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Thierry Madiès / Sonia Paty / Yvon Rocaboy
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Horizontal and vertical externalities: An overview of theoretical and empirical studies

Thierry Madiès, Sonia Paty** and Yvon Rocaboy*** [1]*

Academic literature in public finance has recently focused on horizontal externalities coming from interjurisdictional tax competition –among similar types of local governments– as well as vertical externalities arising from interactions between two overlapping governments which share the same tax base. The purpose of this paper is to provide a survey relating to both theoretical and empirical aspects of these two kinds of externalities that have strong implications for local government finance.

La literatura académica en finanzas públicas se ha centrado recientemente en las externalidades horizontales derivadas de la competición fiscal interjurisdiccional –entre niveles similares de gobiernos locales–, así como las externalidades verticales que surgen a raíz de las interacciones entre 2 niveles de gobierno que comparten la misma base impositiva. El propósito de este trabajo es el de proveer un survey en el que se relacionan los aspectos teóricos y empíricos de ambos tipos de externalidades, con fuertes implicaciones para las finanzas locales.

Key words: Fiscal Federalism, fiscal externalities, tax competition, yardstick competition.
JEL Classifications: H3, H7, H21

* University of Fribourg (Switzerland) and CREM-CNRS (France)

** University of Lille 1 and MEDEE/IFRESI-CNRS (France)

*** University of Rennes 1 and CREM-CNRS (France)

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1. Introduction

The fiscal federalism literature has grown rapidly these last ten years by improving very much our understanding of important issues regarding the relationships between governments of the same level or between different governmental tiers. In particular, a great deal of this literature has focused on the problem of externalities inherent to any decentralised governmental structures. Externalities arise whenever the existence of multi-tiered structure of government is considered, and jurisdictions choose some tax or regulation policy independently. In this case, indeed, the expenditure or tax setting decisions of a given jurisdiction may have positive or negative consequences on the fiscal choices of other governments. These externalities are often called "horizontal" if the interactions occur at the same government level or "vertical" if they relate to two different governmental tiers.

In this paper, we focus on externalities which are mainly due to the mobility and commonality of tax bases between different tiers of government, and to information asymmetries between voters and their representatives in a world where policymakers adopt non-cooperative behaviours. When tax bases are mobile, an action chosen by a jurisdiction affects the budget constraint of another jurisdiction, by means of a policy-driven resource flow among jurisdictions, leading to strategic interactions in local fiscal choices. These fiscal games typically result in inefficient taxation. In the case of horizontal tax competition, taxes are inefficiently low since each policymaker neglects the benefit of expanded tax base that it conveys on other policymakers when it raises its tax rate (for example Wildasin, 1988). On the contrary, in the case of vertical tax competition, tax rates may be too high in the non-cooperative equilibrium, for each level of government does not take into account the negative impact of independently increasing taxation on the common tax base (Keen and Kotsogiannis, 2002).

Externalities also arise whenever information asymmetries between voters and politicians exist. In such a setting, an action chosen by a politician in one jurisdiction affects the informational set of imperfectly informed voters in other jurisdictions. If voters use the performance of other governments as a benchmark, decreasing taxation in one jurisdiction may induce neighbouring politicians to do the same in order not to be signalled as bad incumbents. This informational externality may therefore yield tax mimicking behaviours As far as economic efficiency is concerned, yardstick competition has beneficial effects either in encouraging reve-

nue-maximizing Leviathans to tilt tax rates toward their efficient level, or in signalling to voters the quality of their representatives (Salmon, 1987; Besley and Case, 1995).

Empirical studies have proved the relevance of the theoretical literature on fiscal strategic interactions. The econometric studies have showed a correlation in local fiscal policies. In regard to horizontally related governments, tax rates in one jurisdiction depend on tax rates in the neighbouring jurisdictions. These empirical results have been obtained in the case of European countries (for example Heyndels and Vuchelen, 1997 in Belgian; Buettner, 2001 in Germany; Feld and Kirchgässner, 2001 in Switzerland; Bordignon, Cerniglia and Revelli 2002 in Italy; Solé Ollé, 2003 in Spain and Feld, Josselin and Rocaboy, 2003 in France), as well as in the case of the North American countries (for example Brett and Pinske, 2000 in Canada and Ladd, 1992 in the USA). As far as vertical tax competition is concerned, the empirical findings are much more contrasted. No systematic correlation exists in local fiscal policies performed at different levels of government.

The purpose of this paper is to present a survey of the theoretical and empirical literature on vertical and horizontal externalities. We proceed as follows. The theoretical models are displayed in section 2. In section 3 we present the empirical strategies which have been proposed to test for the existence of such strategic interactions. A conclusion is given in section 4.

2. Theoretical models of fiscal interactions among local governments

The theoretical foundations of strategic interactions among local governments are presented, first, in a situation where competing local jurisdictions belong to the same level of government. Two cases are distinguished, whether competition results from tax base mobility ("tax competition") or from political behaviour ("yardstick competition"). Finally, we deal with vertical tax competition involving several layers of government.

2.1 Horizontal fiscal interactions based on tax base mobility

The numerous models issued from pioneer work of Wildasin (1988, 1989) and Hoyt (1991) have the same theoretical foundations (see Wilson, 1999 for a survey). Local public decision-makers are supposed to be benevolent in the sense that their objective is to maximise the welfare of their own citizens. Households are assumed to be immobile and to

consume both a private good and a local public good. The latter is financed by a tax on capital. Since capital is assumed to be perfectly mobile across local jurisdictions, when a given government raises its tax rate, net return on capital located there falls and then capital chooses to relocate. Marginal productivity of capital within the jurisdiction of departure increases, while marginal productivity of the jurisdiction of arrival decreases. Capital flows carry on until the net return on capital becomes identical everywhere. In the fiscal Nash equilibrium, each local government sets its tax rate in a way that the marginal rate of substitution (MRS) between the public good and the private good is higher than the marginal rate of transformation (MRT) between these two goods: the local public good is under-provided at equilibrium. This inefficiency results from the fact that each jurisdiction sees capital flight as a cost and does not consider the positive fiscal externality generated for other jurisdictions. Consequently, local jurisdictions perceive the marginal cost of public funds (MCPF) as higher than it is in reality for the economy as a whole. Furthermore, it can be straightforwardly shown that the higher the local elasticity of capital (or to put it differently, the greater the number of competing local jurisdictions), the larger the difference to the social optimum (Hoyt, 1991).

