Public Good Spillovers and Location of Firms

Nelly Exbrayat, Stéphane Riou

Public good spillovers and location of firms.

Nelly Exbrayat, Stéphane Riou

March 13, 2006

Abstract

We study the impact of positive public good spillovers on international capital tax competition in a spatial economy with two countries imperfectly integrated and with different levels of productivity. Firstly we analyze the outcomes with local public goods and with interregional public good spillovers. Even if the high productivity country chooses a higher level of tax at the equilibrium, a majority of firms locate here to enjoy higher economies of scale. Introducing public good spillovers yields to a lower tax gap and higher agglomeration. Secondly, we exhibit the resulting regional inequalities. Finally, analyzing the different kinds of fiscal externalities, we show that public good spillovers may aggravate the suboptimality of the tax in one country and mitigate it in the other country.

1 Introduction

Public expenditures often generate international spillovers. Until now, no attention has been given to their impact in a context of tax competition with spatial disparities. Hence, the objective of this paper is to incorporate public good spillovers in a model of asymmetric tax competition. Using a New Economic Geography framework that allows to endogenize spatial disparities, we investigate the size of public good spillovers, their impact on fiscal policies,on the location of firms and on workers' welfare.

The literature on tax competition has shown, in the past two decades, that capital mobility leads governments to adopt a strategical behavior in the design of their fiscal policies[1]. According to Zodrow and Mieszkowski (1986), governments set capital taxes strategically in order to prevent capital outflows, which induces a race to the bottom in capital taxes ending with a suboptimal level of public good provision. However, the location of activities driven by fiscal policies is the only source of interdependence between governments in most of the models of capital tax competition, whereas other channels of interdependence may affect this strategic behavior. Therefore, we have to identify these different possible channels of interdependence between governments in order to tackle tax competition.

On the one hand, international trade and specialisation caused by imperfect competition produces an economic interdependence between countries. The decline of transport costs gives rise to spatial disparities of economic activities, as Krugman (1991) argues in its core-periphery model. In other words, capital mobility is also affected by the location forces coming from the private sector. Recent models analyze tax competition within an economic geography framework in order to endogenize these location forces. They highlight the effect of transport costs on tax base elasticity with respect to the fiscal policy when the private sector is imperfectly competitive. Indeed, everything else equal, unless competition of firms is too tighted on the largest market, it may be more profitable to locate in this market. It makes it possible to meet a larger demand, to exploit economies of scale and to save on trade costs involved by exportation. As a consequence, the government may tax the "agglomeration rent" that firms enjoy. This is what Ludema and Wooton (1998), Kind et al. (1998) and Baldwin and Krugman (2004) find in their asymmetric tax competition models since they show that the government of the largest country can increase its capital tax without suffering from a capital outflow[2]. Finally, as pointed out by Ottaviano and

[1] For a survey see Wildasin and Wilson (2003).

[2] These theoretical predictions are supported by empirical studies such as Krogstrup

Van Ypersele and by Gaigné and Riou (2005), capital tax competition in an imperfect competition environment leads to two sorts of inefficiencies : the well-known inefficiency of the tax levels and the size of the public sector, and an inefficient location of the private sector caused by the tax gap[3].

On the other hand, public good spillovers constitute an other channel of interdependence between governments. Indeed, recall that tax revenues are devoted to the financing of the national public sector according to Musgrave's (1989) definition of state functions. However, expenditures on national public services can have beneficial or harmful effects onto residents in nearby countries. The examples of public expenditures that can have spillovers effects in neighboring countries are numerous: public transport infrastructures improve the accessibility of neighboring countries and favors international trade, education and publicly funded research and development efforts may benefit other countries through knowledge externalities, public spendings aimed at reducing pollution improve the international environment. Case Rosen and Hines (1993), Baicker (1995) or Murdoch, Rahmatian and Thayer (1993) provide good empirical evidence for the existence of such positive public good spillovers. According to Oates (1972), it induces a suboptimal provision of public good when residents are immobile, because governments ignore the positive effects of their public good provision for non-residents[4]. However, this is a model à la Tiebout (1956) where residents are both recipients and taxpayers of public spendings. This may introduce a bias toward efficiency of public good provision even with spillovers[5]. Moreover, this framework could be less relevant in so far as labor mobility is much less significant than capital mobility, especially in European countries. Taking into account both public good spillovers and the fiscal externalities caused by capital tax competition could worsen this suboptimality and weaken the public sector's durability.

To resume, few models consider public good spillovers in a context of

(2003) which shows that the sensitivity of capital flows to fiscal policies depends on agglomeration economies.

[3]In Ottaviano and Van Ypersele (2005), tax competition leads to subsidies to capital funded through taxes on labor. Hence public spendings takes the form of a redistribution between factors, so that there are no public goods.

[4]Later, Besley and Coate (2003) come back to Oates' Decentralization Theorem and analyze, following a political economy approach, the government's behavior in presence of public good spillovers when the economy is made of heterogenous jurisdictions.

[5]Governements internalize fiscal externalities through the location constraint because their citizen are not only recipients of the public sector but also their taxpayers. Thus, Wellisch (1992a, 1992b) shows that the inefficiency of public good provision no longer holds when residents are completely mobile.

international capital tax competition even if the coexistence of these two kinds of interdependence (fiscal and public spending externalities) between governments seems to be relevant. Firstly, Bjortvan and Schjelderup (2002) introduce public good spillovers in the Zodrow-Mieszkowski (1986) framework of symmetric capital tax competition. They show that these spillovers counteract the tax competition distortion even if the size of the public sector remains suboptimal[6]. Indeed, international spillovers, as well as worker's mobility, represent a link between countries which tends to equalize international welfare. Secondly, Kobayashi, Kunizaki and Nakamura (2003) analyze the effect of public good spillovers when governments do not only compete in tax rates but also in their pattern of public spending. These models show how public good spillovers affect the outcome of symmetric tax competition and its inefficiency. Nevertheless they ignore the emergence of spatial disparities caused by market location forces in an imperfectly competitive economy[7]. Therefore, they cannot explore how spatial disparities, shaped by the decline of transport costs, influence tax competition and the size of the public sector faced with spillovers. This is the gap we want to fill in this paper.

To explore these questions, we build an economic geography framework à la Ottaviano, Tabuchi and Thisse (2002) which is presented in the next section. Two countries compete to attract firms in an environment of imperfect competition with transport costs. These countries differ in their level of productivity in the manufacturing sector and we consider that capital mobility depends on the spatial differences in net profits. The public sector can generate positive spillovers whose intensity may be underestimated by governments.

