

CORE DISCUSSION PAPER

2002/32

**COORDINATION OF CAPITAL TAXATION AMONG
ASYMMETRIC COUNTRIES**

Susana Peralta¹ and Tanguy van Ypersele²

May 2002

Abstract

This paper tackles the issue of international fiscal coordination in a world of integrated markets sovereign national governments. Taxation of mobile capital and immobile labor in order to finance a public good generates inefficient fiscal competition.

Two fiscal reforms are considered: a minimum capital tax level and a tax range, i.e., a minimum plus a maximum capital tax level.

We show that the introduction of a lower bound to the capital tax level is never preferred to fiscal competition by all countries while there always exists a combination of both a lower and an upper bound which is unanimously accepted.

Keywords: Capital mobility, Tax Competition, Tax Coordination

JEL Classification: F21, F23, H21, H23, H3, H77

¹CORE-UCL. e-mail: peralta@core.ucl.ac.be. Financial support from Sub-Programa Ciência e Tecnologia do 2ºQuadro Comunitário de Apoio, Fundação para a Ciência e Tecnologia, Portugal is gratefully acknowledged.

²F.U.N.D.P Namur University, CORE-UCL and CEPR. e-mail: tanguy@fundp.ac.be. This research was initiated while the author was visiting Harvard University. Financial Support was graciously provided by the Belgian American Education Foundation and the Université Catholique de Louvain.

We are indebted to Motohiro Sato for his very useful suggestions. Comments by A. Alesina, C. d'Aspremont, E. Cantillon, G. de Clippel, P. Francois, L. Grazzini, E. Helpman, H. Huizinga,

1. Introduction

The ongoing globalization movement allows a superior utilization of resources and a better allocation of risks among countries. However, national economies become more interdependent and fiscal policy affects trade, capital and labor flows. Governments have to take into account their trade partners' behavior when undertaking local redistributive policies or public good supply. A possible consequence of this phenomenon is a downward pressure on the size of the public sector (cfr. Cremer and Al. (1996) or Wilson (1999) for surveys of the literature).

Fiscal competition is an important issue in integrated markets. In the U.S., for instance, undercuts in corporate tax have been used to attract businesses. In his web-based biography, Governor J. G. Rowland of the state of Connecticut clearly states this has a main accomplishment of his two first mandates: *to help the state's economy and create jobs, Governor Rowland has worked to improve the state's overall business climate, including a 1/3 reduction in corporation tax. The state has regained 112 percent of the jobs lost in the recession of the early 1990's.* Similarly, Governor Bob Taft of Ohio and Governor Davis of California cite, in their respective web-pages, important business tax cuts aimed at fostering local economic activity.¹ Fiscal competition is a fact also in the European Union, where a transfer of the tax burden from (mobile) capital towards (immobile) labor has been observed. Between 1980 and 1994, the implicit average tax on capital (indeed, all non-labor production factors) has decreased from 44% to 35% at the expense of an increase from 34% to 40.5% of the implicit tax on labor (European Commission, 1996). This competition is expected to increase in the future as markets will become further integrated. The concern about the negative consequences of tax competition has led both the OECD and the European Commission to advocate tax harmonization (OECD (1991) and the Ruding Report (1992)).

In this paper, we tackle the problem of international tax coordination among national sovereign governments in an integrated market.² We use a simple model, with an arbitrary number of asymmetric countries where competitive firms produce a homogeneous good using mobile capital and immobile labor. National governments tax production factors in order to finance a publicly provided pri-

M. Marchand, A. Razin, D. Rodrik, J. Thisse, F. Trionfetti, J. Tharakan and seminar participants at Harvard University, CORE-UCL, CenTER-KUB and ULG are appreciated. Remaining errors are ours.

This text presents research results of the Belgian Program on Interuniversity Poles of Attraction initiated by the Belgian State, Prime Minister's Office, Science Policy Programming. The scientific responsibility is assumed by the authors.

¹Please refer to www.state.ct.us, www.governor.ca.gov, www.state.oh.us.

²Our analysis requires that each state or country is sovereign to the extent of being able to design its own tax and expense policies.

vate good. The capital tax we consider here, as it concerns productive capital, is to be understood as **a corporate tax**.³

In the design of possible coordination policies, we explicitly take into account their political feasibility. Indeed, coordination among sovereign countries is not an easy task: not only all countries should benefit from the coordination but also national pride or susceptibility has to be taken into account. The challenge is to find a mechanism to implement tax reforms that would not be blocked for political reasons. Let us consider, for the sake of illustration, that a *Pareto improving* capital tax scheme is identified in the EU or the US and the European Commission or the Federal Government manages to impose it.⁴ Most probably, as states are asymmetric, it would induce a different tax for each state. Such an asymmetric treatment would be likely to generate political tensions.

We advocate that a tax coordination mechanism, to be politically acceptable, has to fulfill three basic requirements. It should (i) be **Pareto improving**, (ii) be **anonymous**, in that it applies to all countries in the same way and (iii) respect the **subsidiarity principle**, in the sense that tax decisions have to be taken at the lowest efficient level of government (supra national, national, or regional). Note that the most important recent coordination decision in the EU, the stability pact of the Maastricht treaty, respects the two last principles: anonymity (same debt and deficit constraint for all countries) and subsidiarity (public spending decided at the national level).

We consider two tax reforms: the introduction of a minimum capital tax level and the imposition of a tax range, i.e. a minimum and a maximum capital tax level.⁵ They are both anonymous, i.e. they restrict each country's strategy set, but they do not assign a particular tax level to each country. They both respect the subsidiary principle in that the tax decision is left up to the nation. We show that the first reform is not *Pareto improving* while the second is.

In the literature, capital tax coordination normally comes out as a spin-off of models whose basic concern is tax competition as such. The presence of inefficient decentralized equilibria suggest that some kind of centralization or coordination of decisions is desirable (see, e.g., the survey by Wilson (1999)). Centralization consists in giving taxing authority to a central or federal government. This is the case of the matching grants proposed by De Pater and Myers (1994) and Wildasin (1989) to restore optimality. To the extent that regions may have private information about some technological or preference parameter affecting fiscal policy,

³This view is shared by most of the literature; see, for instance, Person and Tabellini (1992).

⁴We use the term Pareto improving somewhat loosely, meaning an increase in the welfare of all countries (however this welfare is defined).

⁵The first reform has already been used by the European Union to decrease the inefficiency from fiscal competition on value added tax.

they may have an incentive to hide this information from the central authority. This issue is covered in Dhillon et al. (1999), where it is argued that the optimal tax scheme cannot be implemented because it is not incentive compatible. In a sense, tax competition survives the centralization effort.