The basic model has been the object of numerous refinements without questioning the main result of first best sub-optimality. Here only a few examples[2]: Bucovetsky and Wilson (1999) propose a model similar to Zodrow and Mieskowsky's (1986), yet with two periods: in the first period, households determine which fraction of their resource endowments they will save; in the second period, they choose their labour supply. The authors show that, if regions (countries) can only use a source-based tax on both labour[3] and capital to finance local public goods, then both taxes are used at the equilibrium, yet not in optimal proportions, in comparison to Ramsey's rule: labour is overtaxed. Under these conditions, the provision of the public good lays below the optimum. In addition, the capital tax rate decreases and tends towards zero when the number of regions (countries) increases, since the elasticity of local capital

[2] For a thorough synthesis on the work on fiscal competition between local communities, see for example Delage (1999), Madiès and Paty (2000) and Wilson (2000). The reader interested in fiscal competition at the international level in particular can refer to Janeba and Bretin (1995), Guimbert and Madiès (2000).

[3] Workers are supposed to be immobile but labour supply is – imperfectly – elastic.

demand to tax rate tends towards minus infinity. Fiscal externality remains nonetheless, even if the tax on capital equals zero, because labour is itself taxed. Finally, it can be shown that the Nash equilibrium corresponds to a second best optimum when governments are allowed to tax capital according to both the principle of source and residence.

Bucovetsky (1991), Wilson (1991) and Hwang and Choe (1995) sought to find out if these models provide very different results when local jurisdictions (regions) were not identical anymore. In that case, it is possible that a government seeks to use its fiscal policy to manipulate capital location between regions in order to increase its citizens' well-being (De Paters et Myers, 1994). Bucovetsky and Wilson assume that the asymmetry between regions only results from a difference in population and show that this implies the existence of asymmetric equilibria: In the case where the economy is composed of two regions, the small region (in terms of population) set a tax rate on capital which is lower than the big region's. Under these circumstances, the small region has a higher stock of capital per worker, while according to the assumption, initial capital endowments per capita were identical. Since all workers are identical in the economy as a whole, total production is not as high as it could be. The inhabitants of the small region get a higher utility level at the equilibrium. Furthermore, if the small region is sufficiently small, its inhabitants will prefer the equilibrium obtained through fiscal competition to the centralised solution implemented by a social planner. Kanbur and Keen (1993) obtain similar results in their fiscal competition model on indirect taxation. Fiscal cooperation becomes even more difficult when local regions not only differ in terms of population, but also through their per capita capital endowments (Hwang and Choe, 1995).

Previous works supposed that capital is perfectly mobile and that it responds to every marginal variation of the tax rate affecting it. This assumption is questioned by Lee (1997) who considers a two-period model where transaction costs are limiting capital mobility. While the budget needs to be balanced during both periods, the author shows that if tax rates in both periods are compared with the symmetric model without transaction costs, lower tax rates are imposed during the first period, and higher rates later on (similar conclusions are obtained in the context of strategic negotiation models such as Doyle and Winjnbergen's model (1994)). If comparing the equilibrium obtained through a Nash equilibrium for the static model, there is even less public good offered in the first period. However, the public good is overprovided during

the second period. In the same train of thought, but in a completely different perspective, the existence of increasing returns of scale and of monopolistic competition corresponds to an agglomeration force which makes the idea of mobile factors marginally reacting to slight changes in tax rates illusory[4]. Inertia resulting from agglomeration forces implies a situation where fiscal competition does not necessarily lead to tax rates which are "too low" (as it is the case in non-increasing scale returns models), since the mobile factor is concentrated and produces a taxable rent (see for example Baldwin and Krugman, 2004). It appears furthermore that economic integration, characterised by the diminution of transportation costs, reduces the intensity of fiscal competition at first, but increases it later on. Indeed, it has been known for a while that agglomeration effects, and thus the taxable rent, are the highest for intermediate transportation costs – in other words, for costs that are sufficiently low to make agglomeration happen, and sufficiently high for spatial concentration to be a necessity.

Previous literature supposed that decision-makers were benevolent. Other papers in line with Brennan and Buchanan (1980) conversely assume that these behave like a Leviathan. Edwards and Keen (1996) considered the matter when local policymakers act as Leviathans but look, to some extent, after their citizens' utility. Their conclusion is that tax coordination is better than tax competition if the marginal propensity of governments to misappropriate resources (used a measure of "political inefficiency") is lower than the elasticity of capital demand to the tax (used as a measure of "economic inefficiency"). Finally, the problem of the existence of a unique Nash equilibrium remains, even if Laussel and Le Breton (1998) and Bayindir-Upman and Ziad (2003) introduced contributing elements. Finally, the question of the sign of the slope of the local governments tax reaction functions remains, which comes down to examine whether tax rates are strategic complements or substitutes. In the normal case, it appears that these best-response functions are increasing in tax rates (Laussel et Le Breton, 1998).

2.2 Horizontal fiscal interactions based on information

Salmon (1987) and, more recently, Besley and Case (1995) have used alternative or complementary explanations of public decision-making pro-

[4] See for instance Ludema and Wooton (1998) Kind et allii (1998), Andersson and Forslid (2003), or Forslid and Ottaviano.

cesses in a setting of fiscal federalism. These authors dropped the concept of mobility as explanation for fiscal interactions. In their framework fiscal interactions are mainly based on information asymmetries between voters and their representatives. In a world of imperfect and asymmetric information, voters have restricted possibilities to evaluate the performance of the representatives in their polity. Selfish representatives aim at gathering political rents and hence have incentives to withhold information about their opportunistic behaviour from voters. However, voters can draw inferences on politicians' behaviour, by comparing it to the performance of governments and parliaments in neighbouring jurisdictions. Other things being equal, these neighbours serve as yardsticks for the voters' evaluation. A bad performance in their own jurisdiction compared to other jurisdictions will penalise representatives; these will not be re-elected. In such a concept, public choice would not only be driven by information gathering from neighbouring jurisdictions, but also by mimicking behaviour. Because representatives anticipate the yardstick mechanism, they are able to stay in power by adapting to the policies of their neighbours.