The rest of the paper is organized as follows. In the third section, we compare the outcomes of tax competition with local public goods and with international public good spillovers. Asymmetric tax competition results in a majority of firms located in the high productivity country where the level of taxation is higher. Public good spillovers foster agglomeration because they lead to a lower tax gap. Hence it results in international disparities that we analyze in section four. We show that consumers' surplus and public good provision are higher in the high productivity country. The decline of transport of transport costs favors the convergence of international welfare, while public good spillovers strengthen the difference of consumer's

[6] The suboptimal size of the public sector comes exclusively from the free-riding behavior of governments when the public good is pure.

[7] In these models, equilibrium taxes are symmetric and then public good provision is equal across regions.

surplus. Finally, we carry out an efficiency analysis in the subsequent section and we isolate different kinds of externalities. While tax competition leads to a positive fiscal externality in both countries because of the tax base erosion effect, symmetric public good spillovers leads to a fiscal externality whose sign and intensity differ across countries depending on their tax base elasticities.

2 The model

We consider an economy with two large countries, labelled $r = 1, 2$. The economy is endowed with N firms and $2L$ workers equally distributed across countries ($L_r = L_s = L$). There are two sectors, a public sector and a private one. The public sector of each country is represented by a government levying a unitary tax on firms and providing a public good to domestic households. The private sector consists of a modern industry (M) and a traditional one (T). The M-sector produces a continuum of varieties of a horizontally differentiated product under increasing returns, using workers as the only input. The T-sector produces a homogenous good (the numéraire) under constant returns, using also workers as the only input. Firms of the M-sector are perfectly mobile between countries. Workers are not mobile between countries but are mobile between private sectors.

2.1 Consumption

Preferences for the goods produced in the private sector are identical across workers and, following Ottaviano et al. (2002), are captured by a quasi-linear quadratic utility given by:

$$u(.) = \alpha \int_0^N q(i)\, di - \frac{\beta - \gamma}{2} \int_0^N [q(i)]^2\, di - \frac{\gamma}{2} \left[\int_0^N q(i)\, di \right]^2 + q_O \qquad (1)$$

where $\alpha > 0$ and $\beta > \gamma > 0$. In this expression, α measures the intensity of preferences for the differentiated product with respect to the numéraire. The condition $\beta > \gamma$ implies that workers have a preference for variety. Finally, $q(i)$ is the quantity of variety $i \in [0, N]$ and q_O the quantity of the numéraire. Each worker is endowed with $\overline{q}_O > 0$ units of the numéraire. The initial endowment is supposed to be large enough for her/his consumption of the numéraire to be strictly positive at the market outcome. Her/his budget

constraint can then be written as follows:

$$\int_0^N p(i)\, q(i)\, di + q_O = \overline{q}_O + y_r \tag{2}$$

where $p(i)$ is the consumer price of variety i and y_r is the workers's net income residing in country r with

$$y_r \equiv w_r$$

with w_r the wage tax prevailing in country r. Given the assumption of symmetry between varieties, solving the consumption problem yields the demand functions for a representative variety located in r from country r (q_{rr}) and country s with $s \neq r$ (q_{rs}):

$$q_{rr} = a - (b + cN)\, p_{rr} + cP_r \quad q_{rs} = a - (b + cN)\, p_{rs} + cP_s \tag{3}$$

where

$$a \equiv \alpha / [\beta + (N-1)\gamma] \quad b \equiv 1 / [\beta + (N-1)\gamma] \quad c \equiv \gamma / (\beta - \gamma)[\beta + (N-1)\gamma]$$

and p_{rr} (resp., p_{rs}) is the price of a variety located in country r to consumers of country r (resp., s). Finally,

$$P_r = N_r p_{rr} + N_s p_{sr} \quad P_s = N_r p_{rs} + N_s p_{ss} \tag{4}$$

are the price indices (i.e., N times the average price) of varieties in country r and in country s, respectively, with N_r and N_s the number of varieties/firms located in r and s.

2.2 The private sector

The traditional sector produces a homogeneous good under perfect competition and constant returns to scale. One unit of output requires one unit of labor. The T-good is costlessly traded between countries so that its price is the same everywhere. This makes that good the natural choice for the numéraire, which implies that price of the T-good and, the equilibrium wage of immobile workers are equal to one everywhere. Therefore, the T-sector is not taxed since profits are zero.

The modern sector supplies varieties under increasing returns to scale and monopolistic competition. For a firm located in country r, the production of any variety requires a fixed amount ϕ_r of labor L with

$$\phi_2 > \phi_1$$

In other words, we assume that country 1 has an advantage in terms of productivity. We define θ as the productivity wedge between countries given by $\theta = \phi_1 - \phi_2 < 0$. Hence, as suggested by Bjorvatn and Schelderup (2002) we focus on asymmetric tax competition to explore the role of public good spillovers.

There exists a one-to-one correspondence between firms and varieties. Firms of M-sector compete within a large group of firms. The total mass of firms in this sector is fixed and is equal to N[8]. We consider a market structure with monopolistic competition in which entry is restricted instead of being free. Thus, firms have a market power and will earn positive profits which will be taxed by local governments. We consider that all profits are equally distributed to households located in the economy. We assume that each resident owns an equal share of the total stock of capital.

Varieties of M-good are traded at a cost of τ units of the numéraire per unit shipped between the two countries. As firms bear trade costs, gross profits of a representative firm in country r are as follows:

$$\Pi_r = p_{rr} q_{rr} L_r + (p_{rs} - \tau)\, q_{rs} L_s \quad \text{with } r \neq s \tag{5}$$

where L_r (resp., L_s) is the number of workers located in country r (resp., s). Note that because labor is mobile between sectors, the wage rate is fixed to 1 in the M-sector. Nevertheless, this will be verified only if the sector T is always active in both countries. Then, we have to ensure that a single location alone cannot supply the world demand in the homogeneous good. The condition is $1 < 2q_O$.[9].

When producers maximize profits, they take the price indices as given. Nevertheless, the market as a whole has a non negligible impact on each firm's choice in that each firm must account for the distribution of all firms' prices through an aggregate statistics (the price index) in order to find its equilibrium price. Thus, the market solution is given by a Nash equilibrium with a continuum of players in which prices are interdependent. The profit-maximizing prices are the same obtained by Ottaviano et al. (2002) and are given by

$$p_{rr} = \frac{1}{2}\frac{2a + \tau c(N - N_r)}{cN + 2b} \quad p_{rs} = p_{ss} + \frac{\tau}{2} \tag{6}$$

[8] Picard et al. (2004) have the same assumption in a spatial version of Dixit-Stiglitz model.

[9] An other condition indicates that full agglomeration of the modern sector in one region is not sufficient to promote equilibrium in the labor market of this region, that is $L > 2\phi_r N$ where $\phi_r N$ is the number of workers employed in the modern sector when a core-periphery configuration emerges.

