Equalization and Fiscal Competition: Theory and Evidence

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5 May 2001

Abstract

We develop a model with two countries, producing two goods: one mobile and the other not. The mobile good is taxed according to the origin principle. People decide to buy the good where the price is more convenient for them. The two countries engage in fiscal competition. The introduction of an equalization transfer decreases the fiscal externality due to the tax-base mobility: some of the lost tax "comes back". We test the theoretical results by using tax data from Canada, where an equalization transfer holds, and United States. We find that tax-competition is lower between canadian provinces, than between a canadian province and a US state.

Keywords: fiscal competition, equalization, transfer, externality, tax-rate.

JEL classification: H21, H23.

1 Introduction[1]

Fiscal decentralization is normally justified by two factors. Firstly, local taxes reflect citizens' preferences much more than central taxes. Secondly, the management of local public expenditure would be more efficient than it would be if taxes were centralized.

However, in a federation the geographical subset, where regional Government taxes, can not coincide with the subset where the tax-base of the residents of each region is distributed. In this case with free mobility of persons, goods and capital each region fixes its tax rate without taking into account the benefits in revenue and/or social welfare to the other regions (Mintz and Tulkens 1986; Wilson, 1991; Wildasin, 1988; Kanbur and Keen 1993).

Normally transfers are needed to avoid these inefficiencies (Wildasin1991; Dahlby, 1996). This is a key issue inside the European Community. In fact the Cockfield White Paper (Commission, 1985) and subsequent Commission proposals recommended with the implementation of a VAT origin system (which should symplify a lot the life to the traders because they would deal with only one fiscal administration) the adoptions of two important measures to avoid the fiscal administrations to lose revenue and indeed starting competing by decreasing their tax-rates: harmonization of the tax rates and a clearing house mechanism.The approval of a clearing mechanism would ensure each nation has the same revenue it would have in a destination system. Moreover it should eliminate the incentive for each nation to decrease its taxes. This last statement is what the Coase theorem forecasts: the welfare of an inefficient equilibrium can be improved by using appropriate side payments. Is this working in a federation where states compete by fixing taxes?

In the paper we test the efficacy in welfare terms of a transfer system by looking at a particular federal reality: Canada, where an equalization system among the provinces holds. According to this transfer system each province receives (gives) a quota of its revenue, according to an equalization rate if its tax-base is lower (higher) than a standard tax-base.

In the theoretical part we suppose to deal with a federation where the enforcement problem of the transfer has already been solved (Bordignon et al.2000; Dhillon et al. 1999): each country reveals its true type in its tax-rate decision and the transfer has already been optimally designed (Dahlby and Wilson, 1994; Dahlby, 1996; Boadway and Keen, 1996). We analyse the welfare properties of an equalization transfer, based on differences on fiscal capacities, and show that it is equivalent to a compensation transfer. The intuition is the following: if country j loses a quota of its tax-base bacause some other country decreases its tax, with an equalization mechanism country j recovers part of it because the received (given) transfer will be higher (lower) than it was before the mentioned

[1]I wish to thank Tim Besley, Valentino Larcinese, Imran Rasul and all the participants to the EOPP-STICERD seminar, PET conference (the Second International Conference of the Association of Public Economic Theory - Warwick 2000) and to seminars at IFS (23 February 2001), University of Ferrara and Catholic University of Milan for helpful comments. The usual disclaimer applies.

change.

We highlight the process which leads the equalization transfer to improve the efficiency of a federal fiscal system, by using a simple model with two countries, producing one good. The good is taxed according to the origin principle. So the tax-base can move from one country to the other according to the advantage of the consumers, which, given the production price, is determined by the tax-decision of the fiscal authorities and a transport or transaction cost. The reason of the tax-base mobility can be twofold: first people, given a tax-differential, can cross the border and buy elsewhere the product, second tax-differentials can incentivate smuggling from the low tax-country to the high-tax country. This is equivalent in terms of loss in revenue for the high-tax country to a cross-border shopping phenomenon. This situation, if we assume that the prevailing effect determining the externality level is the public consumption effect (Mintz, Tulkens, 1986; Kanbur and Keen, 1993), leads to too low tax rates with respect to a Pareto-optimal tax decision. We show that, by inserting an equalization transfer based on fiscal capacity, one of the determinants of the coefficient of the tax best reply function, given the tax rate of the other country, is lower than in the case without the transfer. This means that the level of tax-competition decreases.

This result has been tested by using data of two federal countries: Canada and United States. The reason for the choice of Canada and United States is that both are federal countries where each province or state has decision power on taxes, especially on sales taxes or specific taxes on goods. Moreover in US there is no equalization system among the states, Canada has an equalization system based on fiscal capacity. In Canada the transfer is calculated for 30 types of taxes. We test the theoretical model by using sales taxes and cigarettes specific taxes for the period 1984-1994. The test looks at how a Canadian province replies to a tax-change of a neighbouring province/state, according to the nation (Canada or US) the neighbouring province/state belongs. The theoretical intuition is confirmed by the empirical test: in fact a change in tax rate of the Canadian provinces is influenced more by a change in tax-rate of a US neighboring state, than by a change in tax-rate of a Canadian neighbouring province. The reason of that is the following. If a Canadian province loses taxes because a neighboring Canadian province decreases its tax-rate, some of the lost tax "comes back" because of the equalization transfer. If a Canadian province loses taxes because a neighbouring US state decreases its tax-rate, the Canadian province will not recover anything because no equalization system holds. Indeed it will react more heavily if the change in tax-rate is coming from a US neighboring state than if it is coming from a Canadian province.