Literature on the topic has grown rapidly since the late nineties. As this intuition has progressively made its way, a number of significant articles has contributed to improve the understanding of the mechanism of yardstick competition in public decision making (Ladd, 1992; Case, 1993; Case, Rosen and Hines, 1993; Heyndels and Vuchelen, 1997; Figlio, Kolpin and Reed, 1999; Brueckner and Saavedra, 1999; Saavedra, 2000; Bordignon, Cerniglia and Revelli 2002; Solé Ollé, 2003; Josselin and Rocaboy, 2002, 2003). Indeed, interesting theoretical results are obtained from this current of studies. First, due to yardstick competition, changes in tax rate in one jurisdiction are influenced by changes in tax rate in the neighbouring jurisdictions. Yardstick competition thus yields strategic interactions between jurisdictions. Second, in this non cooperative framework, yardstick competition enables voters to tame the opportunistic politicians or to identify bad incumbents, thus reducing rent-seeking. However, this property may no longer exist if politicians are finite-lived incumbents. Under this assumption, the election process may not be an efficient mechanism to reduce opportunistic tax setting behaviours. Indeed, during their last mandate in office, incumbents may take advantage of this situation to maximize rent-seeking. In regard to yardstick competition, the neighbour of such a jurisdiction will not be induced to maintain low tax levels. In this respect, Reulier and Rocaboy (2004)

show that increasing the number of jurisdictions in competition reduces the expected long-run tax rate of the country. Thus decentralization and yardstick competition remain an efficient incentive scheme even in the presence of finite-lived representatives.

Otherwise, the question of the voters' capacity to compare their own fiscal situation to the one prevailing in the neighbouring jurisdictions remains. When the fiscal or the institutional situations in the neighbouring jurisdictions are very complex, it may be difficult for the voters to decipher the right tax level from comparison. For example, Alt et alii (1998) show in the case of the American States, that when the executive and the legislative power are controlled by different parties, increasing taxation does not yield electoral sanction. This may be due to the difficulty for the voters to identify the politicians responsible for this tax increase. More generally, complexity of the local tax systems may be an obstacle for yardstick competition to limit opportunistic behaviours.

Fiscal interactions between jurisdictions belonging to the same level of government are not the only way to generate externalities. They may also result from interactions between two different local government tiers.

2.3 Theoretical aspects of vertical tax externalities

The extensive theoretical literature devoted to local public finance has focused on fiscal interdependence due to tax base mobility among similar local jurisdictions, generating what is known as the "tax competition literature" (see above). However, this literature has for a long time ignored the possibility of vertical externality arising from the existence of a federal government acting as a player (in the sense that it exercises some discretion over tax rates) and not only as a mechanical device aimed at internalising fiscal inefficiencies at the local level (Keen, 1998). A vertical externality is supposed to arise whenever the tax policy of a given layer of government has an impact on the budget of another layer (Boadway and Vigneault, 1996). This is especially the case when (*i*) the taxes accruing to one level of government give rise to a tax credit or an abatement against taxes collected by an other level of government; (*ii*) when one or several layers of government grant tax holidays, (*iii*) or finally when several levels of government set their tax rates on a common tax base independently.

In the following, we will deal with the latter point (*iii*) since almost all the recent literature drawing on the seminal paper by Flowers (1988)

has focused on a particular vertical externality that arises from interactions between overlapping governments that share one (or several) tax bases. However we will leave issues related to both the design of intergovernmental grants (Dahlby, 1996) and redistribution (Boadway, Marchand and Vigneault, 1998) in the presence of vertical tax externalities aside. The usual theoretical analysis assumes that each layer of government acts either as a Leviathan (see papers by Flowers (1988); Keen (1995); Wrede (1996), Flochel and Madiès (2002); Keen and Kotsogiannis (2004)) or as benevolent (Keen (1998); Keen and Kotsogiannis (2002)). Leviathan models generally show that the combined (aggregated) equilibrium tax rate of two overlapping revenue-maximising governments, which share a common tax base, is higher than a single revenue-maximising government tax rate (see for instance Flowers, 1988)[5]. The resulting vertical distortion is enhanced if the federal government acts as a Stackelberg leader but is weaker when "horizontal tax competition" operates at the sub-national level. More precisely, interjurisdictional tax competition at the local level will reduce the combined tax rate set by the two overlapping governments and hence result in rising (and not in reducing) aggregated tax revenues since the combined tax rate lies initially on the backward-bending section of the Laffer curve (see for instance Keen (1998) and Flochel and Madiès (2002)). The explanation behind this result is clear-cut: "as states compete more intensively against one another, setting lower tax rates, so the position of the federal policy maker becomes closer to that of an untrammelled monopolist" (Keen, 1998, p. 473).

More generally, when vertical and horizontal externalities are at work in a federation, they generally distort levels of taxation in opposite directions (Keen, 1998). On the one hand, inter-jurisdictional tax competition (some observers also call it horizontal tax competition) leads to tax rates being too low since each local government ignores that it harms others when it cuts its tax rate in order to attract a mobile base (which is very often capital). On the other hand, co-occupation of a common tax base results in taxes being too high. Indeed, when a policymaker raises its tax rate unilaterally, it ignores the loss in revenues due to the induced contraction of the common tax base that the other level of government will suffer from. Keen and Kotsogiannis (2002) use a

[5] It can also be straightforwardly shown that the global tax rate is increasing with respect to the number of vertically related governments.

model of capital tax competition with a federal government and states as local governments. Each layer of government provides a public good which enters the utility function of a representative consumer[6]. They show that the relative strengths of vertical and horizontal externalities depend on the interest responsiveness of the aggregated supply of savings and the state demand for capital, the extent to which immobile factors are taxed by the states, and the strength of preferences between federal and state public goods. Assuming that rents are not taxed, the vertical externality will dominate if "the effect of state tax changes on the federal tax base (the supply of savings), which determines the vertical externality, is large relative to the sensitivity of capital movements with respect to the interest rate, which shapes the horizontal externality".