Freight absorption by firms located for instance in r is a decreasing function of their relative number. The reason is that as N_r falls, the market in country s becomes more crowded then pushing down local prices. As a result, the elasticity of demand for firms located in r rises on foreign sales while falling on domestic ones. The result is that they find convenient to reduce their operating margins on foreign sales while increasing them on domestic sales (Brander and Krugman, 1983).

By inspection, it is readily verified that p_{rr} is increasing in τ because the local firms are more protected against foreign competition. By contrast, $p_{rs} - \tau$ is decreasing because it is now more difficult for firms to sell on the foreign market. As firms' prices net of trade costs have to be positive for any distribution of workers, we assume throughout this paper that

$$\tau < \tau_{trade} \equiv \frac{2a}{2b + cN}. \tag{7}$$

This condition also guarantees that it is always profitable for a firm to export to the other country.

After introducing (3) and (4) in (5), we get the equilibrium gross profits earned by a firm established in r on the market of the country r and s with

$$\Pi_r \equiv (b + cn) (p_{rr})^2 L + (b + cn) (p_{rs} - \tau)^2 L$$

In our model, price competition acts as a dispersion force while the difference in productivity favors firm clustering in the high productivity country.

Before evaluating the effects of public intervention on existing location forces in the next section, we first define the free-market equilibrium λ^M governed by the spatial differences in gross profits,

$$\pi_r = \Pi_r - \phi_r \tag{8}$$

An interior equilibrium exists if and only if $\pi_r = \pi_s$. This leads to the following location equilibrium:

$$\lambda^M = \frac{1}{2} - \theta \frac{cN + 2b}{LcN (cN + b) \tau^2} \tag{9}$$

characterized by a majority of firms in the country 1 because of higher increasing returns to scale. This agglomeration increases with the productivity wedge and the decline of trade costs, until we reach the core periphery equilibrium. Such a configuration occurs for all θ below the threshold

$$\theta^M_{agglo} = -\frac{LcN (b + cN)}{2 (cN + 2b)} \tau^2$$

As interior equilibria reflect the most common patterns of location, we will restrict our attention to values of the productivity wedge higher than this threshold in what follows.

2.3 The public sector

We define G_r as the amount of total public expenditures in country r. Furthermore, we assume that public goods generate positive spillovers across countries. Non residents enjoy positive spillovers because they benefit from a better environment or tourism amenities for example. Indeed, workers are not completely immobile, especially those located near the frontiers. They can occasionally move to neighboring countries to enjoy recreation facilities which are not provided in their country. Hence we can consider that they are immobile only with respect to the private sector and the labor market to which they need a good daily access; whereas they are mobile with respect to the amenities and infrastructures financed by the public sector that they will occasionally need/want to enjoy[10].

The national public sector enter the utility function of the resident as follows

$$U_r = u(.) + \mu(G_r + \rho G_s) \tag{10}$$

where $0 < \rho < 1$ is the degree of spillovers so that $G_r + \rho G_s$ stands for the effective amount of public goods that residents of country r benefit from. We can distinguish two polar cases : when $\rho = 0$ it is a local public good whereas when $\rho = 1$ it is a pure public good. Thus, the intensity of spillovers is assumed to be variable but symmetric across countries. The parameter μ represents the specific importance of the public sector compared to the private one. Because of the distortions caused by imperfect competition in the private market, it seems relevant that governments give a more important weight to the public sector. Observe that this parameter is also used by Besley and Coate (2003) and Andersson and Forslid (2003) to reflect the different extent to which citizens value the public good.

The public sector is represented in each country by a government acting independently in a fully decentralized framework. We consider that this government is benevolent, so he chooses the level of the unit tax on profits t_r which maximizes its perception about the aggregate welfare of

[10] Thus, we seek to reach a compromise between models à la Tiebout where tax base is made of perfectly mobile citizens and models of capital tax competition where tax base is often made of perfectly mobile physical capital and immobile citizens.

workers/consumers living in its jurisdiction :

$$F_r = S_r L + L + \frac{1}{2}(\pi_r \lambda_r N + \pi_s \lambda_s N) + \mu\left(G_r + \omega \rho G_s\right) \tag{11}$$

with $0 < \omega < 1$ the government's internalization degree of public good spillovers, and S_r the consumer's surplus in country r given by

$$S_r = \frac{a^2 N}{2b} - a(N_r p_{rr} + N_s p_{sr}) + \frac{b + cN}{2}(N_r p_{rr}^2 + N_s p_{sr}^2) - \frac{c}{2}(N_r p_{rr} + N_s p_{sr})^2$$

where prices are given by (6). Thus, the objective function is the sum of four components: the aggregate income L, the aggregate consumer surplus LS_r, the agregate capital income $((\pi_r \lambda_r N + \pi_s \lambda_s N)/2)$, and the available level of public goods according to its government $(\mu\left(G_r + \omega \rho G_s\right))$. Observe that we know from the location stage that $\pi_1 = \pi_2$. Hence (11) becomes $F_r = S_r L + L + \pi_r N/2 + \mu\left(G_r + \omega \rho G_s\right)$.

We can make two comments about this objective function. Firstly, asymmetric capital tax competition affects consumer's surplus via the spatial allocation of firms. Thus, governments want to attract the maximum of firms in order to increase its consumers' surplus, because the stronger competition is on the private market, the lower are prices[11]. Secondly, the extent to which public good spillovers coming from the neighboring country is welfare enhancing according to a government varies with respect to its internalization degree. Indeed, contrary to Bjortvan and Schjelderup (2002), we assume that the international government has got an imperfect information about the extent of public good spillovers[12]. Thus we follow the approach adopted by Kobayashi, Kunizaki and Nakamura (2003) by assuming that international governments underestimate the intensity of such spillovers[13]. To resume, our framework is different from the previous literature of public good spillovers and capital tax competition because it combines imperfect information of local governments with respect to public good spillovers and imperfect competition in the private market, both of them affecting residents welfare.

[11] Such a mechanism cannot occur in Bjortvan and Schjelderup's framework because the private sector is perfectly competitive.

[12] In their model, they assume that regional governments know exactly the intensity of public good spillovers its residents benefit from (according to them $\omega = 1$).

[13] This approach is supported by Case et al. (1993) who mention : "actions of governments that respond to spillovers that they perceive but that do not really exist". In other words, governments may under-estimate or over-estimate the extent of public spillovers.

Finally, public expenditures in each country are financed by tax revenues collected thanks to a unitary source-based tax t_r on firm's profit, so the maximization of its residents' welfare is subject to the following budget constraint :

$$G_r = t_r \lambda_r N \tag{12}$$

where λ_r is the share of firms located in country r with $\lambda_r + \lambda_s = 1$.

2.4 Sequence of events

There are two types of actors: firms and governments. In the first stage, each government chooses simultaneously its tax on firms' profit taking as given the decision of the other government, and anticipating the private sector outcomes and the resulting location equilibrium. In stage 2, given the taxes announced by the two governments, firms choose their place of production.