On the other hand, coordination is about a given set of sovereign states agreeing upon a policy that alleviates the perverse effects of tax competition. That is the focus of this paper. As said above political feasibility becomes an issue in this context. We therefore propose a framework of **more than two countries**, without which we would be unable to design anonymous mechanisms. Moreover, we provide a **non-trivial treatment of tax coordination by considering asymmetric countries**: the setup is rich enough to generate diversity of welfare effects of coordination and pinpoint the characteristics of a given country that make it a loser or a winner from it.⁶ **Our main contribution is the identification of a specific tax coordination mechanism, namely the tax range reform, which would be voted for unanimously by the set of countries.** Unlike the corrective device in DePater and Myers (1994), **our reform may be applied without the intervention of a central government. This is politically more feasible among sovereign countries**, at the cost of not restoring optimality completely as does DePater and Myers (1994) matching grant.

The paper is organized as follows. In the next section, we describe the main features of the model in Peralta and van Ypersele (2002), upon which we base our reform analysis. In Section 3 we study the harmonization procedure and present the main results. Section 4 provides a numerical example of the reform. Section 5 discusses extensions and concludes.

2. Tax Competition

2.1. The Model

This section is devoted to present the main results in Peralta and van Ypersele (2002), which is the model we use as a basis to discuss our policy reforms.

The model takes N sovereign countries, indexed by i , that run a fiscal policy in order to finance a publicly provided private good. Fiscal policies consist of per unit taxes levied on capital (t) and labor (τ) according to the source-based principle. A single good is produced under constant returns to scale: $F(K, L) = Lf(k)$ with $k = K/L$, $f'(k) > 0$ and $f''(k) < 0$.⁷ Firms behave competitively and

⁶In Bucovetsky (1991) and Wilson (1991) the countries are asymmetric, but in such a way that their capital-labor ratios are equal. Only De Pater and Myers (1994) and Grazinni and van Ypersele (1997) consider countries which are asymmetric in their capital-labor ratio endowments.

⁷Some other (mainly technical) conditions are assumed: $f'(0) = \infty$, $f'(\infty) = 0$, $f(0) = 0$

production factors are therefore priced at their marginal productivity: $r = f'(k)$ and $w = f(k) - kf'(k)$ with r and w denoting, respectively, the gross remuneration of capital and labor.

Countries are assumed to be asymmetric with respect to their factor endowments. $\bar{K}_w$ and $\bar{L}_w$ denote the world aggregate endowments of capital and labor. $\bar{K}_i$ is country i 's endowment of capital: $\sum_{i=1}^N \bar{K}_i = \bar{K}_w$. $\bar{L}_i$ is the number of inhabitants of country i : $\sum_{i=1}^N \bar{L}_i = \bar{L}_w$. We define $\lambda_i = \frac{\bar{L}_i}{\bar{L}_w} > 0$ the share of the aggregate population residing in country i . Note that $\sum_{i=1}^N \lambda_i = 1$.

Inhabitants in each country are perfectly homogeneous and supply inelastically one unit of labor to internal firms. Each of them owns $\bar{k}_i = \bar{K}_i / \bar{L}_i$ units of capital, which they can choose to invest in any country. Each individual invests his capital where its net return is higher, which implies that the following arbitrage condition must hold in equilibrium: $r_i - t_i = r_j - t_j = \rho \quad \forall i = 1..N$, with t_i denoting the per unit capital tax and ρ the net capital remuneration on the international market.

They enjoy utility from the consumption of a pure private and a publicly provided private good: the utility of the representative consumer is $W(\rho \bar{k}_i + w_i - \tau_i, \tau_i + t_i \bar{k}_i)$, which is also the objective function of the benevolent government.

At the Walrasian equilibrium, factor prices adjust to clear markets. A labor market exists in each country and international markets are available for the capital and consumption goods. At equilibrium, labor markets clear in each country. The international capital market clearing condition is given by $\bar{L}_w \sum_{i=1}^N \lambda_i k(\rho + t_i) = \bar{K}_w$. As the LHS of this equation is strictly decreasing in ρ , an equilibrium exists, $\rho = \rho(t_1, \dots, t_i, \dots, t_N)$ with

$$\rho_{t_i}(t) = \frac{\partial \rho}{\partial t_i} = - \frac{\lambda_i k'_i}{\sum_{j=1}^N \lambda_j k'_j}.$$

Not surprisingly, ρ is a decreasing function of the taxes in each country: an increase in t_i decreases the national demand for capital and as a consequence international demand for capital. Therefore, for the market to clear, the remuneration has to decrease.⁸

It is important to note that capital movements originate from two sources: the difference in factor endowments and the difference in capital taxes. In the absence of capital taxes, capital movements lead to an equalization of the invested capital

and $f''(k)$ is finite for finite and non-zero values of k .

⁸Note also that $\rho_{t_i} \geq -1$: in a given country, an increase in the tax rate never decreases the gross remuneration of capital $\left(\frac{dr_i}{dt_i} = 1 + \rho_{t_i} \geq 0 \right)$.

labor ratio across countries, i.e., to the efficient allocation of factors in the sense that it maximizes overall production per capita. When capital taxes are not equalized across countries, part of the capital movements is not motivated by allocative efficiency but by fiscal opportunism. This generates a distortion since with different source-based tax rates, arbitrage implies different gross interest rates (r_i), which in turn means that the capital labor ratio is not equalized across countries.

The other possible source of inefficiency in our setting would be the under-provision of the publicly provided private good. This is nonetheless provided at the efficient level thanks to the non-distortive labor tax. As shown by Peralta and van Ypersele (2002), this allows us to simplify matters by considering a uni-dimensional problem for the government. In what follows, each government maximizes total consumption (pure private and publicly provided private good), that is, $U_i = \rho \bar{k}_i + w_i + t_i k_i$ by its choice of t_i . This is in all regards equivalent to the maximization of W_i .

2.2. Taxation effects and equilibrium

Note that the government's objective $\rho \bar{k}_i + w_i + t_i k_i$ is in fact per capita GNP, i.e., the value of the domestic product minus the net contribution from abroad:

$$U_i = (r_i k_i + w_i) - \rho (k_i - \bar{k}_i) = f(k_i) - \rho (k_i - \bar{k}_i)$$

where $\bar{k}_i = \bar{K}_i / \bar{L}_i$ is the aggregate relative endowment of country i and $k_i = K_i / L_i$ is the production factors ratio effectively invested in country i . Note that U_i is continuous in t_i .

