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Federalism versus Centralism: Too High or Too Low Capital Taxes?

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Abstract

We analyse taxation of capital in a two-country model, where one country is unitary while the other one is federal, and it is divided into two identical regions. Both national and regional governments levy a tax on capital. The two countries play a game à la Nash between them, with the government of the federal country acting as a Stackelberg leader with respect to its regional governments. We show under which circumnstances capital tax rates of the federal and the unitary country are inefficiently too high or too low, at equilibrium. We also provide conditions under which, the federal country chooses a too low capital tax rate while the unitary country sets instead a too high capital tax rate, at equilibrium.

Keywords: Tax competition, Mobility of factors of production, Fiscal federalism.

JEL Classification: H23, H77, H87.

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1 Introduction

Much of the theory of fiscal federalism concentrates the attention on two kind of tax externalities: horizontal and vertical externalities. Horizontal externality arises when governments at the same level tax a base, like capital investments, which is mobile across their borders. In this case, capital tax rates are chosen strategically by governments in order to attract more capital investments inside their country. Since each government does not take into account the harm it does others, capital tax rates tend to be set at too low levels. On the contrary, vertical exernality arises when different levels of government tax the same base. Since each level of government neglects the adverse effect it has on the other by raising its tax rate, and thus causing the common tax base to shrinks, tax rates may be too high at the non cooperative equilibrium. Accordingly, horizontal and vertical externalities distort levels of taxation in opposite directions, and one interesting question to raise is whether capital tax rates tend to be too high or too low, at equilibrium, when both externalities are considered simultaneously.

The present approach tries to answer to the previous question taking into account not only the strategic behaviour of national governments, but also the features of their institutional structure. In particular, we are interested in analysing whether too high or too low equilibrium capital tax rates may depend on the fact that, when considering a federation of countries, some of them have a unitary structure while others are themselves of a federal type, i.e. they are composed by regions whose governments can choose independent fiscal policies. The European Union, for instance, can be seen as a federation of countries where some of them have predominately a unitary architecture like France, while others are instead federal ones, like Germany, Belgium, and now Italy too.

To this aim, we propose a model describing a federation where one country is unitary while the other one has a federal structure since it is divided into two identical regions. Both state and regional governments tax capital according to the source-based principle. The two countries play a game à la Nash between them, with the government of the federal country acting as a Stackelberg leader with respect to its regional governments, which in turn play a game à la Nash between them. Thus, two sources of horizontal externalities arise: firstly, between regions inside the federal country and secondly, between countries, at a national level. Further, a vertical externality arises between regional and national governments inside the federal country. Our main result shows that the standard finding in the horizontal

competition literature, according to which two unitary countries competing on acquiring mobile capital tax base tend to choose too low capital tax rates, may change when one of the two countries has a federal structure. In this set-up, we show that the federal country may still set an inefficiently too low tax rate, while the unitary country may instead choose an inefficiently too high tax rate, at equilibrium. Accordingly, in this case, vertical externality dominates horizontal externality, but somewhat surprisingly for the unitary country.

Firstly, horizontal and vertical externalities have been studied by two separate strands of literature.[1] However, some recent contributions have concentrated the attention on both externalities simultaneously, given that both effects are important in federal frameworks, and their interaction may be crucial to understand whether capital tax rates tend to be too high or too low, at equilibrium. To analyse this point, Keen and Kotsogiannis (2002) propose a model with a federal country composed by identical states, and since horizontal and vertical externalities point in opposite directions, they study under which circumnstances one dominates the other. On the one hand, they show that state taxes are too high or too low, at equilibrium, depending on the relative elasticity of the supply of savings and the demand for capital, and on the extent to which the states tax rents. On the other hand, federal tax rates, obtain as too high or too low, at equilibrium, depending on whether the horizontal or vertical externality dominates in the setting of state taxes, and on whether federal and state taxes are strategic substitutes or complements.[2] The interplay between horizontal and vertical externalities is at the heart also of a paper by Janeba and Wilson (2002). They show that decentralization, and so more vertical tax competition, may have a counterdistortionary role to offset the inefficiencies due to horizontal tax competition, in terms of public goods underprovision. Such counterdis-

[1] Horizontal competition has been more extensively studied. Seminal contributions are those by Gordon (1983), Wilson (1986), Zodrow and Mieszokowski (1986), Wildasin (1989), and Persson and Tabellini (1992) who use a political economy approach. Clear and comprehensive surveys are Wilson (1999) and Wellisch (2000, Ch. 4). Vertical competition has been more recently examined. Among those papers adopting benevolent governments see, for instance, Johnson (1988), Dahlby (1996), Boadway, Marchand and Vigneault (1998), Wrede (2000) and Dahlby and Wilson (2003). Cassing and Hillman (1982) and Flowers (1988) use instead a Leviathan approach. Sato (2003) examines a set-up where fiscal decisions made by governments are conditioned by rent-seeking groups. Keen (1998) reviews the literature on vertical fiscal externalities, analysing both the cases when governments act as benevolent dictators or malevolent Leviathans.