Information of players is common knowledge and the game is solved by a sub-game perfect equilibrium involving backward induction beginning with the last stage. We first determine the location equilibrium for given taxes which is such that $\pi_1 = \pi_2$, with $\pi_r = \Pi_r - \phi_r - t_r$ and we get

$$\lambda(t_1, t_2) = \frac{1}{2} - (cN + 2b)\frac{t_1 - t_2 + \theta}{cNL(b + cN)\tau^2} \tag{13}$$

As governments anticipate this behavior of firms with respect to their location choice, we will describe the policy outcome at the first stage given by Nash taxes. Then we will describe the location equilibrium that we get by inserting Nash taxes values in (13).

3 Outcome in a decentralized economy

Firstly we study the case when each local government provide local public goods. Then we introduce positive public good spillovers across countries in this framework in order to see if it affects the tax setting.

3.1 With local public goods

The only public goods that residents benefit from are those provided by their government because public goods are exclusively local ones. Thus we assume that $\rho = 0$. Hence the government's objective function is the sum

of its local public good provision and the aggregate consumer surplus. The maximization program is given by

$$\begin{array}{l} t_r \text{ arg Max } LS_r + L + \dfrac{\pi_r}{2}N + \mu G_r \\ \text{s.c } G_r = t_r \lambda_r N \end{array} \tag{14}$$

with $G_r = t_r \lambda_r (t_r, t_s) N$ the level of local public goods and $S_r = S_r (\lambda_r (t_r, t_s))$ the consumer surplus which depends the location of firms for given fiscal policies.

Thus spatial interaction between governments is only indirect as Revelli (2004) means. He argues that governments can interact through three channels : preferences, constraints and expectations. International capital tax competition with local public goods exclusively refers to the interdependence acting through the budgetary constraints. Each government independently chooses its tax to maximize the welfare of its own residents without taking account the impacts of its choice on the size of the tax base available to the other government.

3.1.1 Stage 1: Nash tax equilibrium

Maximizing (14) with respect to the capital tax t_r, we get the first order condition of the government:

$$L\frac{\partial S_r}{\partial \lambda_r}\frac{\partial \lambda_r}{\partial t_r} + \frac{N}{2}\left[\frac{\partial \Pi_r}{\partial \lambda_r}\frac{\partial \lambda_r}{\partial t_r} + 1\right] + \mu N\left[\frac{\partial \lambda_r}{\partial t_r}t_r + \lambda_r\right] = 0 \tag{15}$$

where λ_r is given by (13). Note that $\partial \lambda_r / \partial t_r < 0$ because of the tax base erosion effect: everything else equal, an unilateral increase of the capital tax leads to a capital outflow. The second term in the first order condition represents the effect of an unilateral capital tax increase on the agregate capital income of residents ($\partial (\pi_r N/2) / \partial t_r$). On the one hand, each government has incentives to choose a low level of capital taxes to avoid from suffering a capital outflow. Indeed, it would be harmful for the provision of public good, for consumer surplus and for the net capital income. On the other hand, each government has an interest in setting a high enough level of capital tax to increase the size of its public sector devoted to the local residents, but also to limit the level of competition on the private market which has a negative impact on gross capital income.

Solving this system yields the following Nash tax equilibrium

$$\begin{array}{l} t_1 = \frac{1}{4}(b + cN)\tau L \frac{\Lambda(\tau)}{\mu(cN+2b)^2} - \Upsilon(\mu)\theta \\ t_2 = \frac{1}{4}(b + cN)\tau L \frac{\Lambda(\tau)}{\mu(cN+2b)^2} + \Upsilon(\mu)\theta \end{array} \tag{16}$$

with $\Lambda(\tau) = \left(2\tau b^2 + 4b\mu cN\tau - 4ba + 2\mu c^2N^2\tau - 4cNa - c^2N^2\tau\right)$ and $\Upsilon(\mu) = 8\mu b + cN(4\mu - 1)/2(12\mu b + cN(6\mu - 1))$

The sign of the first term is ambiguous and depends on the sign of $\Lambda(\tau)$. When

$$\tau > \tau^* = 4a\frac{cN + b}{c^2N^2(2\mu - 1) + 4b\mu cN + 2b^2} \tag{17}$$

$\Lambda(\tau)$ and the first term in Nash taxes are positive, with $\tau^* < \tau_{trade}$ for a high enough level of μ[14].

In what follows, we assume that these conditions are checked, so that the government of the high productivity country has incentives to levy a positive tax on profits. To sum up, this implies that the supply of public good gives rise to scale returns in terms of utility and that transport costs are high enough. The effect of transport cost requires more detail. Indeed, a transport cost decline strengthens the location forces coming from the market since $\partial^2\lambda_r/\partial t_r\partial\tau = 2(cN + 2b)/cNL\tau^3(b + cN) > 0$. In other words, the tax base erosion effect, which induces governments to decrease their capital tax, gets stronger as trade costs fall. Thus, governments have to promote lower taxation to preserve their attractiveness. It is no more profitable to levy positive taxation. That is why, we will focus throughout the paper on high enough trade cost so that public good provision matters for governments.

Some calculations show that the tax rate of the low productivity country is also positive provided that the productivity wedge is low enough

$$\theta > \tilde{\theta}^{\rho=0} = -\frac{1}{2}(b + cN)\tau L\Lambda(\tau)\frac{6\mu(2b + cN) - cN}{\mu(2b + cN)^2(4\mu(2b + cN) - cN)}$$

This condition is assumed to be checked in the rest of the paper because we are interested in public good spillovers when there is a public sector in both countries.

We can make two main comments about the expression of Nash taxes. The first term in brackets is common to both countries and explains the evolution Nash taxes with respect to the trade cost value, while the second term relates to the evolution of Nash taxes with respect to the productivity wedge. Considering the first component, we show that $\partial t_r/\partial\tau > 0$ when

$$\tau > \hat{\tau} = 2a\frac{b + cN}{2b(b + 2\mu cN) + c^2N^2(2\mu - 1)} \tag{18}$$

[14]More precisely, $\tau^* < \tau_{trade}$ if and only if $\mu > \bar{\mu} = \frac{b^2}{(cN+2b)cN} + 1$. Since $b^2 < 1$, we consider this condition holds throughout this paper.

whereas it is negative otherwise, with $\hat{\tau} < \tau^*$. Thus, for the range of trade costs such that taxes are positive, taxes decrease with the decline of transport cost. Moreover $\partial t_1/\partial\tau = \partial t_2/\partial\tau$, so the decline of transport costs does not affect the tax gap.