It is interesting to notice that this can be thought as a test of the "Coase Theorem". Each province, in fact, is given a transfer, which in the theoretical part is shown to be partially equivalent to a compensation transfer, linked to the difference between its tax-base and a Canadian standard tax-base. We show that this transfer influences the negative fiscal externality, related to the interprovincial tax-base mobility, but not the negative externality related to the international tax-base mobility.

It is interesting to note that in the specific geographical area we have chosen the way how provinces and/or states relates in their tax-decisions on cigarettes seems to be quite important according to the last report of the World Health Organization (1999) on tobacco control. The report put the attention on the fact that "differential in the price of tobacco products among neighbouring countries may lead to both casual cross-border shopping and illegal bootlegging. Cross-border sales may even occur within countries, such as Canada and United States, given the intracountry price differences among Canadian provinces and states within the United States". If the states and/or provinces are aware of that, they will choose their tax-rates by looking at the nighbouring choice. This is what seems to be happened between the 80's and 90's when the cigarettes smuggling between the States and Canada became a huger and huger problem and culminates with the "92-94 smuggling crises". Smugglers profit of the difference in sales and cigarettes taxes among provinces. "Cigarettes are smuggled from ...Alberta to British Columbia....by road through mail order operators, by commercial couriers and airline baggage" (The Globe and Mail, July 28, 1997). Inspector Ferguson of the RCMP's economic crime unit in British Columbia declared in an interview (The Globe and Mail, July 28, 1997) in 1997: "Inter-provincial smuggling is costing millions and millions of dollars in lost taxes. It's a huge problem. People don't realize how serious it is." Similar problems are supposed to hold among other provinces. Difference in cigarettes tax among bordering provinces sometimes is really huge. Take for example the western part of the country: in 92 Newfoundland has a tax per pack which is more than half the bordering PEI, Quebec and New Brunswik.

The paper is organized as follows. The second section develops the theoretical model. The third section discusses the impact in welfare terms of an equalization transfer. In the forth section the model is tested. Section 5 concludes.

2 The model

Consider an economy with two countries. In each country there is an identical number of residents. Two goods are produced: a mobile good x and an immobile good z. The two goods are produced by means of a constant return to scale production function, with labour l as the only input. Each resident can decide where to buy the consumption good x, according to the post-tax price and a transport or transaction cost. This action can be legal or illegal. In the former case we talk about cross-border shopping, whose level is constrained by the distance from the border and so the transport cost. In the latter case the tax-base mobility is due to smuggling and each resident bears an ethical cost.[2] Another way to interpret the cost linked to the illegal tax-base mobility is the remuneration of risk, the smugglers bear to be discovered from the police, which is higher, the higher the number of residents to be provided is. If the residents

[2] One can think of an imaginary line where people are uniformly distributed according to their observance level of the law.

are uniformely distributed the risk and so the cost increases with the distance from the border. Each country decide the tax-level on the good x and the good z, given the bahaviour of the residents in the two countries.

Let us index the two countries as 1 and 2. Let us consider country 1. In each country there is the same number of residents $\overline{n}$, uniformly distributed, and each resident is identical, in the sense that it has the same utility function:

$$U = -l + u(x) + m(z) \tag{1}$$

where:

l_1 labour supply

$x_1$consumption demand of the mobile good

$z_1$consumption demand of the immobile good

The quasilinearity in labour (the income source for each resident) is justified by the fact that normally the income effect is not significant in determining the demand for cigarettes (Baltagi, Levin 1992).

Each resident can be subject to two different kinds of budget constraints. If it decides to buy the good in its country:

$$(1 + t_1)\, x + z\,(1 + s_1) = l \tag{2}$$

where t_1 and s_1 are respectively per-unit specific tax on x and z.

We assume that the goods are produced with a linear production function of the type $x = l$ and $z = l$. This allows us to write the following normalization:

$$p_z = p_x = w = 1$$

where:

p_z and p_x production price of z and x.

w input price

which justifies the way how (2) is written.

If the resident decides to buy the good of the other country, its budget constraint is:

$$(1 + t_2)\, x = l - \theta$$

where θ is the total transaction cost the θth resident must bear. We are assuming, for simplicity, that the per unit transaction cost is 1, indeed θ is also the distance from the border of the consumer who is indifferent between shopping in 1 or 2 or between shopping smuggled cigarettes from 2 or legal cigarettes.

In the former case θ is the phisical distance of the resident from the border, which determines its total transport cost; in the latter case it is its morality level, its respect for the law of the country where it lives.

2.1 The second stage

If the consumer decides to buy the good x sold and taxed in its country it will solve the following problem:

$$\max_{l,x} U - \lambda\left[(1+t_1)\,x + (1+s_1)z - l\right]$$

from which we obtain:

$$x = (u')^{-1}(1+t_1) \tag{3}$$

$$z = (m')^{-1}(1+s_1) \tag{4}$$

$$l = (1+t_1)\,x(t_1) \tag{5}$$

Substituting (3), (4) and (5) in (1):

$$V_1^1 = -(1+t_1)x(t_1) + u(x(t_1)) + m(z(s_1)) \tag{6}$$

If the consumer decides to buy the good from the other country it will solve the following problem:

$$\max_{l,x} U - \lambda\left[(1+t_2)\,x + (1+s_1)z - (l_1 - \text{e})\right]$$

obtaining:

$$x = (u')^{-1}(1+t_2) \tag{7}$$

$$z = (m')^{-1}(1+s_1) \tag{8}$$

$$l = (1+t_2)\,x(t_2) + \text{e} \tag{9}$$

Substituting (7), (8) and (9) in (1):

$$V_2^1 = -(1+t_2)x(t_2) - \text{e} + u(x(t_2)) + m(z(s_1)) \tag{10}$$

Each resident decides if to buy in 1 or 2, by comparing (6) and (10). A resident in 1 will be willing to buy x in 2 or the good x illegally coming from 2 as far as:

$$V_2^1 > V_1^1 \tag{11}$$

If we take (11) as an equality it is possible to obtain the number of residents, θ, buying x in 2 or smuggled from 2, given that $t_2 < t_1$. Moreover, totally differentiating and using Roy's identity:

$$\frac{d\theta}{dt_1} = x(t_1)$$

and:

$$\frac{d\theta}{dt_2} = -x(t_2)$$

When t_1 increases, given t_2, the number of people which decides to buy the good from 2 increases, and vice-versa when t_2 increases, given t_1.