[2] The same kind of question is analysed also by Keen and Kotsogiannis (2003), but in a model where governments behave as revenue-maximising Leviathans.

tortionary role is analysed also by Flochel and Madies (2002) in a Leviathan setting. They show that when tax competition is more intense, public subsidies are more efficiently provided at a federal level rather than at a local level. As in the previous paper, Wrede (1996) also analyses both horizontal and vertical externalities in a Leviathan model, but does so under the assumption that the elasticity of the tax base is infinite.[3]

This paper extends this literature as follows. The interaction between horizontal and vertical externalities is analysed in a set-up where both the strategic behaviour of regional and national governments and the institutional architecture of countries is taken into account. The literature cited above typically examines both externalities in the framework of a single federal country divided into regions. Our model adds to such a framework a second country which has a unitary structure in order to study not only the interplay between horizontal and vertical externalities within a federal country, but also the effects of such an interplay on the strategic interaction between countries with a different insitutional structure. It seems to us that such an issue may become even more interesting, for instance, with respect to the expected enlargment of the European Union, which will lead to the coexistence of many countries differing in their institutional structure within the same federal set-up.

The plan of the paper is as follows. Section 2 describes the model, and section 3 analyses the solution of the game between regions inside the federal country and between countries. Section 4 discusses the question of whether capital national tax rates are too high or too low, at equilibrium. Section 5 contains some concluding remarks.

2 The model

We study a two-period and two-country model. Specifically, consider a world economy composed of two countries, Home and Abroad, labeled by H and A respectively. Country A has a unitary system while country H has a federal structure, i.e. it is divided into two identical regions, r and s. Both state

[3] On the empirical side, Goodspeed (2000) estimates the impact of horizontal and vertical externalities on changes in income taxes by local governments belonging to a federation. By using a sample of 13 OECD countries for the period 1975-1984, he shows that higher national income tax rates and lower poverty rates lead to lower local income tax rate. On the contrary, Besley and Rosen (1998) find a positive reaction of states to a change in U.S. federal gas and cigarette taxes.

and regional governments have the power to levy a per unit tax on capital, which is taxed according to the source based principle. Capital is assumed perfectly mobile while agents are immobile.[4] In order to stress the role of the institutional features of the two countries in defining their strategic fiscal behaviour, we figure out that national and regional governments use tax revenue to finance lump-sum transfers to their citizens. Thus, we do not consider the inefficiency in local public goods provision. On the contrary, we concentrate our attention on a standard excess-burden exercise, concerning the level of inefficiency due to tax policies, and affecting not only the allocation of time between first and second period consumption, but also capital flows between countries.

Events in the model unfold as follows. Firstly, both countries choose their capital tax rate playing à la Nash between them, and with the federal country acting as a Stackelberg leader with respect to its regions. Secondly, both regions in the federal country choose their capital tax rate playing à la Nash between them, and acting as Stackelberg followers with respect to their national government.[5] Finally, agents in both countries make their consumption and investment decisions.

To simplify the analysis, we suppose that there is a single consumer in each region of country H, so that in each country there are only two consumers. In particular, the two countries are inhabited by individuals with the same preferences and initial endowment. More precisely, each agent i, $i = r, s, A$, owns $\overline{k}$ units of capital. His preferences are described by the following utility function:

$$U_i = U(C_i^1) + C_i^2, \qquad i = r, s, A \tag{1}$$

where $U(\cdot)$ is a well-behaved utility function, and C_i^1 and C_i^2 denote consumption in the first and second period, respectively. In the first period, each agent decides how much to invest and where to invest. His budget constraint is given by

[4] Some recent contributions analyse tax competition problems and fiscal federalism issues by considering both capital and labour mobility, and also other specific aspects of economic integration, such as migration (see, for instance, Wellisch (2000), Ch. 4 and 5, Kessler, Lülfesmann and Myers (2002), Bretschger and Hettich (2002)).

[5] See also Goodspeed (2002) and Keen and Kotsogiannis (2002) for papers where the national government acts as a Stackelberg leader, while local governments act as followers with respect to the central government, but play a Nash game between them. Keen and Kotsogiannis (2002) consider also the case when each local government plays Nash relative to all other governments, local and central.

$$\overline{k} = C_i^1 + k_i^r + k_i^s + k_i^A, \qquad i = r, s, A \tag{2}$$

where k_i^r, k_i^s, k_i^A denote capital invested by agent i in region r, s and country A, respectively. Accordingly, individual savings are given by $S_i \equiv \overline{k} - C_i^1 = k_i^r + k_i^s + k_i^A$, $i = r, s, A$. In the second period, each agent receives principal and interest on his savings, plus a lump sum transfer from both the regional and the national government in the case of an agent living in H, only from the national government in the case of an agent living in A. Thus, the second period budget constraint for an agent i living in country H is given by

$$\begin{aligned} C_i^2 = [1 + (r^r - t^r - T^H)]k_i^r + [1 + (r^s - t^s - T^H)]k_i^s \\ +[1 + (r^A - T^A)]k_i^A + g^i + G^H, \\ i = r, s \end{aligned} \tag{3}$$

while the second period budget constraint for an agent i living in country A is given by

$$C_A^2 = [1+(r^r - t^r - T^H)]k_A^r + [1+(r^s - t^s - T^H)]k_A^s + [1+(r^A - T^A)]k_A^A + G^A, \tag{4}$$

where r^i, $i = r, s, A$, denotes the gross remuneration of capital invested in region r, s, and country A; t^r, t^s, T^H, T^A denote the capital tax rate in region r, s, country H and A, respectively; g^i, $i = r$, s, denote the regional lump sum transfer while G^H and G^A denote the national lump sum transfer in country H and A, respectively.