The latter result only focuses on the state tax rate equilibrium and requires no particular assumption on the federal government behaviour. If the federal government acts as a Nash player, then it will set its tax rate optimally (given the equilibrium state tax rate). However, things are much more complicated when the federal government acts as a Stackelberg leader since it will deviate from the former rule in order to induce a favourable shift in the state tax rate. In general, whether the federal government sets its tax rate too high or too low depends on both (*i*) whether horizontal or vertical externality dominates in the state tax setting and (*ii*) whether federal taxes are strategic substitutes or complements. Consequently there is a very large range of possibilities and theoretical analysis can not conclude unambiguously on whether the aggregated (federal plus state) tax rate is too low or too high. Note that according to Keen (1998), the reaction is positive when the elasticity of the tax base is constant, but is negative when the tax base is linear in the tax rate. In short, the tax reaction function cannot be unambiguously signed and then it is necessary to perform an empirical analysis to identify the direction of the vertical interaction (Esteller-Moré and Sollé-Ollé, 2003).

3. The empirical tests of horizontal and vertical tax interactions

The first developments in empirical local public finance focused on the

[6] Madiès (2004) shows that if states provide a public input which increases the marginal productivity of capital rather tan a residential public good, then results related to tax-coordination issues turn out to be dramatically different.

tax competition hypothesis by trying to test the impact of taxation on firms' location. Most studies in this literature test for strategic interaction by estimating reaction functions, which show how a government responds to the policy choices of neighbouring governments in setting the level of its own decision variable (Brueckner, 2003).

The presence of tax mimicking is often confirmed as the estimated reaction function shows interdependence between budgetary choices (Ladd, 1992; Case, Rosen and Hines, 1993; Anderson and Wassmer, 1995; Besley and Case, 1995b; Shroder, 1996; Brueckner, 1996; Figlio, Kolpin and Reid, 1997; Smith, 1997; Brueckner and Saavedra, 2001). European studies are more recent (Heyndels and Vuchelen, 1998; Buettner, 2001; Paty, Jayet and Pentel, 2002; Revelli, 2001, 2002; Solé-Ollé, 2003; Feld, Josselin and Rocaboy, 2002; Bordignon, Cerniglia and Revelli, 2001; Feld and Reulier, 2002; Leprince, Paty and Reulier, 2002). Both horizontal and vertical externalities are now the focus of a growing empirical literature (Goodspeed, 1999, 2000; Hayashi and Boadway, 2001; Revelli, 2001; Brett and Pinske, 2000; Esteller-Moré and Sollé-Ollé, 2001, 2002; Leprince, Madiès and Paty, 2003).

First we briefly provide an overview of the spatial econometrics techniques used to test the existence of strategic interaction. We then present the main results of this empirical literature on horizontal and vertical externalities.

3.1. Testing for horizontal and vertical externalities

Most empirical tests on strategic interaction use spatial econometrics to estimate the slope coefficient of reaction functions which connects each government's policy choices to the decisions of neighbouring governments and to its own socio-economic characteristics (see the general specification in 1). The previous discussion showed that the reaction function slope is nonzero when strategic interaction occurs.

Table 1. Specification of the strategic interactions

The spatial models that are the most commonly used in the empirical literature are described below (Verdonck, 2000). Some papers only test the existence of horizontal interactions [1]; some others the vertical interactions [2]; more recent papers try to test both types of interactions [3]. Such models are often estimated using spatial panel data to control non-observed fixed local characteristics.

Horizontal interactions [1]

$$T_{i,t} = \alpha_O^i + \alpha^2 Z_{i,t} + \beta \sum_{j \neq i}^{n} w_{ij} T_{j,t} + \varepsilon_{i,t}$$

Vertical interactions [2]

$$T_{i,t} = \alpha_O^i + \alpha^1 X_t + \alpha^2 Z_{i,t} + \gamma T_{F,t} + \varepsilon_{i,t}$$

Horizontal and vertical interactions [3]

$$T_{i,t} = \alpha_O^i + \alpha^1 X_t + \alpha^2 Z_{i,t} + \gamma T_{F,t} + \beta \sum_{j \neq i}^{n} w_{ij} T_{j,t} + \varepsilon_{i,t}$$

where:

$T_{i,t}$ the tax rate (or the expenditure level) of a jurisdiction *i* (e.g. municipalities, counties, federal states, etc.) at time *t*

α_O^i the individual fixed effect for each jurisdiction *i*

X_t the common effects (federal or national rate of unemployment, GNP...) to all jurisdictions at time *t* (with parameter α^1)

$Z_{i,t}$ the socio-economic characteristics of jurisdiction *i* at time *t* (with parameter α^2)

γ the federal rate parameter

$T_{F,t}$ the tax rate set by the upper level (e.g. federal, central or regional) at time *t*

$T_{j,t}$ the tax rate decided by jurisdiction *j* ($j \neq i$) belonging to the same level of government at time *t*

β the spatial lag parameter

$w_{i,j}$ the weights (specified a priori) affected to decisions by *j* on choices by *i*

$\varepsilon_{i,t}$ the error term

In most cases, the dependent variable is the tax rate (or the expenditure level). Evidence of horizontal tax interaction (or tax mimicking) is provided if the spatial lag parameter β is significant and positive. Evidence of vertical tax interaction is given if the federal rate parameter γ is significant. A negative sign indicates some substitutability between the federal rate and the lower level rate, whereas a positive sign provides evidence of complementarity between both rates.

As known from the literature on spatial econometrics, three points have to be dealt with before estimating such spatial models (Anselin, 1988).

