial w}{\partial r}\right)\right) \times \\ \left(\tau^w w\left(s\frac{\partial l}{\partial\omega} - l\frac{\partial l}{\partial\varrho}\right) - \tau^r R\left(l\frac{\partial s}{\partial\varrho} - s\frac{\partial s}{\partial\omega}\right)\right) = 0\end{aligned} \tag{A.1}$$

which gives the tax structure

$$\frac{\tau^r}{\tau^w} = \frac{w}{\tilde{R}}\frac{\left(s\frac{\partial l}{\partial\omega} - l\frac{\partial l}{\partial\varrho}\right)}{\left(l\frac{\partial s}{\partial\varrho} - s\frac{\partial s}{\partial\omega}\right)} \tag{A.2}$$

since the first line in (A.1) is equal to $l^2\frac{\partial^2 w}{\partial r^2} > 0$. Using the Slutsky equation, it can be seen from the condition for the tax rates (A.2) above that the rates of both taxes $\{\tau^r, \tau^w\}$ are positive under the assumption that the cross-price derivatives of compensated factor supply functions are negative, i.e. when leisure is a Hicksian substitute with first-period consumption. ■

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