The marginal effect of an increase in the capital tax can be decomposed into two effects: the *capital movement effect* and the *terms of trade effect*. These are respectively identified in the following expression:

$$\begin{aligned} \frac{dU_i}{dt_i} &= \frac{\partial U_i}{\partial k_i} \frac{dk_i}{dt_i} + \frac{\partial U_i}{\partial \rho} \frac{d\rho}{dt_i} \\ &= (f'(k_i) - \rho) \frac{dk_i}{dt_i} - (k_i - \bar{k}_i) \rho_{t_i} \\ &= t_i \frac{dk_i}{dt_i} - (k_i - \bar{k}_i) \rho_{t_i} \end{aligned}$$

The *capital movement effect* has the opposite sign of the tax rate. The intuition behind it is quite straightforward, as pointed out by Wilson (1999). The social value of an additional unit of capital is equal to its marginal productivity: $f'(k)$.

Its social cost - what the country pays for that additional unit of capital - is equal to the net price of capital, since a part (t) of the price paid by the firm ($\rho + t$) is collected by the government. Hence there is a wedge, equal to the tax rate, between the social benefit and the social cost of an additional unit of capital. Therefore, when capital flies away, the country is worse off if it taxes capital and best off if it subsidizes it.

The *terms of trade effect* is signed according to the net exporting position of the country. It represents the gain (loss) that a capital-importing (exporting) country makes through the depression of the international remuneration of capital induced by the increase in the capital tax. We call this the *terms of trade effect* as the logic behind it is exactly the one that justifies the optimum tariff in international trade: the tariff is seen as a way to influence the terms of trade. A country that imports capital has an incentive to increase its capital tax in order to decrease its net cost. For the opposite reason, this effect is a disincentive to capital taxation for a capital-exporting country.

From this, one easily obtains that it is never optimal for an exporter to have a positive tax: the total marginal effect being negative, it has an interest in decreasing it. A parallel argument holds for an importer with a negative tax. At the optimum, both effects must have necessarily opposite signs. The following first order condition of the government's maximization problem should therefore come at no surprise:⁹

$$t_i = -\frac{\rho_{t_i}}{1 + \rho_{t_i}} \frac{\bar{k}_i - k_i}{k'_i}$$

Indeed, exporters subsidize capital and importers tax it.

A capital importer taxes capital since taxation induces a decrease in the net price of capital, therefore in its capital bill. Moreover, given that a part of the productive capital is owned by foreign citizens, they support a part of the tax burden. An exporting country subsidizes capital because it gets capital payments from abroad, therefore, the higher the international net price of capital, the better. Moreover, all the tax burden is supported by national citizens, which of course discourages taxation. This result on exporting countries subsidizing capital has been obtained by DePater and Myers (1994) in a two country model.

We thus have an inefficient equilibrium, since countries use different tax rates and this distorts the allocation of capital from its overall optimum (the equalization of the marginal productivity of capital in all the countries).

⁹In Peralta and van Ypersele (2002) the game in tax rates is defined and conditions for equilibrium existence are presented.

Note that we would have $t_i = 0$ if either $\rho_{t_i} = 0$, or under a symmetric equilibrium, where every country chooses the same tax rate and therefore $k_i = \bar{k}_i$ in equilibrium.¹⁰ Therefore, both the endogeneity of the international net return to capital and the asymmetry among countries are crucial for our result.

3. Fiscal Reforms

The model developed in the former section enables us to analyze different types of reforms. Our aim is to find a fiscal reform that increases the welfare of all the representative consumers and that has the properties of respecting the subsidiarity principle and is anonymous in the sense that the reform applies to all the countries in the same way. We argue that a reform respecting these properties should be politically feasible.

We consider two different reforms: *the minimum tax reform* and *the tax range reform*.

To allow for clear-cut results, we focus on cases where the equilibrium of the non cooperative game is unique. Specifically, we assume that the reaction functions are contractions:¹¹

$$\sum_{j \neq i} \left| \frac{\partial t_i}{\partial t_j} \right| \leq \phi, \forall i, \text{ for some } \phi < 1$$

We also use the assumption of strategic complementarity: $\left. \frac{dt_i}{dt_j} \right|_{\frac{dU_i}{dt_i}=0} \geq 0, \forall i, \forall j \neq i$, whose reasonableness in our framework is argued for in Peralta and van Ypersele (2002).¹² Put simply, following an increase in some other country's tax, the second order impact on ρ_{t_i} (equal $d\rho_{t_i}/dt_j$) should be less important than the first order one on k_i (of the magnitude of ρ_{t_i}). Therefore, the change on the terms of trade effect should be more important than the one on the capital flight effect.

As regards an importer, the decrease in its capital bill induced by its own tax rate is now more important than before; as for an exporter, the decrease in external revenue induced by an increase in its own tax rate is now less heavy. Both are, thus, able to increase their tax rates.

¹⁰When the terms of trade effect does not play a role, then we're left with the capital movement effect, which attains an optimum at $t_i = 0$.

¹¹The fact that a contraction map yields a unique fixed point is a very well know result in mathematics. See, e.g., Friedman (1986).

¹²Note that by the implicit function theorem $\left. \frac{dt_i}{dt_j} \right|_{\frac{dU_i}{dt_i}=0} = - \frac{d^2 U_i / dt_i dt_j}{d^2 U_i / dt_i^2} \Big|_{\frac{dU_i}{dt_i}=0}$ hence it is non-negative if and only if $\left. \frac{d^2 U_i}{dt_j dt_i} \right|_{\frac{dU_i}{dt_i}=0}$ is non-negative.

3.1. The minimum tax reform

The minimum tax reform is a natural candidate since it has already been used to overcome inefficiencies arising from fiscal competition on the VAT in European Union and has been proposed in the Ruding proposition of the EU. As stated in the introduction, one easily sees that this reform respects the subsidiarity principle. Each country decides its tax level under the constraint that it has to be higher than a certain threshold. Therefore the distortion is alleviated via a supra national decision -"the level of the minimum tax"- but countries still decide freely their taxes. It is also anonymous as all countries face the same minimum tax level. The question is whether this reform could increase the welfare of all the representative consumers.

A minimum capital tax (which we call $\underline{\delta}$), in this model, constrains the strategies of the countries. This defines a new game where the payoffs are the same as the original one and the strategy set of each country is truncated. We define this as the *tax constrained game*. We show in the appendix that for all values of the minimum tax there exists an equilibrium of the tax constrained game.