First, in order to deal with the definition of neighbourhood, we have to arbitrarily specify a weighting scheme which indicates the relevance of other governments in the process of interaction. Basically, the weights capture the location of a government *i* relatively to other governments *j*. A variety of weighting schemes are often explored to allow different

patterns of spatial interaction. The most common one is the simple contiguity weighting scheme in which interaction is supposed to occur among jurisdictions sharing geographical boundaries. Under such a scheme, w_{ij}=1 for jurisdictions *j* that are contiguous to *i*, and w_{ij}=0 if they do not share any border. Another possible weighting scheme takes into account the distance from a given jurisdiction to its competitors as imperfect mobility of capital may be a plausible assumption in such models[7] (Brueckner, 2003). Other weighting schemes based on socio-economic characteristics such as population or income can also be used. Finally, each weight matrix is row-normalized prior to estimation so that the aggregation of tax rates consists in a weighted average.

Second, because of strategic interaction, we have to deal with the endogeneity of the jurisdictions' fiscal choices. Policy decisions are endogenous and correlated with the error term. The resulting spatial correlation means that OLS estimates would be inconsistent. In the literature, two methods are used to tackle this problem. The first one is the maximum likelihood (ML) method. A non linear optimisation routine is then used to estimate the model. The second approach is the one of instrumental variables (IV). The fitted values used as instruments for the competitors' policy choices are uncorrelated with the error term. OLS then yields consistent estimates of the parameters. As it is easier to implement, this procedure is frequently used. Although consistent, one of the objections to IV estimators of spatial models is that they ignore the Jacobian term and are therefore less accurate than ML estimates (Anselin, 1988).

Third, the possible presence of spatial dependence in the errors is another issue. Such spatial dependence can arise when the error term includes omitted explanatory variables that are themselves spatially dependent. Uncorrected error dependence may provide spurious evidence of strategic interaction. Several approaches exist in order to deal with this problem. One approach is to use ML to estimate the model, taking account of the spatially correlated error structure (Anselin, 1988). Under ML procedure, a second approach based on the robust tests of Anselin, Bera, Florax and Yoon (1996) can be employed to detect spatial dependence. Finally, an easier remedy is to rely on the IV method which generates consistent parameters for the reaction function even in the presence of spatial error dependence (Kelejian and Prucha, 1998).

[7] Smooth distance decay is taken into account by weights that vary inversely with distance between *i* and *j*, *wij=1/dij*.

3.2. Empirical work on horizontal tax interactions

First, research done in the United States is presented before concentrating on the recent work achieved in Europe and particularly in France. It is equation 1 presented in frame 1 which is subject to estimations, and the results of various econometric tests are synthesised in a table at the end of this section.

a. Tests on US data. The various studies listed deal with mimetic behaviour of counties and municipalities (local communities) as well as of federal states. Pioneer work by Ladd (1992) relates to tax setting of 94 counties for 1978 and 1985. Cross-section estimations are obtained using the method of instrumental variables. The results confirm the hypothesis of fiscal mimicking between neighbouring counties, not only regarding the rate of global tax pressure beard by households (all taxes included) but also for the property tax[8]. On the contrary, mimetic effects are not significant in the case of sales taxes (sales taxes represent 15% of tax revenue of local governments, except federal states) or other local taxes. More precisely, Ladd observes that a 1% increase of the tax pressure in neighbouring counties leads to a significant rise of 0.59 points of the tax pressure in a given county. In the case of the residential property tax, a 1% raise in the neighbouring counties translates into a rise of 0.45 points of this tax rate in a given county. These results seem to indicate that tax rates between counties are strategic complements.

This is confirmed by Brueckner and Saavedra's study (2001) which attempts to test the existence of mimetic behaviour regarding the property tax in 70 municipalities in Boston's metropolitan area. The test was carried out for 1980 and 1990. The maximum likelihood method is used for the estimations. Five distinct weighted schemes are used in order to weigh the tax rates differently, depending on the distance and/or the population of neighbouring municipalities. The authors find a significantly positive coefficient of the slope of the tax reaction function of municipalities for four out of five matrixes used (the weighted matrix based on the population only does not give the same results) for 1980 and 1990. For example, in 1980, the value of the slope of the reaction function ranges from 0.16 to 0.70, depending on the weighted matrix used. Similar results are found at the level of states (Case, 1993; Besley and Case, 1995b). These show that a 1% increase of the average tax pres-

[8] The property tax represents more or less three quarters of the local governments' fiscal revenue (other than states).

sure rate in neighbouring States results in an increase of 0.2 points of this same rate in a given state. More interesting still is the result suggesting that the probability of re-election of governors depends positively on the increase of the average tax rate of neighbouring states and negatively on the one of the state in question (which seems to validate the yardstick competition hypothesis). Moreover, in the American states where governors do not have the legal possibility to re-run for elections, the slope of the authorities function of reaction of the authorities is nil, which means that these do not take into account the fiscal policy of neighbouring states' fiscal policy.

The study of Case, Rose and Hines (1993) is slightly different from the two previous ones, in the sense that they test the existence of mimetic behaviour between American states looking at the expenditures –instead of tax rates– during a period stretching from 1970 to 1985. The weights used do not only depend on geographic proximity, but also on revenue per capita and on the state's racial composition. The results obtained show that the level of state public spending per capita is connected positively to the one of neighbouring states (it is the weighted matrix based on racial composition which confers the best results). All things being equal, facing an average increase of public spending of 1 USD in neighbouring states, a given state will respond with an increase of 70 cents of its own expenditures.

