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Information sharing and tax competition among governments

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Abstract

The residence-based principle has been proposed as a second-best measure to the full international coordination of capital tax policies. This system requires that tax authorities have full information about the foreign investments of their residents. However, the degree of information transmission among governments can be considered as a strategic variable. We show that under some features of the tax system there will not be any information sharing, while there are institutional arrangements under which governments may transmit partial information for strategic purposes. We also show that full information sharing is not necessarily a Pareto optimum.

Key words: International tax competition; Information sharing

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1. Introduction

The growing integration of international capital markets is rendering the issue of international taxation prominent among policy-makers and academics. On the one hand, the coordination or harmonization of capital tax policies ranks high on the agenda of several international forums, for example the European Community. On the other hand, both international economics and public finance academics are giving increasing attention to the differences in capital taxation among countries and to the possible strategic use of these taxes by governments. In recent years, numerous authors have used a game-theoretic approach to examine this issue.[1]

Previous analyses have shown in particular that the institutional setup for taxation strongly influences the strategic incentives of governments. For example, when countries apply the source-based principle of taxation, competition among tax authorities is much fiercer and, under some conditions, tax rates may be driven to zero. On the other hand, when the residence-based principle is applied, competitive incentives are limited and tax rates are higher and closer to their optimal level. For this reason several authors recommend the residence principle as a second-best measure to the full coordination of tax policies.[2]

However, several problems arise in the implementation of the residence-based principle.[3] In particular, a basic requirement for this system to work is that tax authorities have full information about the foreign investments of their residents. Nevertheless, it is generally difficult or legally impossible for a government to monitor investment abroad by its residents. Therefore, for the assumption of full information to hold, either domestic residents truthfully report their investments abroad or foreign authorities provide the information to the domestic government. Given that tax evasion is so widespread, it is unlikely that information will be provided directly by taxpayers and full information thus requires the participation of foreign authorities.

The complete sharing of information, however, does not seem to come as a natural thing and the degree of information transmission among governments can be considered as a variable used strategically in the same way taxes are. Therefore, when examining the strategic interactions among tax

[1] They include Giovannini (1989), Razin and Sadka (1989, 1990 1991a,b), Mintz and Tulkens (1990), Ghosh (1991), and Gordon (1992). See Giovannini (1990) for a survey.

[2] This is also the system recommended by the OECD Model Double Taxation Convention on Income and Capital, 1977. Another reason in favor of the residence principle is interpersonal equity, as it allows for the progressive taxation of worldwide capital income.

[3] One of the problems is that, in general, the residence-based principle is not a Nash equilibrium. Therefore, governments have a tendency to deviate from this system. See Mintz and Tulkens (1990) or Bacchetta and Caminal (1991) for a proof.

authorities it is not sufficient to look at tax rates, but the level of information transmitted among governments should also be taken into account. For example, governments could offset any positive effect of cooperation on tax rates by not providing any information to other governments.

As a matter of fact, the informational arrangements among tax authorities vary greatly. Some countries, like the United States, tend to provide information easily, while other countries, like offshore centers, are more reluctant to do so.[4] An illustration of this diversity is the wide range in the degree of banking secrecy among countries. This confirms the idea that the level of information shared among tax authorities is at the discretion of governments.

The exchange of information among tax authorities represents a crucial aspect of international taxation and this is well understood by policy-makers.[5] Surprisingly, however, this issue has been neglected from a theoretical standpoint and, to our knowledge, there has been no analysis of the use of information as a strategic policy instrument in this context.[6] In this paper we try to fill this gap in the literature and make a first step towards understanding the incentives for a government to transmit information.

A literature on information sharing in strategic situations has developed mainly in oligopoly models.[7] The results are that firms will either fully share their information or will not share it at all depending on the type of uncertainty (private value or common value), the strategic variable (price or quantity) and the source of uncertainty (demand or costs). In the context of financial intermediation, Pagano and Japelli (1993) study the problem of information sharing in credit markets with informational asymmetries; Caballé (1993) examines the incentives of investors in an imperfectly competitive financial market to exchange information; Ghosh and Masson (1993) look at the problem of information exchange and monetary cooperation.

In the context of capital taxation, it is not clear a priori why a government would have any incentive at all to provide information about foreign

[4] See International Fiscal Association (1990) for a description of informational arrangements among industrial countries.

[5] Agreements of information sharing among tax authorities can be traced back to 1843 in a bilateral tax treaty between France and Belgium (see International Fiscal Association, 1990). More recently, one can mention the existence of a 1977 EC directive on this issue (77/799/CEE).

[6] Nevertheless, several authors mention the importance of information. See, for instance, Tanzi and Bovenberg (1990), Razin and Sadka (1991b), or Gordon (1992).

[7] See for example Novshek and Sonnenschein (1982), Clarke (1983), Fried (1984), Vives (1984, 1988), Gal-Or (1985, 1986), Shapiro (1986), and Kirby (1988). See also Vives (1990) for results in a monopolistic competition framework.

investment as this makes foreign investment in the country less attractive, and therefore lowers the country's capital stock and possibly government revenues. A potential explanation is the existence of reputational mechanisms: when governments play a repeated game, it might be optimal for them to share information and they may behave in a way similar to complete coordination (which implies information transmission). In this paper we show that, under several institutional setups, governments might have incentives to share information even in a static framework where reputational aspects are absent.