Consider now the second term $\Upsilon(\mu)$ in the expressions of the Nash taxes, which is positive and enters with the opposite sign for each country. This term tells us if asymmetric tax competition leads to the emergence of fiscal incentives to capital flows. Evaluating the difference of taxes at the Nash equilibrium yields the following tax gap

$$\Delta^{\rho=0} = t_1 - t_2 = -2\ \theta\ \Upsilon(\mu) \tag{19}$$

which is positive. In other words, the taxation of firms is higher in the most productive country. Indeed, on the one hand, the government of the low productivity country has to set its capital tax to a lower level than the other government in order to unless partially compensate its productivity disadvantage. On the other hand, it is possible for the government of the high productivity country to increase its residents' welfare by choosing a higher level of taxation because its productivity allows him to do so without suffering from a capital outflow. Thus,

Proposition 1 *The capital tax is higher in the high productivity country than in the low productivity one.*

Observe that this result can also be obtained with asymmetric population size (Ottaviano and Van Ypersele (2005), Baldwin and Krugman (2004)), and not only with an asymmetry in the technology of production.

3.1.2 Location equilibrium at the Nash taxes

Let now evaluate the location equilibrium at the Nash taxes. Inserting (16) into (13), we get

$$\lambda^{\rho=0} = \frac{1}{2} - 2\theta\mu\frac{(cN+2b)^2}{(12\mu b + cN(6\mu-1))\,cNL(b+cN)\,\tau^2} \tag{20}$$

which is higher than 1/2. In other words, the country with a productivity advantage ends with a higher proportion of firms, even if its government charges a higher tax rate on firms than does the other government. More precisely, it yields complete agglomeration as soon as the wedge productivity falls behind the following threshold value

$$\theta^{\rho=0}_{agglo} = -\frac{1}{4}\tau^2 cNL(b+cN)\,\frac{12\mu b + cN(6\mu-1)}{\mu(cN+2b)^2} \tag{21}$$

which is lower than $\tilde{\theta}^{\rho=0}$. Hence,

Proposition 2 *Asymmetric tax competition leads to a partial agglomeration of firms in the most productive country, even if it chooses a higher level of capital tax than does the other country.*

We can wonder if tax competition enhances the existing agglomeration forces or attenuates them. Because of the difference of productivity levels, capital tax competition leads to fiscal incentives to invest capital in the low productivity country where taxation is lower. So we can expect that asymmetric tax competition without international public good spillovers acts as a dispersion force. To verify this, we compare the location equilibrium resulting from asymmetric tax competition given by (20) with the free-market location equilibrium given by (9) :

$$\lambda^{\rho=0} - \lambda^{M} = \theta \left(cN + 2b\right) \frac{8\mu b + cN\left(4\mu - 1\right)}{\left(12\mu b + cN\left(6\mu - 1\right)\right) cNL\left(b + cN\right)\tau^{2}} \tag{22}$$

which is negative. In other words,

Proposition 3 *Asymmetric tax competition with local public goods yields less agglomeration than at the free-market equilibrium.*

3.2 With international public good spillovers

Now let assume the public good is nor a local public one, neither a international public one. Instead, we consider a parametrized model where the degree of international spillovers is given by $\rho \in]0;1[$ whatever the country it comes from. Hence, the intensity of spillovers for one unit of public good is symmetric across countries, but the aggregate effect of public good spillovers will vary with respect to the tax base allocation.

Politicians are supposed to be aware that their residents benefit from these public good spillovers. However, they do not take into account the fact that their own public sector is also beneficial to non residents. Hence the internalization of public spending spillover is supposed to be asymmetric : each government internalizes only public spending spillover coming from the other government. Besides, contrary to Bjortvan and Schjelderup (2002) who assume that each government perfectly internalize public good spillovers generated by the other governments, we assume that governments can underestimate the intensity of these spillovers. We follow the approach of Kobayashi, Kunizaki and Nakamura (2003), and we suppose each government expects that its residents benefit from a proportion $\omega \in]0;1[$ of public

good spillovers coming from the other country. As a consequence, the lower is ω, the less governments take into account the recursive effects of its own fiscal policy on public good spillovers its residents benefit from the other government's fiscal policy.

Thus the objective function of a government r is[15] :

$$\begin{array}{l} t_r \text{ arg Max } LS_r + L + \dfrac{\pi_r}{2}N + \mu\left(G_r + \omega\rho G_s\right) \\ \text{s.c } G_r = t_r\lambda_r N \end{array} \tag{23}$$

In such a context, interaction between governments is not only indirect because of capital tax competition, but also direct because the capital tax of the other government enters directly in its own objective function through the internalization of public spending spillovers. Thus, according to Revelli's (2004) classification of spatial interactions between governments, public spending spillovers refer to the "preferences" channel of interaction[16]. Public expenditures provided by a country enters directly the welfare function of the neighbored country[17]. As a consequence, fiscal externalities in a decentralized framework can emerge both on the fiscal policy side and on the public policy side of the governments' intervention.

3.2.1 Stage 1: Nash tax equilibrium

The first order condition for the government's r maximization problem is given by

$$L\frac{\partial S_r}{\partial \lambda_r}\frac{\partial \lambda_r}{\partial t_r} + \frac{N}{2}\left[\frac{\partial \Pi_r}{\partial \lambda_r}\frac{\partial \lambda_r}{\partial t_r} + 1\right] + \mu N\left[\frac{\partial \lambda_r}{\partial t_r}t_r + \lambda_r + \rho\omega\left(\frac{\partial \lambda_s}{\partial t_r}t_s + \lambda_s\right)\right] = 0 \tag{24}$$

for all $r = 1, 2$, with $\lambda_r = \lambda_r\left(t_r, t_s\right)$ and $\partial\lambda_r/\partial t_r < 0$ because of the tax base erosion effect. From this expression, we can see that each government has

[15] Bjortvan et Schjelderup emphasize the major role of the parameter μ. They show that the stronger are preferences for the public good, the more important is the distorsion from tax competition relative to free-riding one.

[16] Brueckner (2003) also suggests a classification of strategic interactions between governments. He distinguishes "resource-flow" models and "spillover" models. The first class of model refers to the indirect interaction acting through budget constraints because of tax competition. The second class of model includes public goods spillovers as well as informational spillovers at the root of yardstick competition.

[17] Observe that this channel of interaction is very close to the third channel of interaction exhibited by Revelli (2004) acting through expectations and reflecting behaviors of yardstick competition.

an additional incentive to choose a high level of tax thanks to public good spillovers. A capital outflow following an unilateral increase in the capital tax allows the other country to sustain a higher level of public good provision, which increases the level of public good spillovers its residents benefit from. In other words, the harmful tax base erosion effect is partially counteracted : it may be worthwhile for governments to strategically choose a high level of tax in order to increase the benefit from positive public good spillovers.