In this section, we argue that, under the assumptions of our model, this reform cannot be accepted by all countries, despite the fact that it does increase overall production. Indeed, capital-exporting countries always reject it while capital-importing countries advocate it.

Proposition 1. *The minimum tax reform is never unanimously accepted.*

Proof. The proof is done in the appendix.

The reform causes an increase in the gross price of capital in bounded countries (since ρ variation, in absolute value, is less than $\underline{\delta}$ variation) and a decrease in unbounded countries (since ρ variation is bigger in absolute value than unconstrained tax variation).¹³ There is an overall convergence of marginal productivities, hence an overall gain. Nonetheless, the reform is not Pareto improving in that there are countries who loose from it.

As capital taxes are strategic complements, an increase of the minimum tax not only increases the level of taxation in the bounded countries, as it also increases the equilibrium taxes in all other countries. This plays as an amplified terms of trade effect. It depresses the international remuneration of capital which is detrimental for capital exporting countries and beneficial for capital importing ones. As in any acceptable reform importers are unconstrained ($\underline{\delta} < 0$), their gross interest rate decreases: they benefit from the capital flight effect as well. On the other hand, an unconstrained exporter is harmed by the capital flight effect as well as by the terms of trade one - it therefore vetoes the reform.

¹³See Lemma 2 in Appendix 1 for details.

The only case left for this reform to pass is if exporters are all constrained by the reform, but for this to be the case the minimum tax would certainly be close to zero. Hence, the capital flight effect would be negligible and exporters still loose from the terms of trade effect.

According to our model, if the European Union wants to pass this kind of reform, capital-exporting countries have to be compensated. Even if this is not impossible, it is nevertheless interesting to find another tax reform that would be self contained. We will develop this further in the next section.

It is because countries are asymmetric that the reform is unacceptable for some of them. With perfectly symmetric countries, a minimum tax would not have been rejected as all countries would be bounded the same way. In fact, symmetric countries are indifferent among any equilibrium in which they all fix taxes at the same level. The asymmetry among countries enriches the model so that the coordination discussion is not trivial.

3.2. The tax range reform

A tax range reform is defined as the imposition of a lower ($\underline{\delta}$) and an upper ($\bar{\delta}$) limit to the capital tax level. The tax range is given by $[\underline{\delta}, \bar{\delta}]$. The reform then consists in shrinking the interval, that is, $\Delta \underline{\delta} > 0$ and $\Delta \bar{\delta} \leq 0$. We show that tax reforms that are unanimously preferred to the non-cooperative equilibrium do exist. The success of this reform comes precisely from the weakness of the former. If it is detrimental for the capital-exporting countries and advantageous for the capital-importing ones to be bounded from below, it is reasonable to expect the opposite effect from an upper boundary. As both policies decrease the inter-country difference in capital cost, they both improve the capital allocation efficiency and create a surplus to be shared. We can therefore expect a net gain for both countries from the combination of these two reforms.

We state the following proposition:

Proposition 2. *Tax range reforms that leave international remuneration of capital unchanged exist and are always accepted as long as both extremes converge and $0 \in [\underline{\delta}, \bar{\delta}]$. Moreover, as a result of the tax reform, all capital-exporting countries increase their capital tax and all capital-importing ones decrease it.*

Proof. The proof is done in the appendix.

The intuition behind this result is the following.

As ρ is unchanged, the terms of trade effect on welfare is neutralized. Note that this is possible because the tax range reform consists of two measures, introducing both an upward and a downward pressure on ρ .

This neutralization allows unconstrained countries to secure their pre-reform welfare by maintaining the same tax level. Hence, they weakly prefer the reform.

Tax constrained countries all benefit from the capital movement effect: importers are forced to decrease their tax rates, thereby increasing equilibrium capital and the reverse happens to exporters.

In this proposition, the zero capital tax rate seems to be an objective to tend to, which is not surprising since the labor tax is non-distortive while the capital tax is. We can reasonably conjecture that if labor supply were elastic, a positive capital tax rate would play this role, that is, we would be interested in tax reforms that would bring capital tax rates closer to this optimal positive value.

As we discussed above this reform respects the three conditions we stated in the introduction for political feasibility : *Pareto improvement, anonymity and subsidiarity*.

A more ambitious way of interpreting this work is to see it as an attempt to design supra-national (for Europe) or federal (for Australia, Canada or the US) institutions to avoid the inefficiencies linked to fiscal competition. An institution consists of competencies and a decision rule. The competency of such an institution would be the setting of the tax range. Of course such a supra-national institution would have less of a hard time being accepted if it based its decisions on the unanimity rule, since this gives veto power to sovereign countries involved in it. This is indeed the decision rule prevailing throughout European Union institutions.

4. An Example

In this section, we provide an example of how the tax range reform works, using a particular production function, already used by Bucovetsky (1991) and Grazzini and van Ypersele(1997):¹⁴

$$f(k) = (a - bk)k$$

¹⁴It perfectly fits in the assumptions we impose except for two technical conditions i.e. $f'(0) = \infty$, $f'(\infty) = 0$. These conditions have to be replaced by $\bar{k}_i < \frac{a\gamma_i}{2b}$, in order to ensure positive marginal productivity, where $\gamma_i = \frac{\bar{K}_w}{\bar{K}_i}$.

We may write the first order conditions as:¹⁵

$$\frac{dU_i}{dt_i} = 2b\lambda_i(\bar{k}_w - \bar{k}_i) + \lambda_i \sum_{j=1}^N \lambda_j t_j - t_i = 0 \quad (4.1)$$

Note that $\sum_{j \neq i} \frac{dt_j}{dt_i} = \sum_{j \neq i} \lambda_j \lambda_i = \lambda_i - \lambda_i^2 < 1$ for any $\lambda_i < 1$ hence the reaction functions are contractions, therefore the equilibrium exists and is unique. When the tax range is imposed, the equilibrium of the constrained game solves the system of equations formed by the first order conditions of the non-constrained countries. Again, it is unique, as this is a non-homogeneous system of equations (or, conversely, the contraction assumption is still verified).

We now provide a numerical example of our coordination policy.

Take a three country framework. One easily checks that

$$\rho = a - 2b\bar{k}_w - t_1\lambda_1 - t_2\lambda_2 - t_3\lambda_3 \quad (4.2)$$

The best reply of each country i is given by

$$t_i(t_j, t_k) = \frac{2b\bar{k}_w(\lambda_i - \gamma_i) + \lambda_i(t_j\lambda_j + t_k\lambda_k)}{1 - \lambda_i^2} \quad (4.3)$$

and equilibrium taxes are given by

$$t_i^* = \frac{2b\bar{k}_w(\lambda_i(1 - \gamma_j\lambda_j - \gamma_k\lambda_k) - \gamma_i(1 - \lambda_j^2 - \lambda_k^2))}{1 - \lambda_i^2 - \lambda_j^2 - \lambda_k^2} \quad (4.4)$$

Let us label the countries such that $t_1^* \leq t_2^* \leq t_3^*$. (When the γ are equal in all countries, the equilibrium tax is an increasing function of the λ).