To conduct the analysis we use a two-stage game where governments first decide the level of information on foreign investment provided to the other government and then the level of taxation. We take this approach because informational arrangements are usually of a long-term nature, while tax levels can be modified more easily. We consider various institutional setups such as the existence of withholding taxes and incomplete foreign tax credits.

It is shown that the incentives to transmit information depend critically on the features of the tax system. When there is no tax on non-residents (the pure residence-based system), governments are indifferent as to the amount of information they transmit. However, and more interestingly, when the investment by non-residents pays the domestic tax rate, governments may have an incentive to transmit information for strategic reasons; in this case we show that, under some conditions, in equilibrium governments may provide *partial* information on the investment by non-residents.

The intuition for information sharing with non-cooperative behavior is the following. By providing information to the foreign tax authorities, a government allows them to set a higher tax level on capital as the incentive for tax evasion in foreign countries decreases. This increase in capital taxation abroad in turn makes tax evasion from the home country less attractive, which allows the domestic government to set a higher tax level and earn larger revenues. But, on the other hand, information transmission also makes foreign investment less attractive. These two effects work out such that in equilibrium we may get partial information exchange. However, if the second effect dominates, no information is transmitted.

Another interesting result of the analysis is that full information sharing is not necessarily optimal. If there are distortions in the tax system, such as incomplete foreign tax credits, a partial exchange of information is optimal as it partially offsets the distortions.

The rest of the paper is organized as follows. Section 2 describes the basic elements of the model and Section 3 presents the game played by governments in a general setup. In Section 4 we apply the general analysis to the pure residence system where investors only pay taxes to their own government. Section 5 analyzes the case where foreign investment pays the

domestic corporate tax rate, and receives a foreign tax credit. Section 6 determines the optimal level of information sharing. Finally, Section 7 discusses the policy implications and offers concluding remarks.

2. The model

We consider a two-period and two-country model. In each country (home and foreign) there is a continuum of identical consumers and a government that maximizes the representative individual's utility. Foreign country variables are denoted with an asterisk. It is assumed that individuals have perfect foresight and that the government is precommitted to the policies announced at the beginning of the first period (thus we avoid the problem of time inconsistency).

The individual lives for two periods. He receives an endowment of 1 in the first period, invests it and consumes the after-tax gross return from investment in the second period. The individual also enjoys the use of a public good and his utility function is

$$U(c, g) = u(c) + v(g), \tag{1}$$

where c is second-period consumption and g is the public good; $u' > 0$, $v' > 0$, $u'' \leq 0$ and $v'' \leq 0$.

In both countries there exists a constant-returns-to-scale technology with a net return of r, assumed fixed throughout the analysis. The individual can invest at home in quantity D or abroad in quantity F ($D = 1 - F$). The actual return on each type of investment differs for two reasons. First, there is a net cost of investing abroad. We assume that the total net cost of foreign investment is represented by a continuous and convex function $\eta(F)$, with $\eta(0) = 0$.[8] This net cost of investing abroad is not necessarily positive: while foreign investment bears a mobility cost, it may also provide benefits in addition to the net return.[9] The other difference between foreign and domestic returns is the tax treatment. We assume that individuals do not

[8] Bacchetta and Caminal (1992) and Persson and Tabellini (1992) use a similar function in a related setup. We also consider a particular case in Section 5. A justification for a convex $\eta(F)$ could be found in the factors, other than taxes, which determine foreign investment (diminishing returns from risk diversification, for example); in the case of direct investment, a concave production function for investing abroad would be similar to a convex $\eta(F)$. For simplicity, we assume throughout the analysis that $\eta(F)$ is such that the individual's problem has an interior solution with F in $(0, 1)$.

[9] For example, multinationals set up foreign subsidiaries for reasons that are independent of the net return on capital in other countries. Alternatively, investors might benefit from diversification in the presence of uncertainty. For simplicity, we assume that these potential additional benefits from investing abroad are not taxed.

declare their investment abroad,[10] but that they must pay taxes if there is a source tax abroad or if the foreign government provides information to their own government.[11] The actual taxes on foreign investment depend on the features of the tax system and various alternatives are presented below.

The domestic government is assumed to have complete information about domestic investments, so that there cannot be any tax evasion in domestic earnings. On the other hand, it cannot tax investment abroad unless it receives information on it by the foreign government. We denote by λ^* the proportion of investment abroad on which the foreign government gives information[12] ($0 \leq \lambda^* \leq 1$) and we assume that the value of λ^* is known to the taxpayer. The proportion of information transmitted, λ^*, can be interpreted in several ways. For instance, the foreign government gives information only on a subset of investments that constitutes a proportion λ^* of all foreign investments. Alternatively, the foreign government has a random inspection procedure that detects evasion by foreigners with probability λ^*. In any case, the individual has to pay domestic taxes on the return to the quantity $\lambda^* F$ of foreign investment. We denote by Y the proportion of investment monitored by the domestic government, i.e. $Y = D + \lambda^* F$. Governments will be able to infer the actual amount of their citizens' foreign investments from the equilibrium value of λ, but knowledge of the total amount is useless unless the government can assign an individual tax liability.