Solving this system yields the following Nash tax equilibrium

$$\begin{array}{l} t_1^{\rho>0} = -\Psi(\mu,\rho)\,\theta + \frac{1}{4}(b+cN)\,L\tau\frac{\Lambda(\tau)}{\mu(1-\rho\omega)(cN+2b)^2} \\ t_2^{\rho>0} = \Psi(\mu,\rho)\,\theta + \frac{1}{4}(b+cN)\,\tau L\frac{\Lambda(\tau)}{(cN+2b)^2(1-\rho\omega)\mu} \end{array} \tag{25}$$

with $\Psi(\mu,\rho) = 8\mu b + cN(4\mu-1)/2\left(2\mu(\omega\rho(2b+cN)+6b)+cN(6\mu-1)\right) > 0$ and $\partial\Psi(\mu,\rho)/\partial\rho < 0$.

The tax of country 1 is always positive. Some calculations show that the tax rate of the other country is also positive for the values of productivity wedge such that $\theta > \tilde{\theta}^{\rho>0}$, with

$$\tilde{\theta}^{\rho>0} = -\frac{1}{2}(b+cN)\,\tau L\Lambda(\tau)\,\frac{2\mu(\rho\omega+3)(2b+cN)-cN}{(2b+cN)^2(1-\rho\omega)\mu(4\mu(2b+cN)-cN)} \tag{26}$$

Note also that $\partial t_r/\partial\tau$ is positive when $\tau > \hat{\tau}$ whereas these expressions are both negative otherwise. Moreover $\partial t_1^{\rho>0}/\partial\tau = \partial t_2^{\rho>0}/\partial\tau$. Hence, public good spillovers do not affect the evolution of Nash taxes with respect to the level of transport cost.

Now, we can wonder if the Nash tax is still higher in the high productivity country. Considering the difference of taxes, we get

$$\Delta^{\rho>0} = t_1 - t_2 = -2\,\theta\,\Psi(\mu,\rho) > 0 \tag{27}$$

which exhibits a fiscal incentive to invest capital in the low productivity country. This incentive decreases with the intensity of public good spillovers.

We will now evaluate the location equilibrium to see if in presence of public good spillover, this fiscal incentive still does not compensate the productivity disadvantage which acts in the opposite direction.

3.2.2 Location equilibrium at the Nash taxes

Evaluating the level of agglomeration (13) at the Nash tax equilibrium (25) we get

$$\lambda^{\rho>0} = \frac{1}{2} - 2\mu\theta \frac{(cN+2b)^2(\rho\omega+1)}{LcN(b+cN)\tau^2(2\mu(\rho\omega+3)(cN+2b)-cN)} \tag{28}$$

It yields complete agglomeration as soon as the wedge productivity falls behind the following threshold value

$$\theta^{\rho>0}_{agglo} = -\frac{1}{4}LcN(b+cN)\tau^2 \frac{2\mu(\rho\omega+3)(cN+2b)-cN}{\mu(cN+2b)^2(\rho\omega+1)}$$

which can be lower or higher than $\tilde{\theta}^{\rho>0}$.

Finally, it is straightforward to verify that $\lambda^{\rho>0} < \lambda^M$ because of the tax gap. Tax competition still acts as a dispersion force in presence of public good spillovers. Besides, observing the expression of the location equilibrium given by (28), it is clear that agglomeration increases with the intensity of public good spillovers. We get:

$$\lambda^{\rho=0} < \lambda^{\rho>0} < \lambda^M \tag{29}$$

and consequently $\theta^M_{agglo} > \theta^{\rho>0}_{agglo} > \theta^{\rho=0}_{agglo}$. In other words, the dispersion force induced by asymmetric capital tax competition is mitigated by positive public good spillovers. To understand this result, we have to compare the tax gap with and without public good spillovers, and we get $\Delta^{\rho=0} > \Delta^{\rho>0}$.

This relation holds only for positive values of the internalization degree of public good spillovers. Hence we have to focus on this parameter. We show that $\partial t_1^{\rho>0}/\partial\omega > 0$ and $\partial t_2^{\rho>0}/\partial\omega > 0$ for positive values of taxes. The government increases its tax when it gets a better information about public good spillovers. The intuition behind this result is straightforward. Because of positive public good spillovers, the negative tax base erosion effect caused by an unilateral increase of the capital tax is partially cancelled by more public good spillovers. Hence, the higher the internalization degree about this retroactive effect is, the lower is the incentive to carry out tax cuts. Moreover, $\partial t_1^{\rho>0}/\partial\omega < \partial t_2^{\rho>0}/\partial\omega$. Even if the intensity of public good spillover is symmetric across countries, the low productivity country benefits more from public good spillovers at the Nash equilibrium because both the tax and the tax base are higher in the high productivity country. As a consequence, following a rise in the level of the internalization degree,

this country perceives more incentives to rise taxation. Thus, increasing the internalization degree of public good spillovers favors tax convergence and agglomeration[18]. This effect is not exhibited by Bjorvatn and Schjelderup (2002). Their model yields symmetric Nash taxes so that the allocation of firms across countries is homogenous and consequently international public good provision is also symmetric.

To summarize,

Proposition 4 *Positive public good spillovers guarantees tax convergence, provided that they are unless partially internalized by governments. Moreover, Nash taxes increase with the internalization of public good spillovers, especially in the low productivity country which benefits the most from public good spillovers.*

We have seen that even if tax competition acts as a dispersion force, the majority of firms is located in the high productivity country. To go further, we can wonder how the international welfare will be affected both with respect to the private sector and the public one.

4 International welfare

As we have seen, the agglomeration of firms caused by the wedge productivity is stronger with public good spillovers. These disparities of tax base across countries are not without effects on the inequalities between residents of each country.

To explore these inequalities, we have to define the effective international welfare. It differs from the government's objective function even if it is a benevolent government because of its imperfect information about public good spillovers. Thus, the effective welfare in each country is given by

$$W_r = S_r L + L + \mu \left[\lambda_r t_r N + \rho \left(\lambda_s t_s N\right)\right] + \frac{\pi_r}{2} N$$

Since $\pi_1 = \pi_2$ at the location equilibrium and since the ownership of capital is equally distributed across countries, we allready know that the capital income net of tax is the same in each country. Thus considering the difference

[18] Contrary to Bjorvatn and Schelderup (2002), a perfect internalization degree does not completely offset the tax competition distorsion. In our framework with imperfect competition, an unilateral tax cut yields a capital inflow which is always hamful for the consumer's surplus in the other region.

between effective welfare in each country, we get

$$\Omega = W_1 - W_2 = L\left(S_1 - S_2\right) - \mu N\left(\rho - 1\right)\left(G_1 - G_2\right) \tag{30}$$

To determine the sign of this expression, we first evaluate the difference of workers' welfare with respect to the private sector exclusively. Focusing on the consumer surplus, it is straightforward to show that

$$LS_1 - LS_2 = -\frac{1}{2}LN\left(b + cN\right)^2 \tau\left(2\lambda - 1\right)\frac{b\tau - 2a}{\left(cN + 2b\right)^2}$$

which is positive for all $\lambda > 1/2$. It reflects a higher consumer's surplus in the country 1, since this country hosts a majority of firms. Observe that this difference increases with the intensity of public good spillover given by the parameter ρ because it favors tax convergence and the agglomeration of firms in the high-productivity country. This difference also increases with the decline of transport costs which also fosters this agglomeration.