In both countries, the same consumption good is produced by using the same technology, which uses capital as the sole input. Specifically, in each country, the production function is defined as

$$f(K^i), \qquad i = r, s, A \tag{5}$$

where $K^i = k_r^i + k_s^i + 2k_A^i$, $i = r, s, A$, denotes the amount of capital invested in each region r and s and in country A. Furthermore, we suppose that the market is perfectly competitive, and accordingly firms' profit maximising behaviour implies the following familiar condition on marginal factor productivity:

$$f'(K^i) = r^i, \qquad i = r, s, A. \tag{6}$$

This condition can be used to obtain the demand for capital:

$$K^i = K(r^i) \qquad i = r, s, A. \tag{7}$$

Rents arising in region/state i, $\Pi^i \equiv f(K^i) - f'(K^i)K^i$, $i = r, s, A$, are assumed to be fully taxed at regional level, in case of country H, and at national level, in case of country A.[6]

In each region/country, capital investments are taxed in order to finance a lump sum tranfer to its residents, i.e. we only consider a purely redistributive fiscal policy. Thus, the regional budget constraints obtain as

$$t^i K^i(r^i) + \Pi^i(r^i) = g^i, \qquad i = r, s \tag{8}$$

while the national budget constraints obtain as

$$T^H(K^r(r^r) + K^s(r^s)) = 2G^H, \tag{9}$$

in country H, and

$$T^A K^A(r^A) + \Pi^A(r^A) = 2G^A, \tag{10}$$

in country A.

The presence of capital taxation implies that the cost of capital for firms is different from the return on capital received by capital investors. In particular, because of the assumption of perfect mobility of capital, arbitrage by capital investors insures that, in each region/country, an identical net return on capital, denoted by ρ, will prevail:

$$\rho = r^r - \tau^r = r^s - \tau^s = r^A - T^A, \tag{11}$$

where $\tau^i = t^i + T^H$, $i = r, s$, is the consolidated tax rate in country H. Furthermore, assuming full employment of capital permits to obtain the clearing equation in the international capital market as follows:

$$K^r(\rho + \tau^r) + K^s(\rho + \tau^s) + K^A(\rho + T^A) = \Gamma(\rho), \tag{12}$$

where $\Gamma(\rho) \equiv S_r + S_s + 2S_A$ is total savings, i.e. total supply of capital, with $\Gamma'(\cdot) \geqslant 0$. The net return on capital is the solution to the above equation, which means that it is a function of t^r, t^s, T^H, T^A, i.e. $\rho = \rho(t^r, t^s, T^H, T^A)$. Differentiating (12) with respect to t^i, $i = r, s$, and ρ yields:

$$\frac{\partial \rho}{\partial t^i} = \frac{K^{i'}}{\Gamma' - (K^{r'} + K^{s'} + K^{A'})}, \qquad i = r, s, \tag{13}$$

[6] See Keen and Kotsogiannis (2002) for an analogous assumption. Notice, however, that in our set-up, results are the same when rents are taxed at a national level also in country H, or rents are not taxed at all and are earned by consumers. The reason for this is that capital and rent taxation is simply used to finance lump-sum transfers to individuals. Furthermore, notice that our results do not change relevantly by adopting the standard approach which considers two kinds of public consumption goods, one provided by regional governments and one provided by central governments.

which implies

$$-1 < \frac{\partial \rho}{\partial t^i} < 0 \qquad i = r, s. \tag{14}$$

Similarly, by differentiating (12) with respect to T^H and ρ yields:

$$\frac{\partial \rho}{\partial T^H} = \frac{K^{r'} + K^{s'}}{\Gamma' - (K^{r'} + K^{s'} + K^{A'})} = \sum_{i=r,s} \frac{\partial \rho}{\partial t^i}, \qquad i = r, s, \tag{15}$$

which implies

$$-1 < \frac{\partial \rho}{\partial T^H} < 0, \tag{16}$$

and by differentiating (12) with respect to T^A and ρ yields:

$$\frac{\partial \rho}{\partial T^A} = \frac{K^{A'}}{\Gamma' - (K^{r'} + K^{s'} + K^{A'})}, \tag{17}$$

which implies

$$-1 < \frac{\partial \rho}{\partial T^A} < 0. \tag{18}$$

Accordingly, in region i, $i = r, s$, we also obtain that

$$\frac{\partial r^i}{\partial t^i} > 0, \quad \frac{\partial r^i}{\partial t^j} < 0, \quad \frac{\partial r^i}{\partial T^H} > 0, \quad \frac{\partial r^i}{\partial T^A} < 0 \qquad i, j = r, s, \quad i \neq j. \tag{19}$$

Equivalent expressions obtain for the gross remuneration of capital in country A. Thus, we also obtain that for the demand for capital in region i, $i = r, s$, the following inequalities hold:

$$\frac{\partial K^i}{\partial t^i} < 0, \quad \frac{\partial K^i}{\partial t^j} > 0, \quad \frac{\partial K^i}{\partial T^H} < 0, \quad \frac{\partial K^i}{\partial T^A} > 0 \qquad i, j = r, s, \quad i \neq j. \tag{20}$$

Equivalent expressions obtain for the demand for capital in country A.

3 The solution of the game

In this section, we solve the game described above by backward induction. Firstly, consider the third stage of the game, when consumption and investment decisions are made. In each region r and s of country H (country A), the consumer solve his optimization problem by maximising his utility function (1) subject to the first and second period budget constraints (2)

and (3), ((2) and (4)). It is easy to check that the first order conditions imply that:

$$MRS_{C_i^1,C_i^2} = 1 + \rho, \qquad i = r, s, A \tag{21}$$

and thus, the individual first and second period demand functions obtain as $C_i^1(\rho)$ and $C_i^2(\rho)$, $i = r, s, A$, respectively, while supply function obtains as $S_i(\rho)$, $i = r, s, A$.