The government can tax both the investment principal and the interest, but only the monitored portion can be taxed. While specific tax systems are examined below, in general the tax structure is the following:

t_E = tax on the proportion of the residents' investment that can be monitored by the domestic government, i.e. on Y;
t = tax on the return from monitored investment, i.e. on rY;
t_{NR} = tax on the return of domestic investment by non-residents, i.e. on rF^*.

Furthermore, a proportion a of monitored foreign taxes paid by residents (i.e. $a\lambda^* rF$) can be credited against domestic taxes. We assume that the rate of foreign tax credit, a, is exogenous. If $a = 0$ there is double taxation, $a = 1$ corresponds to a full tax credit, and $a = t$ is the case of taxation after deduction. Finally, all taxes are collected in the second period and the

[10] We do not represent explicitly the incentives for tax evasion. Nevertheless, models of tax evasion with a representative individual (see for example Allingham and Sandmo, 1972, or Cowell, 1990) would produce a similar behavior.

[11] Razin and Sadka (1991a) also introduce tax evasion (or capital flight) in a similar model, but they assume that no information is ever transmitted by governments.

[12] This information transmitted is sufficient to identify the taxpayers concerned and assign an individual tax liability; for example, the names and addresses of a proportion λ of domestic taxpayers investing abroad.

foreign country has a similar tax structure. With this notation, consumption in the second period can be written as

$$c = (1 - t_E)Y + (1 - \lambda^*)F + (1 - t)rY + (1 - \lambda^*)rF - (1 - a\lambda^*)t^*_{NR}rF - \eta(F) . \quad (2)$$

The first two elements on the right-hand side represent the after-tax investment principal, and the next three elements represent the after-tax returns on investment.

As public expenditure, g, is decided by the government (see below), utility maximization by the individual amounts to the maximization of consumption in the second period with respect to foreign investment. By setting the derivative of c with respect to F equal to zero we get

$$F = \eta'^{-1}\{t_E(1 - \lambda^*) + r[(1 - \lambda^*)t - (1 - a\lambda^*)t^*_{NR}]\} . \quad (3)$$

From this equation we obtain the capital allocation of assets between the home and the foreign country as a function of the parameters of the model, the tax rates and the level of information exchange. We can see that the level of investment abroad depends negatively on t^*_{NR} and positively (for $\lambda^* < 1$) on t_E and t. The amount of information transmitted by the foreign government modifies the effect of tax rates and negatively affects foreign investment.

The government determines the quantity of the public good such that it maximizes household utility; it finances it with various tax revenues and does not issue any debt. We assume that there is no cost in collecting and transmitting information. We also assume that governments keep the tax income raised at source from foreign investment. Total revenues depend on the way taxes are collected and on the level of foreign tax credit. In general, the government budget constraint can be written as

$$g = (t_E + tr)Y + t_{NR}rF^* - a\lambda^*t^*_{NR}rF . \quad (4)$$

3. A two-stage game

Governments make decisions in two stages. First they decide simultaneously and independently the information to be provided to the foreign government: (λ, λ^*). At the beginning of the second stage both countries observe the respective λ's. We assume that it is not feasible to change the decision about λ at this time. Thus, given the information transmission levels decided in the first stage, countries decide their respective tax rates simultaneously and independently.

For convenience, we only consider situations where the government chooses the tax rate level, t. The tax rate on non-residents, t_{NR}, may be

either exogenous or equal to t depending on the given institutional setting; t_E is fixed exogenously. Therefore, in the second stage, the domestic government's objective is

$$\max_t w(\lambda, \lambda^*, t, t^*),$$

where w is the indirect utility function derived by substituting c and g, and where t and t^* are the domestic and foreign tax rates, respectively.

The reason why we model the situation as a two-stage game is that the decisions about λ require us to set up specific mechanisms for information transmission that are long-run in nature, so that they are taken as fixed in the second stage. For instance, countries may implement a low λ through the tightening of bank secrecy and blocking laws; if a change in λ requires a legislative modification, then it would seem reasonable to model it as a long-run decision. Tax rates on the contrary may be changed more easily in the short run. We are interested in the subgame perfect equilibria of this game, so we will solve it by backwards induction.

3.1. *Second stage*

To derive the solution, the strategy is to maximize w with respect to the tax rate t, for given (λ,λ^*). Thus

$$u'(c)\frac{dc}{dt} = -v'(g)\frac{dg}{dt}. \tag{5}$$

From this condition we derive $t = t(t^*; \lambda, \lambda^*)$, the fiscal reaction function of the domestic country. Similarly, maximizing $w^*(\lambda, \lambda^*, t, t^*)$ with respect to t^* we get the fiscal reaction function of the foreign country, $t^* = t^*(t; \lambda, \lambda^*)$. Solving the system

$$t = t(t^*; \lambda, \lambda^*); \qquad t^* = t^*(t; \lambda, \lambda^*),$$

we obtain the Nash equilibrium tax rates $t(\lambda, \lambda^*)$ and $t^*(\lambda, \lambda^*)$. For simplicity we assume throughout the analysis the existence of a unique pure-strategy Nash equilibrium, with taxes in the interior of (0,1).