Proposition 2 shows that a tax range reform, $[\underline{\delta}, \bar{\delta}]$, is acceptable as long as it induces a weak convergence of the extreme taxation, $0 \in [\underline{\delta}, \bar{\delta}]$ and ρ is unaffected by the reform. The question we are willing to examine in this example is how far can we go with such a reform. Let us start with a tax range that is such that $\underline{\delta} = t_1^*$ and $\bar{\delta} = t_3^*$. This range induces a weak convergence, doesn't affect the international remuneration of capital and is therefore acceptable for all countries (not surprisingly as it doesn't constrain them). Could we go further? Consider the following tax reform : $[\underline{\delta} + \Delta\underline{\delta}, \bar{\delta} + \Delta\bar{\delta}]$. With $\Delta\underline{\delta}$ and $\Delta\bar{\delta}$ chosen to leave ρ unchanged when country 2 is on its best reply. Using (4.2) and (4.3) or, alternatively, (5.9) in the Appendix, one can check that

$$\frac{\Delta\bar{\delta}}{\Delta\underline{\delta}} = -\frac{\lambda_1}{\lambda_3}$$

¹⁵Note that $\frac{d^2 U_i}{dt_i^2} = (\lambda_i^2 - 1) < 0$ (an equilibrium exists) and $\frac{d^2 U_i}{dt_j dt_i} = \lambda_j \lambda_i > 0$ (strategic complementarity is verified).

and that this reform leaves unchanged the taxation of country 2 as long as country 2 is unbounded.

If $\underline{\delta} + \Delta\underline{\delta} > t_2^*$, country 2 is bounded from below and

$$\frac{\Delta\bar{\delta}}{\Delta\underline{\delta}} = -\frac{\lambda_1 + \lambda_2}{\lambda_3}$$

If $\bar{\delta} + \Delta\bar{\delta} < t_2^*$, country 2 is bounded from above

$$\frac{\Delta\bar{\delta}}{\Delta\underline{\delta}} = -\frac{\lambda_1}{\lambda_3 + \lambda_2}$$

If the reform process is a sequence of small moves and if at any point a country has the possibility to block further convergence, the ultimate tax reform that is going to be acceptable is the one where one of the boundaries is zero. If the lower bound becomes positive, then countries bounded below loose whereas if the upper bound becomes negative, then the one bounded above are losers (conditions (5.7) and (5.8) in Appendix 2).

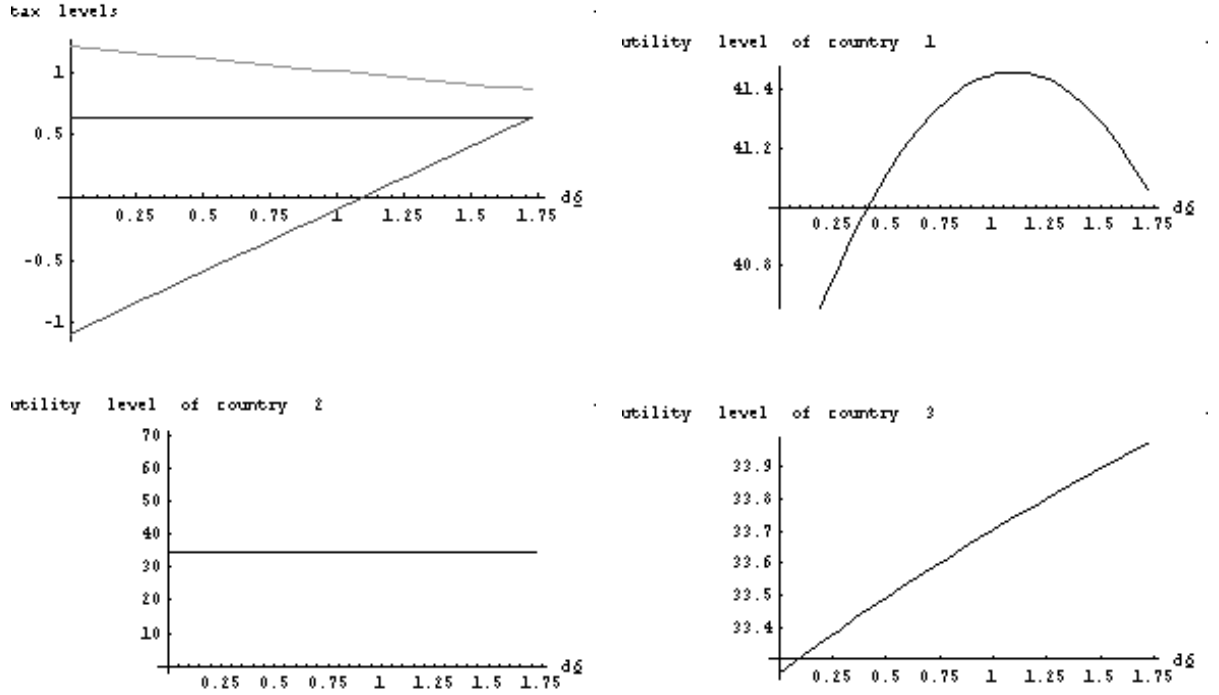
On the other hand, if one were able to further converge the tax boundaries, the reform would achieve a more efficient outcome. The fact that, say, an exporting country is worse when passing - marginally - from a nil to a positive tax rate - does not imply that it is worse when passing from its unconstrained negative tax rate to a given positive one.¹⁶ If that is the case, then the country votes for a once and for all move to the given positive tax, even if he vetoes a marginal move away from zero if the reform is made gradually.

Therefore, the particular institutional way in which the reform is designed is not neutral - more ambitious reforms are achieved if discrete jumps of the tax boundaries are proposed.

Let us give an example where all γ are equal and the relative population sizes are $\lambda_1 = .1$, $\lambda_2 = .4$ and $\lambda_3 = .5$.

The first figure shows us the different tax ranges that do not modify ρ . The three following figures show the welfare of each country as a function of the increase in the lower bound. Note that as soon as the capital exporting country (country 1) is forced to set a positive tax, its welfare starts to decrease, but there are positive taxes for which its welfare is higher than at the initial situation.