Considering now the difference in the size of the public sector between countries we get:

$$G_1 > G_2 \tag{31}$$

because both the tax and the tax base are higher in the high productivity country. Hence, despite the equal number of citizens in each country, the level of public good provision is higher in the country with the productivity advantage. It goes against the principle of territorial equity according to which citizen of different countries should benefit from the same level of public good provision.

Now let define T_1 and T_2 as the effective public good provision in country 1 and 2 taking into account the benefit from public good spillovers:

$$\begin{aligned} T_1 &= \lambda t_1 N + \rho\left(\left(1 - \lambda\right) t_2 N\right) \\ T_2 &= \left(1 - \lambda\right) t_2 N + \rho\left(\lambda t_1 N\right) \end{aligned}$$

Comparing T_1 and T_2 gives $T_1 - T_2 = \left(1 - \rho\right)\left(G_1 - G_2\right)$, which implies that

$$G_1 - G_2 > T_1 - T_2 > 0 \tag{32}$$

Once we take into account the benefit from public good spillovers, the international inequalities with respect to the local public sector become less important. As a consequence, given the expression (30) of the difference between international welfare, it is clear that

Proposition 5 *Residents' welfare is higher in the high productivity country, because both the consumer's surplus and the effective public good provision are higher in this country than in the low productivity one. Moreover:*

(i) public good spillovers strengthen the inequality between international consumer's surplus in the private sector

(ii) the difference of effective public good provision taking into account public good spillovers is lower than the difference of size between local public sectors.

Finally, as a decrease of transport costs affects the tax base allocation across countries, we have to see how the difference of welfare evolves with it. We show that

$$\frac{\partial \Omega}{\partial \tau} = -4a\theta\mu \frac{(\rho\omega + 1)(N\rho - N - \rho\omega + 1)(b + cN)}{c\tau^2 (\rho\omega - 1)(2\mu(\rho\omega + 3)(cN + 2b) - cN)}$$

which is positive for all $\rho < (N-1)/(N-\omega)$. As $(N-1)/(N-\omega) > 1$, this condition is always checked. Consequently, a transport cost decline favors the convergence of international welfare.

5 Fiscal externalities

On the one hand, we could suspect with capital tax competition that the absolute level of taxes in each country is suboptimal because of the standard positive fiscal externality exhibited by Zodrow and Mieszkowski (1986). Indeed when it increases unilaterally its tax rate, the local government does not take into account the inflow of capital that the other country benefit from. This fiscal externality is at the root of the race to the bottom process : each country cuts its capital tax in order to attract capital flows. On the other hand, thanks to the internalization of public good spillovers, governments may raise their expectations about positive feedback effects of public good provision in the other country. Hence, we can expect that the underprovision of public good is mitigated so that taxes are higher. To resume, we expect tax competition to create a distortion which should lead to a race to the bottom, whereas public good spillovers are an other distortion which could lead to a race to the top.

To see which one of these effects is the stronger, we evaluate the effects of one country's unilateral tax increase on the welfare in the other country. The sign of the fiscal externalities differs between countries and we can

decompose the fiscal externality into four components :

$$\frac{\partial W_r}{\partial t_s} = \frac{\partial \lambda_r}{\partial t_s}\frac{\partial S_r}{\partial \lambda_r}L + \frac{\partial \lambda_r}{\partial t_s}\mu N t_r + \frac{N}{2}\left[\frac{\partial \Pi_r}{\partial \lambda_r}\frac{\partial \lambda_r}{\partial t_s} - 1\right] + \boldsymbol{\rho}\mu N \lambda_s \left(1 + \varepsilon_s\right) \tag{33}$$

where $\varepsilon_r = \left(\partial \lambda_r / \partial t_r\right) / \left(t_r / \lambda_r\right)$ represents the tax base elasticity in region r which is negative because of the tax base erosion effect.

Consider the two first fiscal externalities : the first one acts through the consumers' surplus $\left(\partial LS_r / \partial t_s\right)$ while the second one acts through the national public good provision $\left(\partial \left(\mu G_r\right) / \partial t_s\right)$. Because of the tax base erosion effect, these externalities are unambiguously positive. An unilateral tax increase produces a capital outflow toward the other country. This allows this last country to sustain a higher level of public good provision and raises their consumers' surplus. Hence, abstracting from public good spillovers and assuming that capital owners live outside the economy, asymmetric tax competition with local public goods leads to a suboptimal level of tax in both countries.

Now assuming that capital owners live inside the economy, there is a third externality acting through the capital rent $\left(\partial \left(\pi_r N/2\right) / \partial t_s\right)$ which encapsulates two effects: a direct effect and an indirect effect. An increase in t_s decreases directly the net profit in the country s which makes the country r more attractive. On the other hand, increasing taxes on each firm reduces operating profits because we have $\partial \Pi_r / \partial \lambda_r < 0$ and $\partial \lambda_r / \partial t_s > 0$. Attracting more firms intensify the competition on the domestic market and pushes down prices and operating profits. As a result, the net effect of an unilateral increase of the tax on firms' profits seems ambiguous because the indirect effect is negative while the direct effect is positive. However, inserting Nash tax values into $\partial \left(\pi_r N/2\right) / \partial t_s$ we can see that this expression is negative.

Thus, without public good spillover, the capital taxes might be too low or to high from the social point of view. Inserting the Nash taxes into $\partial W_1 / \partial t_2$ and $\partial W_2 / \partial t_1$, we observe that $\partial W_1 / \partial t_2 > 0$ while $\partial W_2 / \partial t_1 \gtrless 0$ when $\theta \gtrless \ddot{\theta} > \tilde{\theta}^{\rho=0}$. Thus, it seems that the low productivity country always chooses a too low level of capital tax, while the capital tax of the high productivity country is too low if its productivity advantage is low enough (or if trade costs are high enough) and it is too high otherwise.

Let consider now the last fiscal externality caused by public good spillover, which we can write as follows : $\partial \left(\rho \mu G_s\right) / \partial t_s$. This effect shows how the public good spillovers coming from the country s evolves when this country increases unilaterally its tax. The sign of this derivative is ambiguous.