3.2. *First stage*

In the first stage of the game the government decides the information transmission level λ taking into account, first, the *direct* effect of λ on the objective function w and, second, the *strategic* effect through the Nash equilibrium tax levels decided in the second stage. In the first stage the objective function is

$$w[\lambda, \lambda^*, t(\lambda, \lambda^*), t^*(\lambda, \lambda^*)]$$

where $t(\lambda, \lambda^*)$ and $t^*(\lambda, \lambda^*)$ are the second-stage Nash equilibrium tax levels. The domestic government maximizes this function with respect to λ. The incentives for information sharing are given by the derivative

$$\frac{dw}{d\lambda} = \frac{\partial w}{\partial \lambda} + \frac{\partial w}{\partial t}\frac{dt}{d\lambda} + \frac{\partial w}{\partial t^*}\frac{dt^*}{d\lambda}. \tag{6}$$

The first term on the right-hand side of (6), $\partial w/\partial \lambda$, is the *direct* effect of information transmission on the objective function of the government. In this model the direct effect of λ is always non-positive, that is, there is no direct gain from giving information to the foreign country whatever the tax system.

The second element on the right-hand side of (6) is equal to zero: from the second-stage optimization we have that $\partial w/\partial t = 0$, i.e. by the envelope theorem the effect on w of a change in t in the second stage is second order.

The last term, $\partial w/\partial t^* \cdot dt^*/d\lambda$ is the *strategic* effect. The level of information transmitted changes the equilibrium foreign tax rate and, since governments are involved in tax competition, it affects the domestic government objective function. If the strategic effect were negative, i.e. $\partial w/\partial t^* \cdot dt^*/d\lambda < 0$, there would be no interior solution for λ and there would never be any information exchange between governments ($\lambda = 0$). In that case the strategic effect would reinforce the direct effect. However, we will find that in some cases the strategic effect is positive, i.e. $\partial w/\partial t^* \cdot dt^*/d\lambda$, and that in equilibrium we have a positive value for λ and λ^*.

As in this model consumption will not depend directly on the level of λ (i.e. $\partial c/\partial \lambda = 0$), from Eq. (6) the first-order condition with respect to λ for an interior solution can be written as

$$\frac{dw}{d\lambda} = v'\frac{\partial g}{\partial \lambda} + u'\frac{\partial c}{\partial t^*}\frac{dt^*}{d\lambda} + v'\frac{\partial g}{\partial t^*}\frac{dt^*}{d\lambda} = 0. \tag{7}$$

Eq. (7) shows the three effects from the transmission of information: a *direct revenue* effect, a *strategic consumption* effect and a *strategic revenue* effect.

By modeling the situation as a two-stage game, we emphasize the influence of the information transmission on the tax levels. If we solve the simultaneous game, where λ and t are decided simultaneously, it can be seen that there is never any exchange of information when governments behave non-cooperatively, as the strategic effect is absent.

For the analysis to be of any relevance, it is necessary to specify the tax system. In Sections 4 and 5 we examine two relevant institutional cases related to the residence-based principle (under the source-based principle, there is no need for information sharing). The distinction between the two cases is usually not relevant when there is perfect information sharing, but is crucial when the latter is imperfect.

4. The pure residence-based system

We first examine the case where residents pay a uniform tax t on their monitored income directly to their government, but do not pay any taxes to the foreign government, i.e. $t_{NR} = 0$. This system is the case most often examined in theoretical analyses and represents a useful benchmark. It should be noticed that the complete residence-based system typically examined in the literature (i.e. with no tax evasion) obtains in this model only with full information sharing between governments, i.e. with $\lambda = 1$. When $\lambda = 0$, we have the case of capital flight as examined in Razin and Sadka (1991a).

In such a system, consumption, foreign investment, and government revenues are

$$\begin{aligned} c &= (1 - t_E)Y + (1 - \lambda^*)F + (1 - t)rY + r(1 - \lambda^*)F - \eta(F), \\ F &= \eta'^{-1}\{(1 - \lambda^*)t_E + r(1 - \lambda^*)t\}, \\ g &= (t_E + tr)Y. \end{aligned} \tag{8}$$

In this case, neither c nor g depend on the level of information provided by the domestic government, λ, nor on the level of foreign taxes, t^*. Thus, the objective function, $w = U(c, g)$, does not depend on λ or on t^*. Examining the first-order condition (7), we see that $dw/d\lambda = 0$ always, as both the direct and the strategic effects are equal to zero. Hence, the level of information is indeterminate. This indeterminacy means in particular that the Pareto-optimal level of information could easily be implemented. (It is shown in Section 6 that this optimum is 1.) While the result of indeterminacy is of considerable interest, it might not be robust to generalizations of the model. For example, in this institutional setting there is no incentive to attract foreign capital. If there were such an incentive, governments would not share information.