¹⁶Note that, at given ρ , the change in utility is given by $(w_1 - w_0) + t_1 k_1 - t_0 k_0$ where the first term is negative but the two others are positive.



5. Concluding Remarks

In this paper we have analyzed fiscal coordination among N sovereign asymmetric countries. We have shown that, when countries behave non-cooperatively, at equilibrium, the capital tax level differs among countries leading to an inefficient allocation of resources. We examined two tax reforms, one that imposes a minimum tax and another that fixes a range in which capital tax levels must lie. The latter is approved by unanimity, while the former is not.

We argued that the tax range reform plus the unanimity rule could be an interesting starting point for discussion of a supranational or federal fiscal institution since it contains some appealing principles like the anonymity of the reforms and the subsidiary principle. We also showed by means of a numerical example that it is not irrelevant to consider reforms consisting of successive marginal changes in tax boundaries as opposed to discrete jumps, this latter allowing us, in principle, to implement more ambitious tax reforms.

The success of our proposal rests on the fact that the policy has two degrees of freedom which may be jointly manipulated as to neutralize the terms of trade effect while making more capital available for countries who like it and less for countries who do not like it. We can therefore reasonably conjecture that in any other setting where, at equilibrium, we do have countries who subsidize and others

who tax capital, some tax range reform is implementable. This would be the case under a variety of assumptions about the governments' fiscal instruments, as no combination of tax instruments is as effective as the source tax on capital to manipulate its net price.

If a residence-base capital tax were available to the government, it would be a perfect substitute of our labor tax, therefore our analysis rests unaltered. Another possible extension is to have endogenous labor supply and/or endogenous savings. If savings or labor are not so elastic as to undermine the government's ability to provide the public good, they still fulfil the role of equilibrating the public budget, in a combination which minimizes the total distortion on labor and savings markets, allowing the source-based tax to be used to manipulate the terms of trade.

Of course, there may be cases when some minimal tax is more appealing than a tax range. We conjecture this to be the case with tax evasion. To be precise, in our model, capital owners (legitimately) place their capital in other countries, they do not engage in illegal activities in order to decrease their tax bill. To address tax evasion issues, we would need a richer framework. When tax evasion is possible (though risky) countries are more prone to coordinate in certain tax policies, as for instance in a minimum withholding tax. Indeed, to avoid getting caught by the tax authority, the capital owner has to get his capital income from abroad (for instance, a Belgian capital owner gets his dividend from a Luxembourg bank even though his capital is invested in Belgium). In this setting, even a residence based tax is not effective, and countries would probably not gain a lot by coordinating in such a tax. However, a minimum withholding tax fights this kind of tax evasion. It is therefore reasonable to suppose that countries would agree to coordinate on such a policy. Typically, the minimum withholding tax would be the lowest one out of the set of the nationally unconstrained preferred residence-based capital tax. Of course, one has to make a rather unreasonable assumption, namely, that no profit is made by the banks distributing the benefits. This would ensure that the only objective pursued by each country is to fight tax evasion. Clearly, this is not the case in countries like Luxembourg, which make huge profits from the financial institutions, and these are likely to block the minimum withholding tax.

Appendices

A1 : The minimum tax reform

The strategies of a constrained game are all the capital tax levels higher than the minimum tax level, $\underline{\delta}$, and the payoff of each country i is $U_i = \rho \bar{k}_i + w_i + t_i k_i$. Let us define $B(\underline{\delta})$ as the set of countries bounded when the minimum tax level is $\underline{\delta}$

and $\beta(\underline{\delta})$ the largest country index of $B(\underline{\delta})$ where, without loss of generality, we are re-indexing countries ordered by tax rates.

Lemma 1. *The tax constrained game has an equilibrium $(\tilde{t}_1^c(\underline{\delta}), \dots, \tilde{t}_i^c(\underline{\delta}), \dots, \tilde{t}_N^c(\underline{\delta}))$, where $\tilde{t}_i^c(\underline{\delta}) = \underline{\delta}$ for $i \leq \beta(\underline{\delta})$ and $\frac{d\tilde{t}_i^c(\underline{\delta})}{d\underline{\delta}} > 0$ for $i > \beta(\underline{\delta})$.*

Proof. Peralta and van Ypersele (2002) provide conditions for quasi-concavity of the continuous payoffs and show that strategy sets are compact and convex: hence an equilibrium exists. The equilibrium taxes are increasing functions of the minimum tax level because they are strategic complements. ■

This shows that for each level of the minimum tax rate, an equilibrium exists.

The following lemma addresses the issue of gross interest rate convergence.

Lemma 2. *The reform is efficiency enhancing:*

the effect of a minimum tax reform $\Delta\underline{\delta} > 0$ is to decrease k_i for $i \leq \beta(\underline{\delta})$ and to increase k_i for $i > \beta(\underline{\delta})$.

Proof. We first show that the variation in t_j for j not in B has to be smaller than $\Delta\underline{\delta}$. Suppose it is not, and pick up the country with the largest increase in t , say M . We have that $\Delta\underline{\delta} \leq \Delta t_M$ and also $\Delta t_j \leq \Delta t_M$, $j \neq M$. We then reach a contradiction:

$$\Delta t_M = \sum_{i \in B} \frac{dt_M}{dt_i} \Delta\underline{\delta} + \sum_{i \notin B} \frac{dt_M}{dt_i} \Delta t_i \leq \Delta t_M \sum_i \frac{dt_M}{dt_i} \leq \Delta t_M \phi < \Delta t_M$$

Hence, we must have $\Delta t_j < \Delta\underline{\delta}$ for any $j \notin B$.

As for ρ variation:

$$|\Delta\rho| = \sum_{i \in B} |\rho_{t_i}| \Delta\underline{\delta} + \sum_{i \notin B} |\rho_{t_i}| \Delta t_i < \Delta\underline{\delta} \sum_i |\rho_{t_i}| = \Delta\underline{\delta}$$

Moreover, note that $\sum_i \frac{dt_j}{dt_i} < 1$ and $\sum_i |\rho_{t_i}| = 1$, therefore $|\Delta\rho| > \Delta t_j$ for $j \notin B$.

We therefore have: for $i \in B$, $\Delta r_i = \Delta\underline{\delta} + \Delta\rho > 0$ and for $j \notin B$, $\Delta r_j = \Delta t_j + \Delta\rho < 0$.

In particular, $1 \in B$ and $N \notin B$ therefore there is a convergence in marginal productivities of capital across the world.