B. Tests on European data. Pioneer work for the European Union was accomplished by Heyndels and Vuchelen (1998). They made use of fiscal data of 589 Belgian municipalities which have significant autonomy in terms of education, police, social action and transportation infrastructures. Local taxes account for 40% of total municipal revenues (the remaining 60% originate from grants). The municipalities decide on the rates of approximately twenty taxes but the tax bases are the same on the whole territory. Two main taxes can be distinguished however: the local income tax (in addition to the national income tax) and the *précompte immobilier* (which is a kind of property tax), which added up represent roughly 40% of the total fiscal revenue of municipalities[9]. An equation for each tax is estimated simultaneously for the 589 municipalities for 1992, using the 3 OLS method as well as the IV method. Similar to

[9] Taxes decided on by local decision-makers are to be added to the federal rates for the income tax and the regional rate for the tax on real estate property. The bases of these two taxes are established at the federal level. The proposed test focuses on these two taxes.

papers using US data, the results show that the rates of both local taxes are significantly influenced by the ones of neighbouring municipalities, which confirms the existence of mimetic behaviour. Indeed, the increase (respectively, the decrease) of 1% of the average municipal rate of the income tax leads to an increase (respectively, decrease) of 0.67% of the same tax rate in a given municipality. An increase in the average municipal rate on real estate property by 1%, results in an increase of the rate of a given municipality of 0.69%. The extent of the reaction is thus almost identical in both cases. These results are globally confirmed by the study made by Richard, Tulkens and Verdonck (2000) which focus on the same additional taxes on which municipalities have discretional power. A dynamic model is estimated on the base of the panel data of the 589 municipalities. The authors show, in particular, that the adjustment speed in reaction to changes of tax rates in the other municipalities is very low: for the *précompte immobilier*, the gap between the effective rate and the desirable rate due to tax interactions is only reduced by 6% annually; as for the income tax, this gap is only reduced by 0.1% annually.

Similar tests have been carried out in Germany, Switzerland, Italy and Spain. In Germany, Buettner (2001) analysed the tax behaviour of the municipalities between 1980 and 1996 regarding the local business tax: the *Gewerbesteuer*. It is a tax shared by the *Gemeinde* (63.5%), the *Länder (*28.25%) and the *Bund* (18.25%). This tax is collected by the municipalities, which possess an extensive fiscal autonomy, and its tax base is composed mainly of revenues issued from non-agricultural companies (90%) and operating capital (10%). In order to estimate his model, Buettner uses the method of instrumental variables, and shows that municipalities mimic each other. Similar results are obtained by Feld and Reulier (2002) in the Swiss case. They tested, based on the cantonal (i.e., regional) data over a period ranging from 1984 to 1999, the existence of strategic behaviour in relation to the local income tax (the local income tax and the local business tax account for 50% of the cantonal and communal tax revenues). The results using the IV method show that the effective cantonal income tax rates are closely dependent upon the ones of neighbouring cantons, yet the intensity of strategic interactions varies according to the levels of taxable income (the local income tax is progressive). The significance of Feld and Reulier's paper lies in the fact that it confirms the hypothesis about fiscal competition between cantons brought to the fore in earlier work by Feld and Kirchgässner (2001; 2002). They showed that both households and companies are sensitive to local fiscal disparities.

In Spain, Solé-Ollé (2003) tried to verify the existence of fiscal interaction between municipalities (*municipios*) over the 1992–1999 period. The IV method was used. Results confirm the existence of interactions in relation to the choice of tax rates for two of the three taxes tested; that is, the property tax and the local tax on vehicles. But the most important contribution of this paper is the introduction of an electoral, or popularity equation capable of capturing the potential back-effect of the fiscal choices on the probability of re-election of local public decision-makers[10]. The author can thus test the hypothesis according to which local mimetic behaviour results from the behaviour of voters who compare tax burdens between municipalities. In particular, he shows that an increase of taxes in a given municipality is influencing negatively the probability of re-election of local decisions-makers. These last results confirm the yardstick competition hypothesis already mentioned in the case of the American data by Besley and Case (1995b). Similar results are also found in Bordignon, Cerniglia and Revelli (2003) who tested the idea according to which the tax rates are an integral part of local-level "political competiton". Their study focuses on the local property tax set by Italian cities in Lombardy in the nineties. Results in relation to mimetic behaviour at the municipal level are closely linked to election dates. If a mayor is candidate to his own re-election, then tax rates of his municipality will be positively linked with neighbouring cities. The correlation is nil when the mayor is not eligible to run for elections again.

Finally, Revelli (2003) estimated a popularity equation using British local fiscal data over the 1970-1990 period. The local tax on which the paper is based on is the property tax, which is the main source of revenue of British districts before its disappearance at the beginning of the nineties. The results of his estimations confirm the existence of a comparison made by voters according to political performance. They show that the popularity of an elected person depends negatively on the rise of tax rates in the own district, and positively on the fiscal augmentation in neighbouring districts.

c. Tests of French data. In France, econometrical tests have been made recently relative to the local business tax (*taxe professionelle,* TP) and

[10] The relation between the percentage of votes in favour of the local government in office and the variation of the tax rate on the previous period are tested. If an increase of the rates has a negative impact on the votes in favour of the elected politician in office, then the yardstick competition hypothesis is not disproved.

using both municipal and regional data. The work of Paty, Pentel and Jayet (2002) attempts to demonstrate the existence of "fiscal mimicking" – type of behaviour between municipalities belonging to so-called "employment zones" of the *Nord-Pas de Calais*. Like Brueckner and Saavedra (2001), these authors tested several interaction matrixes and ended up keeping the one which offers the best results. It is the matrix whose weight is proportional to size and inversely proportional to distance. This particular matrix has the advantage to include not only spatial contiguity which is superior to one, but also the relative weight of the municipalities. The results obtained thanks to the method of the maximum likelihood, confirm the general hypothesis of fiscal mimicking. Positive and significant coefficients of the slope of the best-response function are found in three out of the four employment zones of study. Considering the exception of the mineral basin, the best response of a municipality to the variation of the business tax rate in neighbouring municipalities is clearly a comparable modification of the own tax rate. Depending on the location, estimations of the spatial auto-regression coefficient are different, with variations ranging from 0.58 to 0.76. This suggests that mimetic behaviour does not have the same intensity everywhere.