5. An initial source tax

In the second case we consider, residents still pay a uniform tax on their monitored income directly to their government, but foreign investment is also taxed initially by the foreign government at the uniform foreign tax rate t^*. Thus, $t_{NR} = t$. This system is typically applied to multinationals when they pay the foreign corporate tax rate on profits from their foreign subsidiaries but usually only receive a partial tax credit. We show that in this case governments may exchange information voluntarily even when they behave non-cooperatively. When no information is provided, however, this

version of the residence-based system turns out to be equivalent to the source-based system.

In this case, private consumption, capital outflows and government consumption are given by (2), (3) and (4) by setting $t_{NR} = t$ and $t^*_{NR} = t^*$. Now there is both a direct and a strategic effect. First, there is a negative direct effect as g depends negatively on λ (through F^*). Second, there is a strategic effect as both c and g depend on t^*.

To evaluate the strategic effect, one should first notice that when the domestic government provides information to the foreign government, tax evasion in the other country is reduced and the foreign tax rate may be increased (i.e. $dt^*/d\lambda > 0$). The strategic *consumption* effect is negative: higher taxes abroad mean a higher tax burden. The *strategic government* revenue effect is ambiguous in general. On the one hand, an increase in foreign taxes increases g as investment abroad decreases and foreign investment in the home country increases (due to an increase in tax evasion from abroad). On the other hand, an increase in t^* means bigger tax credits, which has a negative effect on g. Nevertheless, if foreign investment is somewhat elastic to after-tax returns, the first effect will dominate and the strategic revenue effect will be positive. This effect may be large and offset the negative direct revenue effect and strategic consumption effect. In this case, we would have $\lambda > 0$.

To determine whether the transmission of information can actually be an optimal strategy for governments behaving non-cooperatively, it is necessary to solve the full problem with specific utility and cost functions. We consider the simplest possible case. First, we use the following linear utility function:

$$U(c, g) = c + kg\,, \tag{9}$$

where k is a positive parameter. As for the cost of investing abroad, we use the same function as in Persson and Tabellini (1990):

$$\eta(F) = \frac{1}{2\mu}F^2 - \gamma F\,, \tag{10}$$

with $\mu > 0$, $\gamma \geq 0$ and $\gamma < (1/2)\mu$; μ is a measure of capital mobility (a large value for μ implies a high degree of capital mobility) and γ represents the benefit from investing abroad in addition to the net return. In this case, the optimal consumption and foreign investment are

$$c = 1 - t_E + (1 - t)r + \frac{F^2}{2\mu}\,,$$

$$F = \mu\{(1 - \lambda^*)t_E + r[t - t^* - \lambda^*(t - at^*)] + \gamma\}\,. \tag{11}$$

Note that with this specification although the government's objective function is linear in c and g, it is concave with respect to F. Moreover, the

indirect utility function, w, is concave on t as long as $k \geq 1/2$; we assume that this condition holds. Solving the game by backwards induction, a first-order condition for the government in the second stage of the game is $dw/dt = 0$ for given λ and λ^* [Eq. (A1) in Appendix A], from which the fiscal reaction function for the domestic government can be derived:

$$t = \frac{\alpha}{\beta} t^* + \frac{z}{\beta r}, \tag{12}$$

where α, β, and z are functions of λ and λ^*, defined in Appendix A. A similar function obtains for the foreign country. Hence, the tax reaction functions are linear and positively sloped. Appendix A shows that the strategic effect has a positive sign when $k > 1$ and γ is not too large,[13] so that it will be able to compensate the direct revenue effect. In fact, it is quite possible that the strategic effect dominates the direct effect, as the following example illustrates.

An illustration

To demonstrate the possibility of information sharing in a non-cooperative game, we present a small numerical example. Assume the following set of parameters:

$$k = 1.3\ ; \qquad \gamma = 0.05; \qquad \mu = 4;$$

$$r = 0.15; \qquad a = 0.5; \qquad t_E = 0.1\ .$$

In this case, we find that $[dw(\lambda, \lambda^*, \tilde{t}, \tilde{t}^*)/d\lambda]_{\lambda=\lambda^*=0} > 0$ (this derivative equals 0.0078), i.e. that λ must be greater than zero in equilibrium. Computing the full solution we find the following set of values:[14]

$$\lambda = \lambda^* = 0.200; \qquad c = c^* = 1.022; \qquad F = F^* = 0.497;$$

$$t = t^* = 0.390; \qquad g = g^* = 0.122.$$

In this example, governments would provide information on a fifth of total foreign investment. The degree of information provided will of course change with the parameters. For example, with the same set of parameters but with $k = 2$, we have $\lambda = 0.50$. When $k = 1.15$, $\lambda = 0$.

Finally, it is interesting to compare the non-cooperative solution with the cases of zero and full information sharing. When $\lambda = \lambda^* = 0$, $t = t^* = 0.244$, $c = 1.058$, $g = 0.077$, and $F = 0.60$. When $\lambda = \lambda^* = 1$, $t = t^* = 0.718$, $c =$

[13] Notice that $k > 1$ is only a sufficient condition. The impact of other parameters on the optimal λ is ambiguous.