3.1 Nash game between regions

In stage two of the game, regions r and s composing country H have to decide the capital tax rate to levy on regional investments. In the noncooperative game between these regions, each of the two governments behave as a Nash player, i.e. taking as given the tax rate in the other region. Furthermore, each government acts as a Stackelberg follower with respect to the national government, and thus it also takes as given the national capital tax rate, T^H. By the solution to the consumer maximization problem in stage 1 and by the regional government budget constraint (8), the indirect utility function of agent i obtains as

$$V_i = U(\overline{k} - S_i(\rho)) + (1+\rho)\, S_i(\rho) + \Pi^i(\rho + \tau) + t^i K^i + \frac{T^H}{2} \sum_{i=r,s} K^i, \quad i = r, s \tag{22}$$

where the reader must keep in mind that ρ depends on t^r, t^s, T^H, T^A, i.e. $\rho = \rho(t^r, t^s, T^H, T^A)$. For expositional convenience, consider the case of region r. Noticing that $\Pi^{i\prime} = -K^i$, The first order condition with respect to t^r is the following

$$\frac{\partial \rho}{\partial t^r} S_r(\rho) - K^r \left(1 + \frac{\partial \rho}{\partial t^r}\right) + \left(K^r + t^r \frac{\partial K^r}{\partial t^r}\right) + \frac{T^H}{2} \left(\sum_{i=r,s} \frac{\partial K^i}{\partial t^r}\right) = 0. \tag{23}$$

Each of the terms in this expression can be given a simple interpretation. The first term describes the negative impact on the net remuneration of individual savings following an infinitesimal rise in t^r. The second term is negative by (14), and it describes the reduction in rent tax revenue deriving from an increase in the cost of capital which follows an increase in the regional tax rate. The third term represents the direct and the indirect effect on regional tax revenue of the tax increase, respectively. As usual, the direct effect is positive while the indirect effect is negative, in the case of a

positive tax. More precisely, the latter describes the positive *horizontal fiscal externality*, in terms of capital flight, which benefits region s and country A when region r increases its tax rate. Since region r, when it increases its tax rate, does not take into account such an externality, it perceives this indirect effect in a negative way, i.e. as a deadweight loss, that creates a disincentive to redistribution.[7]. Finally, the fourth term represents the impact on country H tax revenue deriving from a change in the national tax base due to an infinitesimal rise in t^r. More precisely, an increase in t^r leads to a decrease in capital investments in region r while it leads to an increase in capital investments in region s.[8]

Condition (23) defines region r's reaction function:

$$t^r = t^r\left(t^s, T^H, T^A\right). \tag{24}$$

An expression similar to (23) holds for region s so that region s's reaction function obtains as

$$t^s = t^s\left(t^r, T^H, T^A\right). \tag{25}$$

A Nash equilibrium of the game played by the two regions is given by the solution to the system of the two above reaction functions. In what follows, we concentrate our attention on the case of a symmetric equilibrium, i.e. $t^i = t$, $i = r, s$.

3.2 Nash game between countries

We now turn to a description of the first stage of the game, in which the governments of the unitary and the federal country choose their fiscal policy. More precisely, national governments play a noncooperative game between them: each country chooses its capital tax rate, given the capital tax rate chosen in the other country. Furthermore, the federal country acts as a Stackelberg leader with respect to the fiscal decisions of its regions.

Firstly, consider country H. The national government chooses T^H in order to maximise a social welfare function which is given by the sum of the

[7] This point can also be described by rearranging the terms in (13), namely

$$\frac{\partial K^r}{\partial t^r} = \frac{\partial \rho}{\partial t^r}\left(\Gamma' - K^{s^0} - K^{A^0}\right) < 0,$$

where it is shown that the reduction in K^r due to an increase in t^r equals the rise in capital investments in region s and country A.

[8] By differentiating (12) with respect to t^r, and by using (13), it is easy to check that $\frac{\partial K^s}{\partial t^r} = K^{r^0}\left[\frac{\Gamma^0 - K^{r^0} - K^{A^0}}{\Gamma^0 - \left(K^{r^0} + K^{s^0} + K^{A^0}\right)} - 1\right]$ which is positive by (20).

two consumer's indirect utility functions (22) in regions r and s, subject to the public budget constraint (9). Accordingly, its objective function obtains as

$$W_H = 2\left[U(\overline{k} - S(\rho)) + (1+\rho)S(\rho)\right] + \sum_{i=r,s} \Pi^i(\rho+\tau) + \tau \sum_{i=r,s} K^i(\rho+\tau), \quad (26)$$

where $\tau = t + T^H$, and further the reader must keep in mind that $t^i = t^i\left(t^j, T^H, T^A\right)$, $i,j = r,s$, $i \neq j$, and thus $\rho = \rho(t^r(\cdot), t^s(\cdot), T^H, T^A)$. Accordingly, the first order condition with respect to T^H is

$$2S(\rho)\alpha + \sum_{i=r,s}\left(1 + \frac{\partial t^i}{\partial T^H}\right)K^i + \tau \sum_{i=r,s} \frac{dK^i}{dT^H} - \sum_{i=r,s} K^i\left(\alpha + \left(1 + \frac{\partial t^i}{\partial T^H}\right)\right) = 0, \quad (27)$$

where

$$\alpha \equiv \frac{\partial \rho}{\partial T^H} + \sum_{i=r,s} \frac{\partial \rho}{\partial t^i}\frac{\partial t^i}{\partial T^H}, \quad (28)$$

and

$$\frac{dK^i}{dT^H} = K^{i\prime}\left(\alpha + \left(1 + \frac{\partial t^i}{\partial T^H}\right)\right). \quad (29)$$