2.2 The first stage

By using the informations from the second stage we can build up the tax-bases of the two countries. Take, without loss of generality, $t_2 < t_1$:

$$B_1 = (\overline{n} - \theta)\, x(t_1) + \overline{n} z(s_1)$$

and the total tax-base in 2:

$$B_2 = \overline{n} x(t_2) + \theta x(t_2) + \overline{n} z(s_1)$$

By using the informations from the second stage we can also build up the welfare functions in the two countries:

$$W_1 = (\overline{n} - \theta) V_1^1(\cdot) + \theta V_2^1(\cdot)$$

This is a utilitarian indirect welfare function: the sum of the indirect utilities of all the residents: the ones buying in 1 and the ones buying in 2 or buying the smuggled good from 2.[3]

[3] The welfare function of 2 is:

$$W_2 = \overline{n} V_2^2$$

Country 1, for any given t_2, solves the following problem:

$$\max_{t_1,s_1,\mu} L_1 = (\overline{n} - \theta) V_1^1(\cdot) + \theta V_2^1(\cdot) - \mu [\overline{g}_1 - t_1 (\overline{n} - \theta) x(t_1) - \overline{n} s_1 z(s_1)] \quad (12)$$

where:

$\overline{g}_1$ is the exogenous fixed revenue requirement in 1.
From (12):

$$\frac{\partial L_1}{\partial t_1} = -\overline{n} x(t_1) + \mu \left[(\overline{n} - \theta) \frac{\partial x}{\partial t_1} - \frac{\partial \theta}{\partial t_1} x(t_1) \right] t_1 + (\overline{n} - \theta) x(t_1) = 0 \quad (13)$$

$$\frac{\partial L_1}{\partial s_1} = -\overline{n} z(s_1) + \mu \overline{n} \left[z + \frac{\partial z}{\partial s_1} s_1 \right] \quad (14)$$

$$\frac{\partial L_1}{\partial \mu} = t_1 (\overline{n} - \theta) x(t_1) + s_1 \overline{n} z(s_1) - \overline{g}_1 = 0 \quad (15)$$

If we assume that the revenue constraint is binding and indeed $\mu > 0$ and that $t_1 > 0$, then:

$$\frac{\partial g_1}{\partial t_1} = \left[(\overline{n} - \theta) \frac{\partial x_1}{\partial t_1} - \frac{\partial \theta}{\partial t_1} x_1(t_1) \right] + (\overline{n} - \theta) x_1(t_1) > 0 \quad (16)$$

otherwise (13) cannot hold. It should be noted that (16) is empirically supported by previous works: Baltagi, Levin,(1992) found in their work on a panel-data set (1963-88) for the States that the revenue elasticity for cigarettes is significantly positive. Similar results are in Crawford et al.(1995) for alcohol revenue elasticity for the United Kingdom.

2.3 The fiscal externality

The welfare of country 1 is clearly influenced, by the tax-decision of country 2, which does not take into account it, when it decides its tax-rate. The welfare consequence of this non-co-operative behaviour is given by the following expression:

$$\frac{\partial L_1}{\partial t_2} = -\theta x(t_2) - \mu \frac{\partial \theta}{\partial t_2} t_1 x(t_1)$$

This is the analytical expression of the fiscal externality, suffered by country 1. Country 2 does not take into account the excess burden that people from 1 who buy the good from 2, will bear: the higher t_2, the lower the welfare of country 1 is: $-\theta x(t_2)$. This is the so called "private consumption effect" (Mintz, Tulkens, 1986). Moreover country 2 does not take into account that if it

increases t_2, it gives back to 1 a quota of revenue: $-\mu\frac{\partial \mathbf{e}}{\partial t_2}t_1 x(t_1) \geq 0$. This is the "public consumption effect" (Mintz, Tulkens, 1986). The higher the sensitivity of n to a change in t_2, the higher this last effect is. If $-\mu\frac{\partial \mathbf{e}}{\partial t_2}t_1 x(t_1) > -\mathbf{e}x(t_2)$ country 2 chooses too low a tax-rate from the point of view of country 1.[4] In this case it is important to introduce some mechanism to incentivate the countries not to decrease their tax-rates. This is what the EU wants to do by trying to implement a compensation mechanism togheter with a VAT origin tax-system.

2.4 Best reply slope

If we totally differentiate with respect to t_1 and t_2, (13), (14) and (15), we get the best reply slope of country 1 to a tax-change in country 2. This is not a very tractable and trasparent expression. If we assume that the marginal social cost of taxation (the shadow price of government revenue) remains fixed (Besley, Rosen 1998) we can identify the two main effects which generate the slope of the best reply function: the revenue effect and the dead weight loss effect. If we totally differentiate (13)-(15) by assuming μ fixed, there is no more link among (13), (14) and (15). By totally differentiating (15) we get:

$$\frac{dt_1}{dt_2} = -\frac{-t_1\frac{\partial \mathbf{e}}{\partial t_2}}{(1-\epsilon_1)(\overline{n}-\mathbf{e}) - t_1\frac{\partial \mathbf{e}}{\partial t_1}} \tag{17}$$

If we take account of (16), (17) tells us that if 2 increases its tax-rate, 1 decreases its own. The intuition is that an increase in 2's tax-rate will decrease the tax-base flow from 1 to 2 and country 1 can satisfy its revenue requirement with a lower tax-rate. Let's go through the coefficient. The numerator is the "public consumption effect" of the externality. The higher the sensitivity of n to a change in t_2, given t_1, is, the higher the externality level is. The denominator tells us that the higher the number of residents buying the good from 2 is, the less the answer to a change in t_2, because the tax-base elasticity in this case results to be very high. The same reasoning applies to ϵ_1, which is the per-capita demand elasticity in 1. And finally the higher the sensitivity of n to a change in t_1 is, the lower the incentive of country 1 to increase t_1 is, if t_2 decreases.