Finally, the study of Feld, Josselin and Rocaboy (2002) attempts to demonstrate the existence of mimetic behaviour in 22 French regions over the 1986-1998 period. The specification retained by the authors supposes that regional tax policy is dependent on the non-weighted average of taxes in the geographically neighbouring regions, that is, the regions sharing borders[11]. According to their results, the local tax rates are significantly and positively influenced by the ones of neighbouring regions. The local business tax seems to be the regional tax which causes the highest degree of mimicking. In the short run (long run), an increase of one point of the TP rate in the neighbouring communities of a given region translates into an augmentation of 0.225 (0.6) points of the same tax rate in that very region. Conversely, the property tax seems to be subject to a much weaker mimetic behaviour, the estimated coefficient representing 0.081 in the short term and 0.29 in the long term.

[11] For instance, the elected politicians of the Ile de France rely on the behaviour of the Haute-Normandie, the Picardie, the Champagne-Ardennes, Bourgogne and Centre in terms of imposition, in order to define their own policy. As the average is non-weighted, none of the considered regions has more influence than the others on the fiscal choices of the Ile de France.

Thus, generally speaking, these results tend to show that regional tax rates are strategic complements. The authors explain this fact through the existence of political competition since, in opposition to the results of the fiscal competition models, the regional rates in France converge towards a rise over the period considered.

As a conclusion, in spite of the specificity of each institutional context characterising each country, researches often conclude on the existence of a significant interdependence between the fiscal decisions made by the territorial entities studied.

3.3. Horizontal and vertical interactions: Some empirical results

Contrary to the previous articles, the following papers test the existence of both horizontal and vertical externalities[12]. The main results are provided in table 2.

a. A test on 13 OECD countries. Goodspeed (2000) estimates the impact of horizontal and vertical externalities on the choices of income tax rate operating in a federation. The IV method is used to estimate equation [3] with a panel data set of 13 OECD countries over the period of 1975-1984. In order to deal with the empirical difficulty of the horizontal externality, the author used a poverty index[13] making the following assumption: The lower the poverty rate, the more mobile is the population expected to be ("tax competition" argument). But a lower poverty rate may also facilitate comparisons across jurisdictions ("yardstick competition" argument). The results indicate that local governments decrease their use of income taxes in reaction to a higher national income tax rate and a lower poverty rate[14]. The direction of the "vertical" reaction contrasts therefore with the previous results of Besley and Rosen (1998).

[12] Besley and Rosen (1998) only test the presence of vertical interaction and find that when the federal government increases taxes, there is a significant positive response of state taxes. A 10% per gallon increase in the federal tax rate on gasoline leads to a 3.2% increase in the state tax rate.

[13] It is the proportion of income received by the poorest 20% of the population. The greater is the index, the lower is the poverty rate.

[14] The reaction of the local government to the national government change shows that a 1% increase in the national government income tax rate leads to a fall of about 0,17% in the local government income tax rate. Turning to horizontal test, the reaction of the local income tax rate to a 1% increase in the income earned by the poorest 20% of the population is about −0,59%.

b. Tests on American data. Esteller-Moré and Solé-Ollé (2001) estimate the reaction of state personal income and general sales taxes to federal tax rates in the US. They test the spatial model with panel data for the period 1987-1996 by using the IV method. The results confirm the existence of tax mimicking in setting the state income tax policies. A 1% point change in the tax burden of neighbouring states is followed by a reaction of 0.20% in the state income effective tax rate. Personal income and general sales taxes are also shown to be complementary for the state policymakers. They find that a one point increase in the federal effective tax rate is followed by an increase of 0.10 points in the state income tax rate and 0.22 when considering income and general sales tax together. They finally provide evidence of the impact of the tax deductibility of state taxes in the federal income tax base as states allowing reciprocal tax deductibility react less than the average. Interdependencies due to vertical tax externality or to tax deductibility are shown to account for half of the total reaction only, the rest is due to fiscal illusion in state tax setting.

Hayashi and Boadway (2001) test the existence of the two sorts of tax interaction in the Canadian federation. They estimate a set of tax-setting functions for the federal government, Ontario, Quebec and an aggregate of the remaining eight provinces. They assume first that governments act as Nash competitors, taking the policies of other governments as given. They include dynamic characteristics in their model by making the assumptions that governments react to tax rates of other governments wit one-period lag and that they also adjust their current tax rates only partially to their desired ones. They use a panel data set on business income tax rates for 1963-1996. Their results confirm the existence of both externalities but their magnitudes vary across governments. They find that the vertical response of provincial taxes to the federal tax are negative, only Ontario's response remains insignificant. The provincial effects on the federal rates are significant and positive only for Ontario. Horizontal interactions are also significant and positive; there is, therefore, tax mimicking among Canadian provinces. Still, Ontario does not significantly react to any of the taxes of other governments. Quebec exhibits a large and positive horizontal response to Ontario. The authors also test an alternative model representing a system in which the federal government acts as a Stackelberg leader. The estimates for the provincial governments appear to be unchanged in this second specification. Finally they conclude that the choice between the Nash and the Stackelberg systems remains inconclusive.

As federal transfers could also be expected to affect tax-setting behaviour of provincial governments, Esteller-Moré and Solé-Ollé (2002) test the existence of interactions between the provincial tax rate, on the one hand, and the federal tax rate the tax rate set by competing provinces, and the standard equalisation tax rate, on the other hand. Basically, they assume that vertical externalities may also arise when equalisation transfers are present as an increase in the standard equalisation tax rate provides incentives to raise taxes to the receiving provinces. To test the validity of this assumption, they estimate provincial tax setting functions with data on Canadian personal income taxation for the period 1982-1996 by using the IV method. They find that the reaction to horizontal competition is stronger in the provinces that do not receive equalisation transfers. There is also a significant positive response of provincial tax rates to changes in the federal income tax rate, the tax rates of competing provinces, and the standard equalisation rate.