Firstly notice that, at this stage of the game, α describes the effect of an infinitesimal increase of T^H on the net remuneration of capital, ρ, according to the previously specified function, $\rho = \rho(t^r(\cdot), t^s(\cdot), T^H, T^A)$. In particular, an infinitesimal change in T^H affects the net remuneration of capital, ρ, in two ways: *directly,* $\frac{\partial \rho}{\partial T^H}$, and *indirectly* via the change in the regional tax rates, $\frac{\partial \rho}{\partial t^i}\frac{\partial t^i}{\partial T^H}$, $i = r,s$. Secondly, the expression for α can be simplyfied by noticing that $\frac{\partial \rho}{\partial t^r} = \frac{\partial \rho}{\partial t^s} = \frac{\partial \rho}{\partial t}$, and $\frac{\partial t^r}{\partial T^H} = \frac{\partial t^s}{\partial T^H} = \frac{\partial t}{\partial T^H}$, $i = r,s$, at a symmetric equilibrium of the game played by the two regions i and r. More precisely, (28) can be rewritten as follows

$$\alpha \equiv 2\frac{\partial \rho}{\partial t}\left(1 + \frac{\partial t}{\partial T^H}\right), \quad (30)$$

where we have used the fact that $\frac{\partial \rho}{\partial T^H} = 2\frac{\partial \rho}{\partial t}$ by (15), at a symmetric equilibrium. Since $\frac{\partial \rho}{\partial t} < 0$ by (14), the sign of the term α depends on the value taken by $\frac{\partial t}{\partial T^H}$. In this respect, we make the following assumption:[9]

[9] It seems to us that this assumption is plausible and empirically sustainable (see references in footnote 4).

A.1: *Country H and regions i, i = r, s, tax rates are either strategic complements, i.e.* $\frac{\partial t}{\partial T^H} > 0$*, or are moderately strategic substitutes, i.e.* $-1 < \frac{\partial t}{\partial T^H} < 0$.

Thus, by direct inspection of (30), it is easy to check that $\alpha < 0$. In words, this means that we are considering the case when an infinitesimal change in T^H negatively affects the net remuneration of capital.

We are now in a position to interpret the terms in the first order condition of country H maximization problem. To this aim, equation (27) can be rewritten as follows

$$2S(\rho)\alpha+\left(1+\frac{\partial t}{\partial T^H}\right)\sum_{i=r,s}K^i+\tau\sum_{i=r,s}\frac{dK^i}{dT^H}-\left(\alpha+\left(1+\frac{\partial t}{\partial T^H}\right)\right)\sum_{i=r,s}K^i=0. \tag{31}$$

Under assumption A.1, all the terms in (31) can now be signed. The first term of (31) represents the negative impact of an infinitesimal increase in T^H on the net remuneration of individual savings. The second term is given by the sum of the *direct* effects on *national* and *regional* tax revenue of the domestic national tax increase. The direct effect on national tax revenue is always positive, while the direct effect on regional tax revenue is positive (negative) when country H and regions i, $i = r, s$, tax rates are strategic complements (substitutes). The latter term describes the increase (reduction) in regional tax revenue due to the increase (decrease) in the regional tax rate in response to the increase in the domestic national tax rate, i.e. a *vertical tax externality* - the *revenue effect* (Goodspeed (2000)). However, notice that the sum of the two direct effects is always positive when $\alpha < 0$. The third term is instead given by the sum of the *indirect* effects on *national* and *regional* tax revenue of the domestic national tax increase. both the indirect effect on national tax revenue and that on regional tax revenue are negative since $\frac{dK^i}{dT^H} < 0$, (in the case of $T^H > 0$ and $t > 0$).[10] This means that an increase in T^H, and accordingly a decrease in the net remuneration of capital, at the margin leads to a decrease in the capital investments in regions r and s, and so to a decrease both in national and regional tax revenue. Thus, the term on national tax revenue describes the *positive horizontal fiscal externality*, in terms of capital flight, which benefits country A when country H increases its tax rate. The term on regional tax revenue describes instead a *negative vertical fiscal externality*, i.e. a *tax base effect*. Finally, the fourth term describes the reduction in rent tax revenue

[10] It can be easily checked simply by using (30) and (15) into (29).

deriving from an increase in the cost of capital which follows an increase in the national tax rate.

Similarly, the government of country A chooses T^A in order to maximise a social welfare function which is given by the sum of the two consumer's indirect utility functions subject to the public budget constraint (10). Thus, its objective function is

$$W_A = 2\left[U(\overline{k} - S_A(\rho)) + (1+\rho)S_A(\rho)\right] + T^A K^A(\rho + T^A) + \Pi^A(\rho + T^A), \quad (32)$$

where the reader must keep in mind that for country A's government the international net remuneration of capital depends on t^r, t^s, T^H, T^A, i.e. $\rho = \rho(t^r, t^s, T^H, T^A)$. By maximising (32) with respect to T^A, we obtain the following first order condition

$$2\frac{\partial \rho}{\partial T^A} S_A(\rho) + K^A + T^A \frac{\partial K^A}{\partial T^A} - K^A\left(\frac{\partial \rho}{\partial T^A} + 1\right) = 0, \quad (33)$$

where

$$\frac{\partial K^A}{\partial T^A} = K^{A\prime}\left(\frac{\partial \rho}{\partial T^A} + 1\right),$$

which is negative by (18). As usual, the terms in the above expression can be given a simple interpretation. The first term in (33) describes the negative impact of an infinitesimal increase in T^A on the net remuneration of individual savings. The second term represents the positive direct effect on national tax revenue of the national tax increase, while the third term describes the negative indirect effect on national tax revenue of the national tax increase. As usual, the latter effect represents the *horizontal fiscal externality*: an unilateral increase in the tax rate leads to a capital flight towards country H. Finally, the fourth term describes the reduction in rent tax revenue deriving from an increase in the cost of capital which follows an increase in the national tax rate.