[4] If we face the problem symmetric to (11) for country 2, we get the following externality expression:

$$\frac{\partial L_2}{\partial t_1} = \mu\frac{\partial \mathbf{e}}{\partial t_1}x(t_2)\,t_2$$

In this case the fiscal externality coincides with the "public consumption effect", because people from country 2 are not buying the good from 1 and so country 1 cannot export its excess burden in country 2. Country 1 does not take into account that if it increases t_1, a quota of residents from 1 goes to 2 and the revenue of country 2 increases: country 1 chooses too low a tax-rate from the point the point of view of country 2.

When we totally differentiate (13) we get:

$$\frac{dt_1}{dt_2} = -\frac{\mu\left[\frac{\partial^2 B_1}{\partial t_1 t_2} t_1 + \frac{\partial B_1}{\partial t_2}\right]}{-\overline{n}\frac{\partial x}{\partial t_1} + \mu\left[\frac{\partial^2 B_1}{\partial t_1^2} t_1 + 2\frac{\partial B_1}{\partial t_1}\right]} = \phi(\mu) \tag{18}$$

It is interesting to highlight that when we look at (18) by assuming that μ does not change, it is like controlling (18) for the revenue effect, isolating the dead weight loss effect. The best reply coefficient we would have, by totally differetiating the system, without fixing μ, would be a "particular combination" of these two effects.

3 The equalization transfer

Think of a simple transfer which solves the following equation:

$$\bar{t}\frac{B_1}{\overline{n}} + \tau_1 = \bar{t}\frac{B_1 + B_2}{2\overline{n}} \tag{19}$$

where:
$\bar{t}$ is the equalization rate
τ_1 is the per-capita transfer received or given from country 1
and:

$$B_1 = (\overline{n} - 1)\, x(t_1)$$

$$B_2 = \overline{n}x(t_2) + 1x(t_2)$$

from (19) we obtain the total transfer from country 1:

$$T_1 = \overline{n}\tau_1 = \bar{t}\left[\frac{B_2 - B_1}{2}\right] \tag{20}$$

In Canada the equalization rate is the average tax-rate of all the provinces, indeed:

$$\bar{t} = \frac{t_1 B_1 + t_2 B_2}{B_1 + B_2} \tag{21}$$

As in the empirical part we will test the effects on the fiscal externalities of the Canadian equalization system, we derive the theoretical results by using the Canadian transfer formula. If we use (21), (20) becomes:

$$T_1 = \frac{t_1 B_1 + t_2 B_2}{B_1 + B_2}\left[\frac{B_2 - B_1}{2}\right] \tag{22}$$

Take the derivative of (22) with respect to t_1 and get:

$$\frac{\partial T_1}{\partial t_1} = \overline{t}\left[\alpha\frac{\partial B_2}{\partial t_1} - \beta\frac{\partial B_1}{\partial t_1}\right] + (\beta-\alpha)\left[\frac{\partial g_1}{\partial t_1} + \frac{\partial g_2}{\partial t_1}\right] \tag{23}$$

where:
$\alpha = \frac{B_1}{B_1+B_2}$
$\beta = \frac{B_1}{B_1+B_2}$
It is easy to see that:

$$\frac{\partial B_1}{\partial t_1} = (\overline{n}-\theta)\frac{\partial x(t_1)}{\partial t_1} - \frac{\partial \theta}{\partial t_1}x(t_1) < 0 \tag{24}$$

If t_1 increases the tax-base of country 1 decreases, because people shopping in 1 decreases their demand, $(\overline{n}-\theta)\frac{\partial x(t_1)}{\partial t_1}$, and because the number of people buying the good taxed in 2 increases: $-\frac{\partial \theta}{\partial t_1}x(t_1)$;

$$\frac{\partial B_2}{\partial t_1} = \frac{\partial \theta}{\partial t_1}x_1(t_2) > 0 \tag{25}$$

if t_1 increases the tax-base of country 2 increases, because the number of people buying the good taxed in 2 increases. Moreover we know that:

$$\frac{\partial g_2}{\partial t_1} = \frac{\partial \theta}{\partial t_1}t_2x_1(t_2) > 0 \tag{26}$$

If we use (16), (24), (25) and (26) to evaluate the sign of (23), it is clear that:
if $\beta-\alpha>0$ then $\frac{\partial T_1}{\partial t_1}>0$
if $\beta-\alpha<0$ then $\frac{\partial T_1}{\partial t_1}>0$ if $|\beta-\alpha|$ is small enough. Which means that the difference in per-capita tax-base must be not very high. This can be reasonable if we think that in the empirical part we deal with cigarettes tax-bases.