[14] To compute the full solution, it is necessary to solve a system of four simultaneous non-linear equations. We did it with GAUSS 2.1.

0.942, $g = 0.208$, and $F = 0$. The higher is the level of information shared, the higher are government revenues and the lower are private consumption and foreign investment. It will be shown in Section 6 that the higher level of utility is not necessarily reached with full information sharing.

An alternative tax system, typically applied to non-equity portfolio investment, is one where residents pay a predetermined withholding tax on their foreign investment to the foreign government (instead of t^*). It can be shown that in this case a strategic effect also exists but is weaker as it works only through F^*: when λ increases, t^* increases and F^* increases. There is no strategic effect through investment abroad by residents, F, as the foreign tax rate on F is not influenced by λ. Thus, when there is a predetermined withholding tax on foreign investment, governments have fewer incentives to provide information than in the case of an initial source tax.

6. Welfare analysis

An important issue is the optimal degree of information sharing, i.e. how much information governments would exchange if they can cooperate. Although the intuition might suggest that full information sharing is optimal, we show below that this is not necessarily true and that the optimal level of information exchange depends on the institutional features of the tax system.

Consider the case where governments cooperate in information but not in taxes. The second stage of the game corresponds to the non-cooperative case and the first-order condition is described by Eq. (5). On the other hand, the first stage of the game differs from the non-cooperative case described by Eq. (7). Assuming that countries maximize the simple sum of utilities in each country, $w + w^*$, we have [when (5) holds for both countries]:[15]

$$\frac{dw}{d\lambda} + \frac{dw^*}{d\lambda} = \frac{\partial w}{\partial \lambda} + \frac{\partial w^*}{\partial \lambda} + \frac{\partial w}{\partial t^*} \cdot \frac{dt^*}{d\lambda} + \frac{\partial w^*}{\partial t} \cdot \frac{dt}{d\lambda} = 0 . \tag{13}$$

Given that $\partial c / \partial \lambda = 0$, (13) can be written as (in a symmetric equilibrium)

$$v'(g) \cdot \left(\frac{\partial g}{\partial \lambda} + \frac{\partial g^*}{\partial \lambda} + \frac{\partial g^*}{\partial t} \cdot \left(\frac{dt^*}{d\lambda} + \frac{dt}{d\lambda} \right) \right) + u'(c) \cdot \left(\frac{\partial c^*}{\partial \lambda} + \frac{\partial c^*}{\partial t} \cdot \left(\frac{dt^*}{d\lambda} + \frac{dt}{d\lambda} \right) \right) = 0 . \tag{14}$$

[15] This formulation selects the symmetric Pareto efficient point. Another possibility is to use the Nash bargaining solution, that in this context would maximize the product of the differences between the payoffs from the cooperative and the non-cooperative outcome.

The optimal λ is given by (14) and (5). To determine it, the international tax system must be specified. We consider in turn the two cases presented in Sections 4 and 5. In the first case, the pure residence-based system, it can be easily seen that $\partial g/\partial\lambda = 0$, $\partial g^*/\partial t = 0$, and $\partial c^*/\partial t = 0$. Thus for (5) and (14) to hold, we just need the following to hold:

$$\frac{\partial g^*}{\partial \lambda} \cdot \frac{\mathrm{d}c}{\mathrm{d}t} = \frac{\partial c^*}{\partial \lambda} \cdot \frac{\mathrm{d}g}{\mathrm{d}t}. \tag{15}$$

By computing the various derivatives in (15) [from (10)], it can be seen that this equation holds if and only if $\eta'(F^*) = 0$. From the individual's first-order condition, this is only the case when $\lambda = 1$. Hence, (5) and (14) hold if and only if $\lambda = 1$, i.e. in the pure residence-based system the full sharing of information is optimal.

In the second case, with an initial source tax, Eq. (15) cannot be used as $\partial g^*/\partial t \neq 0$, $\partial c^*/\partial t \neq 0$, and $\partial g/\partial\lambda \neq 0$. Furthermore, by computing the various derivatives in (5) and (14) [from (4)], it can be seen that both equations do not hold in general when $\lambda = 1$. This implies that full information sharing is not in general an interior solution. Nevertheless, we can still have $\lambda = 1$ as a corner solution [in this case we would have $(\mathrm{d}w/\mathrm{d}\lambda + \mathrm{d}w^*/\mathrm{d}\lambda)_{\lambda=\lambda^*=1} > 0$], i.e. the full exchange of information might be optimal.

In some cases, however, the optimal λ is less than one. In Appendix B we show that we can have $(\mathrm{d}w/\mathrm{d}\lambda + \mathrm{d}w^*/\mathrm{d}\lambda)_{\lambda=\lambda^*=1} < 0$, which means that $\lambda = 1$ is not a corner solution and that the optimal λ is less than 1. This means that if governments cooperate to determine the optimal level of information sharing, they will decide to provide less than full information to each other. What is the intuition behind this result? Imperfect tax credits cause distortions in consumers and governments decisions. In some cases the incomplete supply of information to other governments can reduce the distortions.