By solving equation (27), we obtain the country H's reaction function, namely

$$T^H = T^H\left(t^r\left(t^s, T^H, T^A\right), t^s\left(t^r, T^H, T^A\right), T^A\right). \quad (34)$$

Similarly, by solving equation (33), we obtain the country A's reaction function, namely

$$T^A = T^A\left(t^r, t^s, T^H\right). \quad (35)$$

A Nash equilibrium of the game played by the two countries is given by the solution to the system of the two above reaction functions.

4 Equilibrium analysis: will capital be overtaxed or undertaxed?

In this section, we raise the question whether the two countries H and A choose too high or too low capital tax rates, at equilibrium. In particular, we are interested in checking whether the answer to the previous question is affected by the fact that country H has a federal structure while country A is a unitary state.

To investigate this point, consider country H and country A social welfare functions which obtain at the equilibrium of the first stage of the game described in the previous section. More precisely, country H social welfare function obtains as in (26) and country A social welfare function as in (32), but where the reader must keep in mind that the net remuneration of capital, at equilibrium, is now given by

$$\begin{aligned} &\rho = \rho(t^r\left(t^s, T^H, T^A\right), t^s\left(t^r, T^H, T^A\right), \\ &T^H\left(t^r\left(t^s, T^H, T^A\right), t^s\left(t^r, T^H, T^A\right), T^A\right), T^A\left(t^r, t^s, T^H\right)), \end{aligned} \tag{36}$$

where we have used (34) and (35). Accordingly, national capital tax rate is inefficiently too high (low), at equilibrium, i.e. there is overtaxation (undertaxation),[11] when $\left.\frac{\partial W_i}{\partial T^i}\right|_{Nash} < (>)0$, $i = H, A$.

We are now in a position to state the following proposition concerning country H.

Proposition 1 *Under assumption A.1, in country H, there is*

(i) undertaxation if national tax rates are strategic complements, or are strategic substitutes and $-\frac{\partial\rho/\partial T^H}{\partial\rho/\partial T^A} < \frac{\partial T^A}{\partial T^H} < 0$*;*

(ii) overtaxation if national tax rates are strategic substitutes and $\frac{\partial T^A}{\partial T^H} < -\frac{\partial\rho/\partial T^H}{\partial\rho/\partial T^A}$.

Proof. By substituting (36) into (26), we obtain country H social welfare function, at equilibrium, which can be differentiated with respect to T^H, giving rise to

[11] Overtaxation and undertaxation are intended only in the sense that a national tax increase would rise or decrease welfare when regional taxes were to remain unchanged. See also Keen and Kotsogiannis (2002).

$$\left.\frac{\partial W_H}{\partial T^H}\right|_{Nash} = 2S(\rho)\frac{d\rho}{dT^H} + \tau \sum_{i=r,s} \frac{dK^i}{dT^H} - \frac{d\rho}{dT^H} \sum_{i=r,s} K^i, \tag{37}$$

where

$$\frac{d\rho}{dT^H} \equiv 2\frac{\partial \rho}{\partial t}\frac{\partial t}{\partial T^H} + 2\frac{\partial \rho}{\partial T^H} + \frac{\partial \rho}{\partial T^A}\frac{\partial T^A}{\partial T^H}, \tag{38}$$

and

$$\frac{dK^i}{dT^H} = K^{i\prime}\left(\frac{d\rho}{dT^H} + \left(1 + \frac{\partial t}{\partial T^H}\right)\right).$$

Since we evaluate (37) at the Nash equilibrium, we use (27) into (37), which accordingly obtains as

$$\left.\frac{\partial W_H}{\partial T^H}\right|_{Nash} = \left(\frac{d\rho}{dT^H} - \alpha\right)\left(2S(\rho) + \tau \sum_{i=r,s} K^{i\prime} - \sum_{i=r,s} K^i\right) = \beta\psi,$$

where

$$\beta \equiv \frac{d\rho}{dT^H} - \alpha = \frac{\partial \rho}{\partial T^H} + \frac{\partial \rho}{\partial T^A}\frac{\partial T^A}{\partial T^H}, \tag{39}$$

by using (38) and (30), and

$$\psi \equiv 2S(\rho) + \tau \sum_{i=r,s} K^{i\prime} - \sum_{i=r,s} K^i. \tag{40}$$

Now, rewrite (27) as follows

$$\left[2S(\rho) + \tau \sum_{i=r,s} K^{i\prime} - \sum_{i=r,s} K^i\right]\alpha = -\tau\left(1 + \frac{\partial t}{\partial T^H}\right)\sum_{i=r,s} K^{i\prime}. \tag{41}$$