Similarly, if we differentiate (23) with respect to t_2 we get:

$$\frac{\partial T_1}{\partial t_2} = \overline{t}\left[\alpha\frac{\partial B_2}{\partial t_2} - \beta\frac{\partial B_1}{\partial t_2}\right] + (\beta-\alpha)\left[\frac{\partial g_1}{\partial t_2} + \frac{\partial g_2}{\partial t_2}\right]$$

In this case we can state:
if $\beta-\alpha>0$ then $\frac{\partial T_1}{\partial t_2}<0$ if $|\beta-\alpha|$ is small enough.
if $\beta-\alpha<0$ then $\frac{\partial T_1}{\partial t_2}<0$
We take from now the simplifying assumption that $|\beta-\alpha|$ is small enough. This can allow us to state that: $\frac{\partial T_1}{\partial t_2}<0$ and $\frac{\partial T_1}{\partial t_1}>0$.

It means that if an equalization system holds, each country knows that if it increases its tax-rate, given the tax-rate of the other, it will get (give) more (less) revenue than in the case without equalization, because a decrease (increase) in its tax-base due to an increase (decrease) in its tax-rate means an increase (decrease) in the transfer it receives (gives), via the decrease of its tax-base,

$\frac{\partial B_1}{\partial t_1} = (\overline{n} - \theta)\frac{\partial x(t_1)}{\partial t_1} - \frac{\partial \theta}{\partial t_1}x(t_1)$, and the increase of the tax-base of the other country: $\frac{\partial B_2}{\partial t_1} = \frac{\partial \theta}{\partial t_1}x(t_2)$. Each country in this case takes into account that an increase in its tax-rate, given the tax-rate of the other country, will benefit the other country, because it will get part of this benefit through the equalization system.

The same reasoning can be applied to examine how the perception of an increase in the other country 's tax-rate is, when an equalization system holds. In this case each country knows that if the other country increases its tax-rate, it will get (give) less (more) revenue than in the case without equalization, because an increase (decrease) in its tax-base due to an increase (decrease) in the other's tax-rate means an decrease (increase) in the transfer it receives (gives), via the increase of its tax-base, $\frac{\partial B_1}{\partial t_2} = -\frac{\partial \theta}{\partial t_2}x(t_1)$, and the decrease of the tax-base of the other country: $\frac{\partial B_2}{\partial t_2} = (\overline{n} + \theta)\frac{\partial x(t_2)}{\partial t_2} + \frac{\partial \theta}{\partial t_2}x(t_2)$.

3.1 The transfer and the externality

We derive the fiscal externality, by taking into account that the transfer (21) is holding and determines the revenue level in each country:

$$\frac{\partial L_{1e}}{\partial t_2} = -\theta x(t_2) + \mu\left[-t_1 x(t_1)\frac{\partial \theta}{\partial t_2} + \frac{\partial T_1}{\partial t_2}\right] \tag{27}$$

From (27) we notice that the introduction of the equalization transfer can make the "public consumption effect" smoother than before.

It is interesting to highlight that the compensation mechanism the EU is trying to implement togheter with an origin-based VAT consists of a side-payments scheme which restablishes, in revenue terms, the destination principle. In our model country 1 should get $\theta t_1 x_1$.If we derive the externality formula by inserting this compensation transfer, the public consumption effect would disappear. In fact if we take for example country 1, the derivative of its compensation transfer with respect to t_2 is: $\frac{\partial \theta}{\partial t_2}t_1 x(t_1)$[5]. It is interesting to see that if we go through (26) we find among the other terms: $-\beta\overline{t}\frac{\partial B_1}{\partial t_2} = \beta\frac{\partial \theta}{\partial t_2}\overline{t}x_1(t_1)$. Indeed a quota of the equalizing transfer reveals some compensation properties. But what really makes a compensation trasfer very close to an equalizing transfer, as regard their effects on the fiscal externality, is the identical sign (negative) of their derivatives with respect to the tax-rate of the other country. This shows that the effect of an equalizing transfer like the Canadian one goes in the same direction of a compensating transfer, necessary to implement the Coase theorem if fiscal externalities hold. This means that a federation, which adopts a proper equalization scheme, could not need any compensation scheme to avoid fiscal externalities if an origin-based tax system holds.

[5]This expression is negative: if country 2 increases its tax-rate, it will receive a lower tax-base quota from country 1. Indeed country 1 bears a lower fiscal externality and needs lower compensation.

3.2 The new slope

We can test this welfare property of the equalization transfer concentrating our attention on one of the two determinats of the best reply slope: the revenue effect. The anlytical structure of this effect allows to establish, as we have already seen (section 2.4), a clear link with the fiscal externality:

$$\frac{dt_{1e}}{dt_{2e}} = -\frac{-t_1\frac{\partial \mathbf{e}}{\partial t_2} + \frac{\partial T_1}{\partial t_2}\frac{1}{x_1(t_1)}}{(1-\epsilon_1)(\overline{n}-\mathbf{e}) - t_1\frac{\partial \mathbf{e}}{\partial t_1} + \frac{\partial T_1}{\partial t_1}\frac{1}{x_1(t_1)}} \tag{28}$$

By applying the previous results on the derivatives of the total transfer with respect to the tax-rates, it is quite evident that for any given t_2 :

$$\left.\frac{dt_{1e}}{dt_{2e}}\right| < \left.\frac{dt_1}{dt_2}\right| \tag{29}$$

(29) is motivated by the fact that the introduction of the equalization transfer has decreased the externality country 1 bears. This fact affects the numerator by decreasing it. In this case it is true that if 2 increases t_2, 1 receives back a quota of migrated tax-base, which, for any given t_2, is lower if equalization holds. This induces also a lower extent of the decrease in t_1, for any given t_2. Moreover this behaviour is also motivated by the fact that, for any given t_2, an increase in t_1 increases the revenue more than without equalization, because the migrating tax-base quota will be lower than without equalization. In fact: $\frac{\partial T_1}{\partial t_1}\frac{1}{x_1(t_1)} > 0$. This fact affects the denominator by increasing it.