In the numerical example presented above, the solution to the co-operative game is $\lambda = 0.773$ (the non-cooperative equilibrium value of λ was 0.200). Moreover, when a is smaller the optimal λ is also smaller. When tax credits are incomplete, investment abroad is discouraged as it is (partially) taxed twice. By exchanging information only partially among themselves, governments reduce the distortion provoked by imperfect tax credits.

We have shown that if governments cooperate in information only, the full exchange of information is not necessarily optimal. This result can also be shown to hold when governments cooperate both in taxes and in-formation. It should be clear, however, that if governments did cooperate in all aspects of the tax system, this would be a first-best world (in this model) and full information sharing would be optimal.

Finally, it is interesting to notice that non-cooperative tax rates are in

general too low compared with their optimal level (i.e. when there is cooperation on the level of information sharing). This implies that, as in most of the literature on tax competition,[16] the public good is usually underprovided. This result can be easily seen in the pure residence system. With cooperation, we have $dg/dt = -dc/dt$, which implies that $u'(c) = v'(g)$. In the non-cooperative case, it can be verified that $dg/dt \leq -dc/dt$; hence, $u'(c) \leq v'(g)$.

With the initial source tax regime, $dg/dt < -dc/dt$ when $a < 1$. It can be shown that dg/dt increases when λ increases, i.e. the ratio $v'(g)/u'(c)$ decreases with λ. This means that the degree of underprovision of the public good decreases when λ increases. In all the cases we considered, cooperation implies an increase in λ and hence non-cooperative tax rates are too low.

7. Concluding comments

This paper has examined the incentives for governments to share information about foreign investment with other governments. While the analysis should be considered only as a first step in the understanding of this issue, it shows that the informational behavior of governments is crucial and should be taken into account when designing the optimal international tax system. An important insight of the paper is that the incentives to transmit information depend on the precise institutional setup of the international tax system. For example, the problem of information appears less acute for foreign direct investment, which usually pays the domestic corporate tax rate.

The model used in this paper is highly stylized and rests on some strongly simplifying assumptions. A critical assumption is that the tax system is given at the outset and is not chosen optimally by governments. Alternatively, we could have allowed tax authorities to choose tax credits (a) and taxes on non-residents (t_{NR}) in the first stage of the game (see Janeba, 1992, for an analysis along these lines in a full information setting). It can be easily seen that this would not qualitatively alter our analysis in the sense that both the direct and the strategic effects would still be present.

An important assumption in the analysis is that countries are symmetric. An extension of considerable interest is to examine asymmetric countries. A conjecture (confirmed by numerical simulations) is that a large country will have a bigger incentive to share information, as the strategic effect will be larger and the direct effect smaller, than a small country. This is the case because for the big country the tax base of residents is large compared with

[16] See, for example, Wilson (1986), Zodrow and Mieszkowski (1986) or Wildasin (1988).

foreign investment. Hence, the gains from increasing taxes at home (the strategic effect) will more easily offset the loss of revenues from foreign investment (the direct effect). By the same token, small countries will have little incentive to share information as the direct effect dominates. This explains why the countries less willing to share information are usually small (the offshore centers, Luxemburg, Switzerland, etc.). Another interesting distinction to be made is between capital-importing and capital-exporting countries. It is clear that for capital-importing countries the direct effect is larger and the incentive to transmit information smaller.

The model presented in this paper should obviously be developed further in several directions. In particular, the behavior of tax payers (and tax evaders) could be specified in more detail, some of the institutional features of the model could be endogenously determined, and the production sector ought to be introduced in a more realistic manner. The existence of a strategic motive in the transmission of information, however, should be robust to these modifications of the model.

Appendix A

This appendix presents auxiliary results used in Section 5. Only the main steps are presented, but the detailed derivations are available from the authors. The first-order condition for the government in the second stage of the game is

$$[-r + r(1-\lambda^*)F] + k[r + \mu r\{(1-\lambda)t_E + r(t^* - 2t - \lambda(t^* - 2at)) + \gamma\} + \mu r(1-\lambda^*)\{r(t^* - 2t + 2\lambda^*(t - 2at^*)) - \gamma - 2(1-\lambda)t_E\}] = 0 . \quad \text{(A1)}$$

The parameters used in Eq. (12) are defined as

$$\alpha \equiv (1-\lambda^*)[k(1-2a\lambda^*) - (1-a\lambda^*)] + k(1-\lambda),$$

$$\beta \equiv 2k(1-a\lambda) - (1-\lambda^*)^2(1-2k),$$

$$z \equiv \gamma k + \frac{k-1}{\mu} + t_E[(1-\lambda^*)^2(1-2k) + k(1-\lambda)] + \gamma(1-\lambda^*)(1-k).$$

Solving the system (12) and the corresponding foreign reaction function (with parameters α^*, β^*, and z^*), we obtain the Nash equilibrium tax levels for the second stage:

$$\tilde{t} = \frac{\alpha z^* + \beta^* z}{r(\beta\beta^* - \alpha\alpha^*)} , \quad \text{(A2)}$$

$$\tilde{t}^* = \frac{\alpha^* z + \beta z^*}{r(\beta\beta^* - \alpha\alpha^*)} .$$

Returning to the first stage, we substitute the Nash equilibrium levels into the objective function: $w(\lambda, \lambda^*, \tilde{t}, \tilde{t}^*)$. For the information transmission to have a positive value in equilibrium, it is then sufficient to show that under some conditions $[\mathrm{d}w(\lambda, \lambda^*, \tilde{t}, \tilde{t}^*)/\mathrm{d}\lambda]_{\lambda=\lambda^*=0} > 0$, so that we are not at a corner solution with $\lambda = \lambda^* = 0$.