This fiscal externality may be negative if the negative tax base effect on public good provision is stronger than the positive tax effect. Hence, the sign of this externality depends on tax base elasticities. We can check from the expression (33) that the fiscal externality coming from the country s is positive if $\varepsilon_s > -1$ and negative otherwise. Indeed, when the tax base elasticities are limited so that we are on the increasing side of the Laffer curve, then the negative tax-base erosion effect is more than compensated by the positive tax effect on public good provision. The opposite occurs when the tax base erosion effect is so important that a marginal increase of the capital tax has a negative impact on tax revenues. Inserting Nash tax values into $\partial(\rho\mu G_s)/\partial t_s$, the sign of this expression is ambigous for both countries and may differ across them. It means that contrary to Bjorvatn and Schjelderup, public good spillovers may aggravate the inefficient level of public good provision in a country and mitigate it in an other country. Finally we can show that $\partial(\rho\mu G_1)/\partial t_1 > \partial(\rho\mu G_2)/\partial t_2$ at the Nash equilibrium. Hence, the extent and the sign of this fiscal externality vary across countries. In other words, symmetric public good spillovers yields asymmetric fiscal externalities which affect the efficiency of the tax gap. Thus, they do not only affect the size of public sector across countries, but also firms' location on the private one.

To resume, capital taxes may be too low or too high from the social point of view[19]. Some calculations reveal that the net effect depends on which country increases unilaterally its capital tax. Indeed at the Nash equilibrium, we get $\partial W_1/\partial t_2 ? 0$ whereas $\partial W_2/\partial t_1 ? 0$.

6 Conclusion

With the decline of transport costs, the risk of subnational tax competition in a decentralized economy is reinforced because of higher capital mobility. Moreover, it could to be associated with an other form of interdependence between governments caused by public good spillovers. There are practical reasons to integrate these two approaches, especially when we take into account spatial disparities shaped by the decline of transport costs. It gives the following outcomes.

Firstly, we show that public good spillovers affect asymmetric tax competition because it leads to a lower tax gap and thus a higher agglomeration of firms within the high productivity country. This result gives rise to inter-

[19] Observe that when the capital ownership is widespread, we can neglect the fiscal externality acting through the capital rent so that capital taxes are always suboptimal.

national inequalities. Residents' welfare is higher in the high productivity country, because both the consumer's surplus in the private sector and the effective public good provision are higher in this country than in the low productivity one. The resulting difference of aggregate welfare is mitigated by the decline of transport costs, while the difference of consumer's surplus is strengthened by public good spillovers and the decline of transport costs. Secondly, we have evaluated the efficiency of these results by identifying three kinds of fiscal externalities...

To summarize, we have exhibited some of the public good spillovers' implications in a decentralized economy with spatial disparities. While the empirical literature on public good spillovers often focuses on the control of common shocks among countries which could bias the results, it does not control the robustness of these results with respect to economies of agglomeration. It could be interesting to go in this direction.

References

[1] Andersson, F., Forslid, R., 2003. Tax competition and economic geography. *Journal of Public Economic Theory* 5 (2), 279-303

[2] Baicker, K., 2005. The spillover effects of state spending. *Journal of Public Economics* 89, 529-544.

[3] Baldwin, R.E., Krugman, P., 2004. Agglomeration, integration and tax harmonisation. *European Economic Review* 48, 1-23.

[4] Bennassy-Quéré, A., Fontagné, L., Lahrèche-Révil, A., 2003. Tax competition and foreign direct investment. *CEPII Working Paper* N°2003-17.

[5] Besley, T., Coate, S., 2003. Centralized versus decentralized provision of local public goods: a political economy approach. *Journal of Public Economics* 87, 2611-2637.

[6] Bjorvatn, K., Schjelderup, G., 2002. Tax competition and international public goods. *International tax and public finance* 9, 111-120.

[7] Brueckner, J-K., 2003. Strategic interaction among governments. *Working paper.*

[8] Case, A.C, Hines Jr, J.R, Rosen, H.S, 1993. Budget spillovers and fiscal policy interdependence: evidence from the states. *Journal of Public Economics* 52, 285-307.

[9] Charlton A. (2003). Incentive bidding for mobile investment: economic consequences and potential responses. OECD Working Paper, n°203.

[10] Devereux, M., Griffith, R., Klemm,A., 2002. Can international tax competition explain corporate income tax reforms? *Economic Policy* 17 (35).

[11] Forslid, R., Ottaviano, G., 2002. An analytically solvable core-periphery model. *Journal of Economic Geography* 3, 229-240.

[12] Gaigné, C., Riou, S., 2005. Imperfect competition and trade cost: fiscal equalization revisited. *Working Paper.*

[13] Hindriks, J., Myles, G.D., 2005. Intermediate public economics. MIT press.

[14] Kobayashi, Y., Kunizaki, M., Nakamura, K., 2003. Pareto improvement rules of public spending coordination under fiscal competition. *Working Paper.*

[15] Krogstrup, S., 2003. Are capital taxes racing to the bottom in the European Union? *HEI working paper* N°01/2003.

[16] Krugman, P., 1991. Increasing returns and economic geography. *Journal of Political Economy* 99, 483-99.

[17] Ludema, R., Wooton, I., 2000. Economic geography and the fiscal effects of international integration. *Journal of International Economics* 52, 331-357.

[18] Murdoch, J.C, Rahmatian, M., Thayer, M.A., 1993. A spatially autoregressive median voter model of recreation expenditures. *Public Finance Quarterly* 21 (4), 334-349.

[19] Musgrave, R.A., Musgrave, P.B., Public finance in theory and practice. New-York: McGraw-Hill.

[20] Oates, W.E., 1972. Fiscal federalism. Princeton: Harcourt Brace Jovanovich.

[21] Oates, W.E., 1999. An essay on fiscal federalism. *Journal of Economic Litterature* 37, 1120-1149.

[22] Ottaviano G., Thisse J-F., 2002. Integration, agglomeration and the political economics of factor mobility. *Journal of Public Economics* 83 (3), 429-456.

[23] Ottaviano, G., T. Tabuchi and J.-F. Thisse (2002). Agglomeration and trade revisited. *International Economic Review* 43, 409-436.

[24] Ottaviano G. and T. Van Ypersele (2005). Market size and tax competition. forthcoming. *Journal of International Economics* 67, 25-46

[25] Revelli, F., 2004. On spatial public finance empirics. *Working paper.*

[26] Tiebout, C., 1956. A Pure Theory of Local Expenditures. *Journal of Political Economy* 64 (5), 416-424.

[27] Wellisch, D., 1993. On the decentralized provision of public goods with spillovers in the presence of household mobility. *international Science and Urban Economics* 23, 667-679.

[28] Wilson J.D., 1991. Tax competition with international differences in factor endowments. *international Science and Urban Economics* 21, 423-451.

[29] Wilson, J., Wildasin, D., 2003. Tax competition: bane or boon? *Journal of Public Economics* 88, 1065-1091.

[30] Zodrow, G., Mieszkowski, P., 1986. Pigou, Tiebout, property taxation and the underprovision of local public goods. *Journal of Urban Economics* 19, 356-370.