4 The empirical test

Our main goal is to estimate the reaction function relating a country tax to a neighbouring country tax in two different situations: a first one where an equalization system holds, and another one where no equalization holds. We have both situations in Canada. Most of Canadian provinces are in fact bordering both US states and Canadian provinces. In the former case they compete in fixing tax-rates without any revenue equalization, in the latter case they compete in fixing tax-rates with a revenue equalization system holding. In order to isolate the independent impact of the neighbouring tax-rates on the tax-rate of a Canadian province, one must take into account other variables, that might affect the provinces tax-rate. The province's tax-rate on commodities depends on several types of variables:

-Province economic and demographic variables. Province taxation can be influenced by economic and demographic enviroment. We used the following variables: population, per-capita income, state unemployment rate, proportion of population between 5 and 17, proportion of population of 65 and the ratio of tobacco and alchol revenue on total revenue.

-Federal fiscal variables. We take account of the fiscal federal instruments, which can differ from province to province, by controlling for the federal grant -in-aid and the federal income tax colleted in each province.

-Province fixed effect. There are certain unchanging characteristics of a province, that are likely to impact its fiscal system such as climate and geography. We take into account these characteristics by including a dichotomous variable for each province.

-Year fixed effect. Changes in the macroeconomic situation can affect all provinces fiscal policy. To account for this effect we use a dichotomous variable for each year. In our context these effects are very important because in the years 84-94 there was an increasing federal no-smoking policy which leads the federal authorities to increase the tax-rate on cigarettes a lot.This was followed by a very high increase of cigarettes exports year by year.

To summarize our estimating equation is the following:

$$t_{st} = \alpha_s + \beta_t + \gamma_1 \overline{t}_{st} + \gamma_2 \overline{\overline{t}}_{st} + \gamma_3 \delta \overline{t}_{st} + \gamma_4 g_{st} \overline{t}_{st} + \gamma_5 g_{st} \overline{\overline{t}}_{st} + \phi x_{st} + \epsilon_{st} \quad (30)$$

t_{st} is the tax-rate for province s and year t; α_s are state fixed effects; β_t are dummies variables that picks up for macro-shock and common change in fiscal policies; x_{st} is a vector of province specific time varying shocks; $\overline{t}_{st}$ is the tax-rates average for province s in year t of the neighbouring provinces of province s; $\overline{\overline{t}}_{st}$ is the tax-rates average for province s in year t of the neighbouring US states of province s; δ is a dummy which equal to 1 for the provinces bordering the US states; $g_{st}\overline{t}_{st}$ and $g_{st}\overline{\overline{t}}_{st}$ are the variables resulting from the interaction between the ratio of tobacco and alchool revenue on total revenue and respectively $\overline{t}_{st}$ and $\overline{\overline{t}}_{st}$.

4.1 Expected results

In the model oulined in section 2 and 3 we described two main determinants of the best reply coefficient: the revenue effect and the deadweight loss effect. We are able to identify the deadweight loss effect by assuming constant the marginal social cost of taxation. In section 2.4 we have seen that in the case we assume a constant μ, the deadweight loss effect is a function of μ and the revenue effect is not. We proxy μ with the tobacco revenue quota on total revenue. Any given μ implies, in fact, a precise tax structure and so, for any given fixed revenue requirement, a precise level of g_{st}. This procedure allows us to identify the deadweight loss effect with $\gamma_4 \overline{g}_{st}$ for the equalization case and $\gamma_5 \overline{g}_{st}$ for the no-equalization case, where $\overline{g}_{st}$ is the mean of g_{st}. Therefore in the econometric model the best reply coefficient with and without equalization is respectively determined by the following expressions:

$$\frac{dt_{st}}{d\overline{t}_{st}} = \gamma_1 + \gamma_3 \delta + \gamma_4 \overline{g}_{st} \quad (31)$$

$$\frac{dt_{st}}{d\overline{\overline{t}}_{st}} = \gamma_2 + \gamma_5 \overline{g}_{st} \quad (32)$$

In (31) the revenue effect is further splitted to account for the US border effect. It is, in fact well known that the great part of the population of the provinces bordering the US states lives near the border. In this situation it the provincial authority normally cares much more of a US neighbouring state tax-change, than of a neighbouring Canadian province tax-change. One can argue that this fact can explain the difference between $\frac{dt_{st}}{d\bar{t}_{st}}$ and $\frac{dt_{st}}{d\bar{\bar{t}}_{st}}$. As we want to know if this difference can be explained by the equalization system, we identify the quota of the coefficient due to this effect by using the variable $\delta\bar{t}_{st}$. The left coefficient quotas are γ_1 and γ_2. Both could be respectively reflected by a formula as (28) and (17), which does not include the *deadweight loss effect*. γ_1 reflects (28) depurated by the particular behaviour of the provinces bordering the United States. Therefore we can think of γ_1 and γ_2 as proxing the *revenue effect* and we expect from theory:

$$|\gamma_1| < |\gamma_2|$$

4.2 Data description

4.2.1 Tax-rates

We used annual data on the provinces and US bordering states for the years 1984 to 1994, inclusive. Cigarettes in Canada and United States are normally subject to ad valorem general sales taxes as well as unit taxes. We compute a total real unit tax-rate, by taking the unit-tax equivalent of the general sales tax (calculated by multiplying the general sales tax-rate by the price), adding this to the unit tax-rate, and then dividing by the CPI to adjust for inflation. We calculate these total taxes for US by using tax-rates from ACIR annual reports. We took them from the web site of the National Clearinghouse on Tobacco and Health for Canada.[6] The idea is that when setting unit taxes on cigarettes, provinces take into account the general sales taxes levied on these commodities. These last taxes also influence the tax-inclusive prices.