By using (40), equation (41) obtains as

$$\psi\alpha = -\left(1 + \frac{\partial t}{\partial T^H}\right)\tau \sum_{i=r,s} K^{i\prime} > 0, \tag{42}$$

since $\left(1 + \frac{\partial t}{\partial T^H}\right) > 0$ by assumption A.1, and $K^{i\prime} < 0$. Since $\alpha < 0$, (42) implies that $\psi < 0$. Thus, $\left.\frac{\partial W_H}{\partial T^H}\right|_{Nash} \gtrless 0 \Leftrightarrow \beta \lesseqgtr 0$. By using (16) and (18) into (39), it is easy to show that $\beta < 0$ if national tax rates are strategic complements, i.e. $\frac{\partial T^A}{\partial T^H} > 0$, or if they are strategic substitutes with $-\frac{\partial \rho/\partial T^H}{\partial \rho/\partial T^A} < \frac{\partial T^A}{\partial T^H} < 0$. Thus, case (i) obtains. Similarly, it is

easy to check that $\beta > 0$ if national tax rate are strategic substitutes with $\frac{\partial T^A}{\partial T^H} < -\frac{\partial \rho / \partial T^H}{\partial \rho / \partial T^A}$. Thus, case (ii) obtains. □

Proposition 1 shows that, when the two national capital tax rates are strategic complements, or are moderately strategic substitutes, i.e. $\frac{\partial T^A}{\partial T^H} > -\frac{\partial \rho / \partial T^H}{\partial \rho / \partial T^A}$, an increase in T^H implies a decrease in ρ, i.e. $\beta < 0$, and accordingly, T^H is inefficiently too low, at equilibrium. On the contrary, by a symmetric reasoning, when there is a strong substitutability between national capital tax rates, i.e. $\frac{\partial T^A}{\partial T^H} < -\frac{\partial \rho / \partial T^H}{\partial \rho / \partial T^A}$, T^H is inefficiently too high, at equilibrium.

We now turn to the analysis of country A. In this respect, we state the following proposition.

Proposition 2 *In country A, when $\frac{\partial T^H}{\partial t} > 0$, there is*

(i) undertaxation if $\frac{\partial t}{\partial T^A} > 0$, and national tax rates are strategic complements;

(ii) overtaxation if $\frac{\partial t}{\partial T^A} < 0$, and national tax rates are strategic substitutes, or they are strategic complements with $\frac{\partial T^H}{\partial T^A} < -2\frac{\partial T^H}{\partial t}\frac{\partial t}{\partial T^A}$.

Proof. By substituting (36) into (32), we obtain country A social welfare function, at equilibrium, which can be differentiated with respect to T^A, giving rise to

$$\left.\frac{\partial W_A}{\partial T^A}\right|_{Nash} = 2\frac{d\rho}{dT^A}S(\rho) + T^A\frac{dK^A}{dT^A} - K^A\frac{d\rho}{dT^A}, \tag{43}$$

where

$$\frac{d\rho}{dT^A} \equiv 2\frac{\partial \rho}{\partial t}\frac{\partial t}{\partial T^A} + \frac{\partial \rho}{\partial T^H}\left(2\frac{\partial T^H}{\partial t}\frac{\partial t}{\partial T^A} + \frac{\partial T^H}{\partial T^A}\right) + \frac{\partial \rho}{\partial T^A}, \tag{44}$$

and

$$\frac{dK^A}{dT^A} = K^{A\prime}\left(1 + \frac{d\rho}{dT^A}\right)$$

Since we evaluate (43) at the Nash equilibrium, we use (33) into (43), which accordingly obtains as

$$\left.\frac{\partial W_A}{\partial T^A}\right|_{Nash} = \left(\frac{d\rho}{dT^A} - \frac{\partial \rho}{\partial T^A}\right)\left(2S(\rho) + T^A K^{A\prime} - K^A\right) = \delta\gamma,$$

where

$$\delta \equiv \frac{d\rho}{dT^A} - \frac{\partial \rho}{\partial T^A} = 2\frac{\partial \rho}{\partial t}\frac{\partial t}{\partial T^A} + \frac{\partial \rho}{\partial T^H}\left(2\frac{\partial T^H}{\partial t}\frac{\partial t}{\partial T^A} + \frac{\partial T^H}{\partial T^A}\right), \tag{45}$$

and

$$\gamma \equiv 2S(\rho) + T^A K^{A\prime} - K^A. \tag{46}$$

Now, rewrite equation (33) as follows

$$\left(2S(\rho) + T^A K^{A\prime} - K^A\right)\frac{\partial \rho}{\partial T^A} = -T^A K^{A\prime} > 0. \tag{47}$$

By using (46), the L.H.S. of (47) obtains as

$$\left(2S(\rho) + T^A K^{A\prime} - K^A\right)\frac{\partial \rho}{\partial T^A} = \gamma\frac{\partial \rho}{\partial T^A} > 0,$$

which implies that $\gamma < 0$ since we use (18). Accordingly, $\frac{\partial W_A}{\partial T^A}\Big|_{Nash} \gtreqless 0 \Leftrightarrow \delta \lesseqgtr 0$. By using (14) and (16) into (45), when $\frac{\partial T^H}{\partial t} > 0$, it is easy to show that $\delta < 0$ if $\frac{\partial t}{\partial T^A} > 0$, and $\frac{\partial T^H}{\partial T^A} > 0$, thus case (i) obtains; and that $\delta > 0$ if $\frac{\partial t}{\partial T^A} < 0$, and $\frac{\partial T^H}{\partial T^A} < 0$, or $0 < \frac{\partial T^H}{\partial T^A} < -2\frac{\partial T^H}{\partial t}\frac{\partial t}{\partial T^A}$, thus case (ii) obtains.□

Proposition 2 shows that, when country H and its regions tax rates are strategic complements, the strategic complementarity (substitutability) between the two national tax rates and between regions i, $i = r, s$, and country A tax rates leads to undertaxation (overtaxation), at the Nash equilibrium. Furthermore, overtaxation results also when country H and its regions tax rates are strategic complements while country A and regions i, $i = r, s$, tax rates are strategic substitutes, and national tax rates present a sufficiently low strategic complementarity.