Proposition 1. *The minimum tax reform is never unanimously accepted.*

Proof. The utility levels in the constrained game are:

$$U_i = \rho \bar{k}_i + w_i + \tilde{t}_i^c(\underline{\delta}) k_i \quad (5.1)$$

The effect of a marginal change in $\underline{\delta}$ is then given by:

$$\frac{dU_i}{d\underline{\delta}} = (\bar{k}_i - k_i) \frac{d\rho}{d\underline{\delta}} + \tilde{t}_i^c(\underline{\delta}) k_i' \left(\frac{d\tilde{t}_i^c(\underline{\delta})}{d\underline{\delta}} + \frac{d\rho}{d\underline{\delta}} \right) \quad (5.2)$$

Where, for the case of bounded countries $\tilde{t}_i^c(\underline{\delta}) = \underline{\delta}$ and obviously $\frac{d\tilde{t}_i^c(\underline{\delta})}{d\underline{\delta}} = 1$.

We distinguish three cases:

1. The reform is such that $\underline{\delta} < 0$ and there is at least one exporting country who is unrestricted;
2. The reform is such that $\underline{\delta} < 0$ but all the exporting countries are restricted;
3. The reform is such that $\underline{\delta} > 0$.

In the first case, unrestricted exporting countries loose with the reform, and thus vote against. For unbounded countries, and noting that $\tilde{t}_i^c(\underline{\delta})$ is given by the first order condition, (5.2) is equal to:

$$\begin{aligned} \frac{dU_i}{d\underline{\delta}} &= (\bar{k}_i - k_i) \frac{d\rho}{d\underline{\delta}} - \frac{\rho_{t_i}}{1 + \rho_{t_i}} \frac{(\bar{k}_i - k_i)}{k_i'} k_i' \left(\frac{d\tilde{t}_i^c(\underline{\delta})}{d\underline{\delta}} + \frac{d\rho}{d\underline{\delta}} \right) = \frac{(\bar{k}_i - k_i)}{1 + \rho_{t_i}} \left(\frac{d\rho}{d\underline{\delta}} - \rho_{t_i} \frac{d\tilde{t}_i^c(\underline{\delta})}{d\underline{\delta}} \right) = \\ &= \frac{(\bar{k}_i - k_i)}{1 + \rho_{t_i}} \sum_{j \neq i} \rho_{t_j} \frac{d\tilde{t}_j^c(\underline{\delta})}{d\underline{\delta}} \end{aligned}$$

This expression is positive for capital importing countries and negative for capital exporting ones. As long as the reform is such that $\underline{\delta} < \max\{\tilde{t}_i \mid \tilde{t}_i < 0\}$, there is at least one exporting country who is unrestricted, and it loses with the reform. Hence, it votes against and the reform does not pass.

In the third case, all the exporting countries are restricted and they all loose from the reform. (5.2) is in this case given by:

$$\frac{dU_i}{d\underline{\delta}} = (\bar{k}_i - k_i) \frac{d\rho}{d\underline{\delta}} + \underline{\delta} k_i' \left(1 + \frac{d\rho}{d\underline{\delta}} \right) \quad (5.3)$$

From Lemma 2, we know that $0 > \frac{d\rho}{d\underline{\delta}} > -1$ and hence (5.3) is negative for $\bar{k}_i - k_i > 0$.

The only remaining case is the second. We again show that exporting countries are net losers from the reform.

The first term in (5.3) is negative, but the second one is positive since $0 > \frac{d\rho}{d\delta} > -1$. Nevertheless, we may reasonably assume that $\underline{\delta}$ is very close to zero (otherwise, there should be some exporting country whose tax rate was to the right of $\underline{\delta}$). Therefore, the positive part of (5.3) tends to zero and (5.3) is negative. ■

A2: The tax range reform

Again, we re-index countries ordered by their tax rates, we let $B(\underline{\delta}, \bar{\delta})$ denote the set of countries bounded by the minimum tax and we now further define $T(\underline{\delta}, \bar{\delta})$ as the set of countries bounded by the maximum tax. Let also $\beta(\underline{\delta}, \bar{\delta}) = 1 + \max_i B(\underline{\delta}, \bar{\delta})$ and $\theta(\underline{\delta}, \bar{\delta}) = \min_i T(\underline{\delta}, \bar{\delta}) - 1$. β is then the index of the unbound country with the lowest capital tax and θ is the index of the unbound country with the highest capital tax.

Lemma 3. *This game has an equilibrium $(\tilde{t}_1^C, \dots, \tilde{t}_i^C, \dots, \tilde{t}_N^C)$, where $\tilde{t}_i^C = \underline{\delta}$ when $i < \beta(\underline{\delta}, \bar{\delta})$, $\tilde{t}_i^C = \bar{\delta}$ for $i \geq \theta(\underline{\delta}, \bar{\delta})$ and $\tilde{t}_i^C = \tilde{t}_i^C(\underline{\delta}, \bar{\delta})$ when $\beta(\underline{\delta}, \bar{\delta}) < i < \theta(\underline{\delta}, \bar{\delta})$. Where $\frac{d\tilde{t}_i^C}{d\underline{\delta}} \geq 0$ and $\frac{d\tilde{t}_i^C}{d\bar{\delta}} \geq 0$.*

Proof. By the usual argument, the existence of the equilibrium is ensured. As capital taxes are strategic complements, $\frac{d\tilde{t}_i^C}{d\underline{\delta}} \geq 0$ and $\frac{d\tilde{t}_i^C}{d\bar{\delta}} \geq 0$. ■

Each tax range corresponds to a constrained Nash equilibrium. We now turn to the analysis of impact of a tax range reform $\Delta\underline{\delta}$, $\Delta\bar{\delta}$ on the welfare of the different representative agents.

Countries payoffs are given by (5.1). Call $\Delta\rho = \frac{d\rho}{d\underline{\delta}} \Delta\underline{\delta} + \frac{d\rho}{d\bar{\delta}} \Delta\bar{\delta}$. We have the following expressions for welfare variations following the reform.