At a lower level, Brett and Pinske (2000) study the municipal business property tax setting in the province of British Columbia (Canada). They estimate several structural-form equations and a reduced-form tax equation by using IV techniques on data in 1987 and 1991. They find some evidence that there is a positive relationship between own tax rates and the neighbours' rates. However the source of this tax mimicking is not very clear. However, according to the authors, it is difficult to explain this response as arising out of tax competition. The results also confirm the existence of vertical externalities as municipal tax rates are sensitive to taxes set on the same base by super-municipal bodies.

c. Tests on European data. Revelli (2001) tests for horizontal and vertical interactions in a property tax setting by using a panel data set of the English non-metropolitan districts in the 1980s. The results confirm the existence of tax mimicking among districts. A 1% increase in the local property tax of a district's neighbours leads to an increase of 0.45% in its own property tax rate. Nonetheless, the results confirm the absence of vertical interactions between lower-tier authorities (districts) and upper-tier authorities (counties). This absence of tax mimicking between the two levels of government was expected by the authors since in the UK, different levels of governments are in charge of the provision of different public goods and services[15].

[15] Counties provide services such as education, strategic planning, police and fire protection, while districts are responsible for housing, refuse collection, building regulations and environmental health (Punnet, 1994).

This last result could have been expected in France as it is usually considered as a country as unitary as the UK. But the different layers of local governments have a large fiscal autonomy. Leprince, Madiès and Paty (2003) test the existence of interdependencies in the tax setting of the so-called departments, which are the middle-tier of the French local public sector. Focusing on the local business tax rates, they estimate a spatial model with three overlapping layers of local governments by using ML techniques on 1999 and 1995. They reject the hypothesis of tax interactions between the middle-tier (departments) and the upper-tier authorities (regions). However, they provide evidence of tax interactions between the middle-tier and the lowest-tier (municipalities). Finally their result confirm the existence of tax mimicking among French departments.

Table 2 : The empirical tests of horizontal and vertical externalities

Dependent variable	Setting	Horizontal interactions	Vertical interactions
Goodspeed (2000)			
Income tax rate	13 OECD countries Local and national levels 1975-86	Poverty index: -0.59	-0.17
Esteller-Moré and Solé-Ollé (2001)			
Income tax, general sales tax and aggregate tax	United States 41 federal states and federation 1987-96	0.2 for income tax None for aggregate tax	0.1 for income tax 0,22 for aggregate tax
Hayashi and Boadway (2001)			
Business income tax	Canada Québec,Ontario, 8 other provinces and federation 1961-96	Ontario: none Québec: 1.197 (Ontario) and 0.642 (other provinces) Other provinces: 0.526 (Ontario)	Ontario: none Québec: -0.931 Other provinces: -0.403
Esteller-Moré and Solé-Ollé (2002)			
Personal income tax	Canada 10 provinces and federation 1982-1996	0.35	0.2

Brett and Pinske (2000)			
Business property tax	British Colombia (Canada) Municipalities and regional districts 1987 et 1991	1 in models with fixed effects	-0.75
Revelli (2001)			
Property tax	England Districts and non metropolitan counties 1983-90	0.45	None
Leprince, Madiès and Paty (2004)			
Business tax	France Departments and regions Departments and municipalities 1999	0.42	No interaction between department and region 0.33 between department and municipalities

3.4 Discriminating among the theoretical explanations of strategic interactions

The previous section has provided an overview of the empirical tests of horizontal and vertical externalities. In most cases, the results give evidence of tax mimicking between jurisdictions (or federal states) belonging to the same government level. The source of this horizontal interaction is less clear. When the empirical results provide evidence of strategic interaction among jurisdictions as to the choice of a particular tax rate, the following question remains: which behaviour is likely to have generated the observed mimicry (Brueckner, 2003)? Tax mimicking could arise because a mobile resource that locates in a jurisdiction is affected by the tax rate in that jurisdiction as well as by neighbouring jurisdictions' tax rates. This is the so-called tax competition hypothesis. Tax mimicking could also be explained by the yardstick competition approach. Voters use other governments' performance as a yardstick to evaluate their own representatives. Politicians are then sensitive to their relative performance and try not to get too far out of line with policies in neighbouring jurisdictions.

In both cases, the reduced-form spatial reaction functions are the same. Therefore, only estimating a tax rate setting equation does not allow discriminating among the above-mentioned theoretical explanations. To resolve this problem, Brueckner (2003) proposes to implement the fiscal competition approach empirically, by testing the hypothesis supporting that the policy enacted in jurisdiction *i* as well as the policy in neighbouring jurisdictions affect the tax base of jurisdiction *i*. Following this reasoning, Buettner (2003) and Brett and Pinkse (2000) find evidence in favour of the tax competition hypothesis. In regard to yardstick competition, an implication of this hypothesis is that the electoral results in a jurisdiction depend on the own tax rate and on nearby jurisdictions' tax rates. Besley and Case (1995), in the case of the US States' income taxes, and Revelli (2002), in the case of the UK local property taxes, find that own tax changes have a negative effect, and geographic neighbours' tax changes have a positive and significant effect on the politicians' chances of being re-elected. These results seem to be in favour of the yardstick competition approach.

As for the vertical interaction, similar problem may arise. When vertical interdependencies are detected, taxes may be complementary or substitutes for the local or the state policymakers. The source of this observed interaction is not clear either. The specificity of the institutional setting, e.g. the presence of tax deductibility of state taxes in the federal tax base as in Esteller-Moré and Solé-Ollé (2001), is also likely to explain the observed interaction.

4. Conclusion

Research on strategic interaction among local government grew significantly in 1990s. This article brings the various contributions of the fiscal federalism literature on this issue together. First the theoretical studies have been reviewed. Two main approaches can justify the existence of such interaction: the fiscal competition hypothesis and the yardstick competition hypothesis. The former is based on tax base mobility while, the latter is due to electoral purposes. In both cases, there a correlation exists among fiscal policies of nearby jurisdictions. This is the so-called tax mimicking result.

From an empirical point of view, numerous studies find evidence of the tax mimicking hypothesis as far as vertical tax competition is concerned. This is no longer the case when analysing interaction between two different levels of government. One of the most challenging empi-

rical problems of this literature comes from the fact that competing theoretical models to explain fiscal interactions give similar results in terms of reaction function. This suggests that additional tests directly derived from the theory must be performed in order to discriminate among the alternative approaches.

Finally these results give empirical evidence on the existence of various interdependences between local jurisdictions. This turns out to be a major conclusion in that it shows how strategically politicians behave when choosing local fiscal policies.

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