The expression for $[\mathrm{d}w(\lambda, \lambda^*, \tilde{t}, \tilde{t}^*)/\mathrm{d}\lambda]_{\lambda=\lambda^*=0}$ is the addition of the direct effect and the strategic effect:

$$\left(\frac{\mathrm{d}w(\lambda, \lambda^*, \tilde{t}, \tilde{t}^*)}{\mathrm{d}\lambda}\right)_{\lambda=\lambda^*=0} = A + B\left(\frac{\mathrm{d}t^*}{\mathrm{d}\lambda}\right)_{\lambda=\lambda^*=0},$$

where

$$A = -kt\mu r[t_E + r(t^* - at)],$$

$$B = \mu r[(2k-1)rt - (1-k)t_E + rt^* - \gamma].$$

The direct effect, A, is always negative. Then, for information sharing to have a positive value in equilibrium we need the strategic effect, $B(\mathrm{d}t^*/\mathrm{d}\lambda)_{\lambda=\lambda^*=0}$, to be positive. The first term of this effect, B, is positive if $k > 1$ and γ is not very high. Note that in this case the tax on wealth, t_E, reinforces the strategic effect. The second term, $(\mathrm{d}t^*/\mathrm{d}\lambda)_{\lambda=\lambda^*=0}$, can be written as

$$\left(\frac{\mathrm{d}t^*}{\mathrm{d}\lambda}\right)_{\lambda=\lambda^*=0} = \frac{1}{8rk^2(3k-1)}\left[\frac{q_1}{\mu} + q_2 t_E + q_3\gamma\right], \tag{A3}$$

where

$$q_1 = (k-1)[10k^2 - 4ak^2 - 6k + 4ak + 1 - a],$$

$$q_2 = 18k^3 - 6k^2 - 3k + 4ak^3 - 8ak^2 + 5ak + 1 - a,$$

$$q_3 = 8k^3 - 4ak^2 - 4k + 4ak + 1 - a.$$

q_1, q_2, and q_3 are positive if $k > 1$. Thus, $\mathrm{d}t^*/\mathrm{d}\lambda > 0$ when $k > 1$.

Since a large k implies a stronger preference for the public good, the positive government revenue effect matters more than the negative consumption effect. On the other hand, a large γ would imply a strong negative consumption effect, as a significant share of foreign investment would be insensitive to tax rates. The impact of other structural parameters is difficult to evaluate in general. For example, an increase in capital mobility (an increase in μ) means stronger direct and strategic effects as capital is more responsive to tax and information changes. The overall impact on the optimal information level, however, is ambiguous.

Appendix B

This appendix shows that $\lambda = 1$ may not be the cooperative solution as described in Section 6. For this purpose, it is enough to show that $(dw/d\lambda + dw^*/d\lambda)_{\lambda=\lambda^*=1} < 0$ for some set of parameters.

Assume that a and $\eta(F)$ are such that $t(\partial F/\partial t^*) = -(1-a)F$ [this is consistent with the assumptions made about $\eta(F)$]. Then, by evaluating (4) at $\lambda = \lambda^* = 1$, we find that $\partial g/\partial t = -\partial c/\partial t$ and therefore $u'(c) = v'(g)$. From (16), to have $(dw/d\lambda + dw^*/d\lambda)_{\lambda=\lambda^*=1} < 0$, we need

$$\frac{\partial g}{\partial \lambda} + \frac{\partial g^*}{\partial \lambda} + \frac{\partial c^*}{\partial \lambda} + \left(\frac{\partial g^*}{\partial t} + \frac{\partial c^*}{\partial t}\right) \cdot \left(\frac{dt^*}{d\lambda} + \frac{dt}{d\lambda}\right) < 0 \quad \text{for } \lambda = \lambda^* = 1.$$

It can be easily seen that the sum of the first three components is negative:

$$\frac{\partial g}{\partial \lambda} + \frac{\partial g^*}{\partial \lambda} + \frac{\partial c^*}{\partial \lambda} = (t_E + tr)\eta'\eta'^{-1} < 0.$$

The negative sign obtains as the individual's first-order condition implies that $\eta'(F) < 0$. Finally, by assuming that a is such that $a^2 + a - 1 = 0$ and that a and $\eta(F)$ satisfy the conditions specified above, we have that $(\partial g^*/\partial t + \partial c^*/\partial t)_{\lambda=\lambda^*=1} = 0$. Hence, $(dw/d\lambda + dw^*/d\lambda)_{\lambda=\lambda^*=1} < 0$.

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