For a **country bounded from below**, i.e. $i < \beta$, we get:

$$\Delta U_i = \frac{dU_i}{d\underline{\delta}} \Delta\underline{\delta} + \frac{dU_i}{d\bar{\delta}} \Delta\bar{\delta} = (\bar{k}_i - k_i) \Delta\rho + \underline{\delta} k'_i (\Delta\underline{\delta} + \Delta\rho) \quad (5.4)$$

For **countries bounded from above**,

$$\Delta U_i = \frac{dU_i}{d\underline{\delta}} \Delta\underline{\delta} + \frac{dU_i}{d\bar{\delta}} \Delta\bar{\delta} = (\bar{k}_i - k_i) \Delta\rho + \bar{\delta} k'_i (\Delta\bar{\delta} + \Delta\rho) \quad (5.5)$$

And for an **unbounded country**:

$$\Delta U_i = \Delta\rho (\bar{k}_i - k_i) + \tilde{t}_i^C k'_i (\Delta\tilde{t}_i^C + \Delta\rho) \quad (5.6)$$

with $\Delta\tilde{t}_i^C = \frac{d\tilde{t}_i^C}{d\underline{\delta}} \Delta\underline{\delta} + \frac{d\tilde{t}_i^C}{d\bar{\delta}} \Delta\bar{\delta}$

It is now possible to show the following proposition.

Proposition 2. *Tax range reforms that leave international remuneration of capital unchanged exist and are always accepted as long as $\Delta\underline{\delta} > 0$, $\Delta\bar{\delta} < 0$ and $0 \in [\underline{\delta}, \bar{\delta}]$. Moreover, as a result of the tax reform, all capital-exporting countries increase their capital tax and all capital-importing ones decrease it.*

Proof. From (5.4), (5.5) and (5.6), it directly follows that

when $i < \beta$,

$$\Delta U_i = \underline{\delta} k'_i \Delta \underline{\delta} \geq 0 \text{ as long as } \Delta \underline{\delta} > 0 \text{ and } \underline{\delta} \leq 0, \quad (5.7)$$

and, when $i > \theta$,

$$dU_i = \bar{\delta} k'_i \Delta \bar{\delta} \geq 0 \text{ as long as } \Delta \bar{\delta} < 0 \text{ and } \bar{\delta} \geq 0, \quad (5.8)$$

where the conditions on the boundaries and on the reforms are equivalent to the one stated in the proposition;

when $i \in [\beta, \theta]$,

$$\Delta U_i = \tilde{t}_i^C k'_i \Delta \tilde{t}_i^C$$

As by setting $\tilde{t}_i^C$ equal to its tax before, unbounded countries can secure the pre-reform welfare, if they change their equilibrium strategy, it is for the better. That is, $\Delta U_i \geq 0$ and, by the previous equation, $\tilde{t}_i^C$ and $\Delta \tilde{t}_i^C$ should have opposite signs, that is, $\Delta \tilde{t}_i^C \geq (\leq) 0$ when country i is a capital exporter (importer).

Under these conditions, all countries are (weakly) better off. The reform then passes.

To complete the proof, we have to show that such reform exists. To see this, note that

$$\begin{aligned} \Delta \rho &= \sum_{i=1}^N \frac{d\rho}{dt_i} \Delta t_i = \sum_{i \in B} \rho_{t_i} \Delta \underline{\delta} + \sum_{j \in T} \rho_{t_j} \Delta \bar{\delta} + \sum_{\substack{l \notin B \\ l \notin T}} \rho_{t_l} \left(\frac{d\tilde{t}_l^C}{d\underline{\delta}} \Delta \underline{\delta} + \frac{d\tilde{t}_l^C}{d\bar{\delta}} \Delta \bar{\delta} \right) = \\ &= \Delta \underline{\delta} \left(\sum_{i \in B} \rho_{t_i} + \sum_{\substack{l \notin B \\ l \notin T}} \rho_{t_l} \frac{d\tilde{t}_l^C}{d\underline{\delta}} \right) + \Delta \bar{\delta} \left(\sum_{j \in T} \rho_{t_j} + \sum_{\substack{l \notin B \\ l \notin T}} \rho_{t_l} \frac{d\tilde{t}_l^C}{d\bar{\delta}} \right) \end{aligned}$$

For the reform to be such that ρ doesn't change, it suffices to choose $\Delta \underline{\delta}$ and $\Delta \bar{\delta}$ such that:

$$\Delta \underline{\delta} = -\Delta \bar{\delta} \frac{\sum_{j \in T} \rho_{t_j} + \sum_{\substack{l \notin B \\ l \notin T}} \rho_{t_l} \frac{d\tilde{t}_l^C}{d\bar{\delta}}}{\sum_{i \in B} \rho_{t_i} + \sum_{\substack{l \notin B \\ l \notin T}} \rho_{t_l} \frac{d\tilde{t}_l^C}{d\underline{\delta}}} \quad (5.9)$$

Which is possible for some pair(s) $(\Delta \underline{\delta}, \Delta \bar{\delta})$ where $\Delta \underline{\delta} \leq 0$ and $\Delta \bar{\delta} \geq 0$. ■

References

- [1] Bucovetsky S. 1991, Asymmetric Tax Competition, *Journal of Urban Economics*, 30, 167-181.
- [2] Commission of the European Communities, 31-3-1992, Conclusions and Recommendations of the Committee of Independent Experts on Company Taxation, (Ruding Report), Bruxelles.
- [3] Commission of the European Communities, 22-10-1996, Taxation in the European Union: Report on the Development of Tax Systems, Bruxelles.
- [4] Cremer H., Fourgeaud V., Leite Monteiro M. and P. Pestieau (1995) Mobility and Redistribution : A Survey, CORE Discussion Paper 9566.
- [5] De Pater, J. and G. M. Myers, 1994, Strategic Capital Tax Competition: A Pecuniary Externality and a Corrective Device, *Journal of Urban Economics* 36, 66-78.
- [6] Dhillon, A., C. Perroni and K. A. Scharf, 1999, Implementing Tax Coordination, *Journal of Public Economics*, 72, 243-268.
- [7] Friedman, J. W., 1986, *Game Theory With Applications to Economics*, Oxford University Press.
- [8] Grazzini L. and T. van Ypersele, 1997, Tax Harmonization and Political Competition, CORE Discussion Paper 9754.
- [9] OECD 1991, *Taxing Profit in the Global Economy*, Paris.
- [10] Peralta, S. and T. van Ypersele, 2002, Capital Tax Competition Among an Arbitrary Number of Asymmetric Countries, Draft.
- [11] Persson T. and Tabellini G., 1992, The Politics of 1992: Fiscal Policy and European Integration, *Review of Economic Studies*, 59, 689-701.
- [12] Wildasin, D. E., 1989, Interjurisdictional capital mobility: fiscal externality and a corrective subsidy, *Journal of Urban Economics*, 25, 193-212.
- [13] Wilson, J. D., 1991, Tax Competition with Interregional Differences in Factor Endowments, *Regional Science and Urban Economics*, 21, 423-451.
- [14] Wilson J. D., 1999, Theories of Tax Competition, *National Tax Journal*, 52(2), 269-304.