Taxes on cigarettes vary among Canadian provinces. In 1991, as an example, PEI provincial taxes on 20 cigarettes were 1.80$ (in Canadian dollars), New Brunswick 2.50$, Nova Scotia 1.85$, Québec 1.52$, Ontario 1.66$, Newfondland 1.97$, Saskatchewn 1.66$, Manitoba 1.94$, Alberta 1.40$, British Columbia 1.60$.

As noted above our main focus is on the different relationship between province cigarettes tax-rate and the Canadian neighbouring tax-rate and the US neighbouring tax-rate. We estimate the neighbouring tax-rates by doing the mean of the neighbouring Canadian provinces tax-rates (CCt_{st}) and/or US states tax-rates ($CUSt_{st}$) and dividing the former for the Canadian CPI and the latter for the US CPI. The Canadian tax-rates are further divided by the PPP index.[7]

[6] www.cctc.ca

[7] The PPP index for Canada-US was downloaded by the OECD web site

4.2.2 Other variables

There is a set of time varying variables characterizing the province's economic and demographic situation: province population (POP_{st}), population density ($DENS_{st}$), province per-capita income in 89 US$ (INC_{st}), province unemployment rate ($UNEMP_{st}$), proportion of individuals in the province who are between 5 and 17 ($CHILD_{st}$) and proportion of individuals who are over 65 ($AGED_{st}$). As a rough measure of cigarettes tax-base elasticity we use the ratio of tobacco and alchool revenue[8] on total revenue ($PTOB_{st}$). we take account of the federal policy influence, specific for each province by controlling for federal grant-in-aid in 89 US$ ($GRANT_{st}$) and federal tax-revenue in each province in 89 US$ ($INCT_{st}$).[9]

4.2.3 Results

All the results of the regressions in table 1 are with years and provinces effects. Column (1) reports the results relative to the regression with the controls. Column (2) reports the results of the regression with only the indepedendent variables. In column (3) we have the results for the estimated equation (30) not instrumented. In column (4) we have the results for the estimated equation with instrumentation. We instrumented the neighbouring tax-rates with their economic and demographic variables, which are significantly related to the neighbouring tax-rates, but not related to the considered province tax-rate. We instrument the neighbouring tax-rates because we assume (as standard theory does) that tax-rates are simultaneosly determined by all the provinces (Mintz, Tulkens 1986; Kanbur and Keen 1993; Besley, Case, 1995). In this case $\overline{t}_{st}$ and $\overline{\overline{t}}_{st}$ are functions of t_{st}, so the independent variables, $\overline{t}_{st}$ and $\overline{\overline{t}}_{st}$, of (30) are correlated with the disturbance term ϵ_{st} and the forth Gauss-Markov condition is violated. As a consequence the estimates of the standard errors will be invalid and the coefficients will be biased. To avoid this problem we instrument the endogenous variables by using the Two-Stage Least Squares method.

The regression with only the fixed effects explains the 77% of variance of t_{st}. As we already mentioned, in Canada during the last 80s and the first 90s, the federal tax-rate increased, because of a strong anti-smoking federal government policy: in 1988 the total federal tax (federal specific + sales tax) on 20 cigarettes was 0.76 $ (Canadian dollars); in 1993 it arrived at 1.93 $. This federal behaviour

[8] Canadian Statistics do not offer a disaggregated measure of tobacco provincial revenue. By taking the aggregated measure we assume that tobacco and alchool revenue are not correlated and that the quota of alchool on total revenue does not explain the choice of the cigarettes tax-rate. In this case the bias introduced by not considering only the tobacco revenue should be very small

[9] All the socio-economic variables for the USA have been collected by using the following web sites:

www.census.gov

www.bea.doc.gov

www.stats.bls.gov

The socio-economic variables for Canada have been bought from Canadian Statistics (www.statcan.ca)

is incorporated in the year effect and it influences positively the province tax-rate, conferming a recent result on vertical externalities (Besley, Rosen, 1998). If we look at column (1) we see that it explains 87% of the variance but almost all the control are not significative. In column (2) we have the regression with the dependent variables. Almost all of them are significative and the R^2 increases (0.93). In column (3) we use both the dependent variables and the controls and the R^2 increases further (0.97), making almost all the controls significative. This means that the depent variables are really essential in the economy of the regression. Putting in other words the bias on the controls, if we omit, the dependent variables is much higher, than the bias on the dependent variables if we omit the controls. This tells us that the only year effects cannot explain the variance of t_{st} and the high R^2. In this case in fact the values of the controls in column (3) would not change a lot from the ones in column (1), which are already controlled for the years and province effects. Moreover the standard deviations of $\overline{t}_{st}$ and $\overline{\overline{t}}_{st}$ are not so small to allow only the year effects to explain the variance of t_{st}.

The coefficient $\gamma_3 = 0.84$ shows the role of the provinces bordering the US in making not significant the part of the coefficient due to the *revenue effect* (linked to the externality level). The reason is that the great part of the population lives near the US border. In fact, if we estimate the regression without this coefficient control, we get a very small γ_1 (-0.064), which is not significative (col.5). In the regression in column 3 $\gamma_1 = -0.41$ and significative at 5%. This is the revenue effect in the equalization case, depurated from the border effect. The robustness of this interpretation is also confirmed by the fact that if we replicate the regression with only the provinces bordering the US, γ_1 is very small and again negative (col.6).

The econometric results confirm the theory in fact:

$$|\gamma_1| < |\gamma_2|$$

So the existence of the equalizing transfer offsets the externality which drives the extent of γ_1,determining the above inequality.