Finally, before discussing our results, it is useful to consider as a benchmark case the framework when both countries are unitary. Indeed, this set-up corrisponds to the standard one analysed in the horizontal tax competition literature. In this respect, we can state the following

Corollary 1 *When countries H and A are unitary, there is undertaxation (overtaxation) in both countries if national tax rates are strategic complements (substitutes).*

Proof. We only provide a sketch of the proof, which can be easily derived by using the same reasonings underlining the proofs of propositions

1 and 2. In particular, by using $t^i = 0$, $i = r, s$, it is immediate to check firstly, that $\frac{\partial W_H}{\partial T^H}\Big|_{Nash} = \beta\psi$, with $\beta \equiv \frac{\partial \rho}{\partial T^A}\frac{\partial T^A}{\partial T^H}$, and $\psi < 0$ as in (40), and secondly, that $\frac{\partial W_A}{\partial T^A}\Big|_{Nash} = \delta\gamma$, with $\delta \equiv \frac{\partial \rho}{\partial T^H}\frac{\partial T^H}{\partial T^A}$, and $\gamma < 0$ as in (46). Since the two countries are symmetric, it follows that $T^H = T^A$, $\psi = \gamma$, and $\beta = \delta$.□

In order to discuss our results, instead of considering all possibilities. we concentrate our attention on the case when national tax rates are sufficiently low strategic complements, i.e. $\frac{\partial T^H}{\partial T^A} < -2\frac{\partial T^H}{\partial t}\frac{\partial t}{\partial T^A}$. In this set-up, when both countries are unitary (and large enough to make the net return on capital endogenous), corollary 1 shows that there is undertaxation, i.e. inefficiently too low capital tax rates, in both of them. This result is consistent with common intuition and it describes the set-up usually examined by horizontal tax competition literature. However, when one of the two countries has a federal structure, the previous result does not hold anymore. More precisely, capital tax rate is still inefficiently too low, in the federal country (see case (i) of proposition 1). On the contrary, capital tax rate may be now inefficiently too high, in the unitary country. This may happen if there is also strategic complementarity between national and regional tax rates, in the federal country, and a strategic substitutability between regional tax rates of the federal country and national tax rate of the unitary country (see case (ii) of proposition 2).[12] In this respect, notice that capital overtaxation in the unitary country is a somewhat surprising result which is due to vertical competition effects. Specifically, when the previous conditions are satisfied, an increase in the unitary country tax rate leads to an increase in the net remuneration of capital because of chain effects related to vertical competition (see (45)). On the contrary, when both countries are unitary, such chain effects disappear and an increase in the unitary country tax rate leads as usual to a decrease in the net remuneration of capital.

Accordingly, our main result shows that the standard finding according to which two countries competing on acquiring mobile capital tax base tend both to undertax capital, may not hold any more when one of the two countries is of a federal type. However, quite surprisingly, the federal country continues to undertax capital, while the unitary country overtax it. There-

[12] The latter relation, namely between regional tax rates of the federal country and national tax rate of the unitary country, refers to a sort of "mixed" strategic substitutability since it takes into account both the horizontal competition between countries and a sort of vertical competition between regional governments of country H and national government of country A.

fore, the interactions of vertical tax competition between regional tax rates of the federal country and national tax rates of both states appear to be, in some sense paradoxically, more relevant for the level of the unitary country capital tax rate rather than for that of the federal country.

5 Concluding remarks

In this paper, we have analysed strategic interaction between two countries of a federation where one country is unitary while the other one is itself of a federal type, i.e. composed by two identical regions. In our set-up, horizontal tax competition arises not only between countries but also between regions within the federal country, together with a vertical competition between national and regional governments.

The question we raise is whether the two countries choose inefficiently too high or too low national capital tax rates, at equilibrium. In particular we are interested in analysing whether the answer to such a question is affected by the fact that a country has a federal structure while the other one is instead a unitary state. In this respect, we provide conditions under which national capital tax rates are inefficiently too high or too low, at equilibrium. More precisely, our main result is obtained when national tax rates present a sufficiently low strategic complementarity. In this case, if both countries were unitary, we show that their equilibrium capital tax rates are inefficiently too low. This result is in line with standard horizontal fiscal competition literature. However, when one of the two countries has a federal structure such a result does not hold any more. Indeed, when there is also strategic complementarity between national and regional tax rates in the federal country, while there is strategic substitutability between regional tax rates of the federal country and national tax rates of the unitary country, we show that national capital tax rate is still inefficiently too low, in the federal country, but it is now inefficiently too high, in the unitary country. Thus, the interaction between national tax rates of both states and regional tax rates of the federal country shows that vertical tax competition may be somewhat paradoxically more relevant for the level of the unitary country capital tax rate rather than for that of the federal country.

Finally, notice that our analysis has been cast into a particular model of strategic interaction between countries. Firstly, countries are different with respect to their institutional structure, but they are identical in all other respects. Thus, problems related to different population size, preferences for equity, and social composition are not taken into account. Secondly, capital

taxes are simply used to finance uniform lump-sum transfers to individuals, and more complicated income redistributive policies or public goods provision are left aside. However, we feel that such issues are open fields for further research.

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