When we instrument, our results do not change. γ_1 and γ_2 increase in absolute value and also their difference increases. (col.4)

5 Conclusion

In the second section we derive optimality conditions and the slope of the best reply function of one country, given the tax rate of the other. We show that the tax rate choice is inefficiently low because the consumer of one country can buy the good produced in the other country (fiscal externality). Moreover we discuss how the the fiscal externality is reflected in the slope of the best reply function.

In the third section we then study how the introduction of an equalization system, based on fiscal capacity, can affect the first order conditions, by changing the extent of the fiscal externality. We show that a Pareto improvement occurs:

each country, given the tax rate of the other, chooses a higher tax-rate. We look finally at how the effect of the equalization system is reflected in the best reply function slope.

We find that the best reply function is less steep if we introduce equalization. This is because the fiscal externality is partially offset by the existence of the transfer and the slope of the best reply function depends on the extent of the fiscal externality.

So in our case raising welfare by decreasing the fiscal externality level means decreasing the best reply function slope.

We are interested in the best reply function slope because this is the link with the empirical test. If we are able to understand the entity of the welfare effects due to the introduction of an equalization system, by analysing the changes in the best reply function slopes we are able to test what the theory predicts, in welfare terms, if the equalization system is introduced.

The second part of the paper develops a test of the theoretical result by using a data-set Canada-US 1984-1994 with sales taxes and specific cigarettes taxes. The test confirms the theoretical result that the introduction of an equalization system decreases the fiscal externality due to tax-base mobility.

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table 1

Column	1	2	3 (no instr)	4 (instr)	5	6
dt		0.813	0.845	0.826		
		(10.78)**	(13.86)**	(10.49)**		
CCt		-0.232	-0.41	-0.539	-0.065	-0.196
		-1.86	(2.36)*	(2.26)*	-0.17	-0.48
CUSt		-6.169	-6.611	-9.795	-9.35	-12.245
		(4.42)**	(7.57)**	(7.50)**	(3.27)**	(2.84)**
TOB*CCt		1.255	1.803	2.221	0.933	2.08
		(2.98)**	(3.88)**	(3.85)**	-0.87	-1.63
TOB*CUSt		18.844	18.464	29.679	35.919	45.175
		(3.71)**	(5.14)**	(6.05)**	(3.40)**	(3.03)**
TOB		-777.512	-605.136	-874.973	-852.589	-1,361.76
		(4.66)**	(4.92)**	(5.28)**	(2.73)**	(2.74)**
DENS	0.00007		-0.025	-0.034	-0.035	-0.057
	0		(2.12)*	(2.74)**	-1.74	(2.20)*
UNEMP	3.753		6.499	5.6	0.867	-0.797
	-1.19		(4.50)**	(3.58)**	-0.28	-0.19
POP	0.00006		0.000074	0.000085	0.000075	0.00011
	-0.93		(3.27)**	(3.46)**	-1.33	-1.75
POP2	-5.90E-12		-2.10E-12	-1.63E-12	-3.07E-12	-2.31E-12
	-1.36		-1.52	-1.16	-0.71	-0.54
GRANT	0.005		-0.002	0	0.006	0.003
	-0.47		-0.44	-0.06	-0.62	-0.23
INCT	7.10E-07		-5.39E-06	-4.73E-06	-3.87E-06	5.72E-06
	-0.1		-1.7	-1.44	-0.5	-0.79
INC	-0.076		-0.068	-0.058	-0.031	0.037
	-1.81		(2.53)*	-1.97	-0.59	-0.67
INC2	2.44e-0.6		2.61E-06	2.20E-06	6.43E-07	-2.12E-06
	-1.45		(2.46)*	-1.86	-0.31	-0.99
AGED	-2,398.64		-1,324.20	-1,593.58	-3,635.39	-6,001.14
	-1.16		-1.55	-1.71	-1.73	(2.82)**
CHILD	-874.937		-784.907	-411.484	128.134	894.873
	-1.38		(2.65)**	-1.51	-0.2	-1.03
Cons	799.453	141.193	773.232	765.171	778.294	539.22
	(2.01)*	(4.69)**	(4.25)**	(3.93)**	-1.76	-1.17
Year effect	yes	yes	yes	yes	yes	yes
Prov effect	yes	yes	yes	yes	yes	yes
Obs	110	110	110	110	110	88
R-squared	0.84	0.93	0.97	0.96	0.87	0.88
prob>F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Robust t-statistics in parentheses * significant at 5%; ** significant at 1%

Variable	Obs	Mean	Std. Dev.	Min	Max
UNEMP	110	11.48727	3.724186	5	21
POP	110	2718113	3110024	126614	1.08E+07
POP2	110	1.70E+13	3.16E+13	1.60E+10	1.17E+14
AGED	110	0.1147428	0.016317	0.0751419	0.1443351
CHILD	110	0.1920226	0.017095	0.1692943	0.2533236
GRANT	110	1932.388	1712.002	202.3971	6160.091
INCT	110	3672641	4936601	71352.41	1.94E+07
INC	110	13218.68	1992.018	9491.453	17006.31
INC2	110	1.79E+08	5.29E+07	9.01E+07	2.89E+08
DENS	110	12792.08	11288.32	2488.433	38197.43
t	110	92.57335	36.96801	26.55915	191.7426
TOB	110	0.2717595	0.0990709	0.0237248	0.4527629
CCt	110	88.37573	30.96711	26.55915	152.6628
CUSt	110	24.70422	14.44066	0	48.14418

CORRELATION MATRIX

	t	dCCt	CCt	CUSt	TOB*CCt	TOB*CUSt
t	1					
dCCt	0.39	1				
CCt	0.58	0.4199	1			
CUSt	0.02	0.7977	0.1372	1		
TOB*CCt	0.6	0.0356	0.6048	-0.0328	1	
TOB*CUSt	0.08	0.6894	0.0781	0.9285	0.1832	1