Empirical Assessment of the Existence of Taxable Agglomeration Rents

Souleymane Coulibaly

The World Bank*

1818 H Street NW, 20433 Washington DC, USA

Tel: +1 202 473 9845

E-mail: scoulibaly2@worldbank.org

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Abstract

The New Economic Geography literature claims that firms are ready to pay more tax in “big markets” because of agglomeration rents. Tax authorities can thus set higher tax rates in denser economic area, hence an opposite mechanism to the “race to the bottom” process described by the classical tax competition theory. The aim of this paper is to empirically assess the existence of such agglomeration rents. We use Swiss data on municipalities corporate income tax rates and firms location to test the tax gap between these municipalities and the most peripheral one using a theory-based relation. Our estimations indicate that municipalities with higher agglomeration rents (measured as the number of firms plus the "potential of neighboring firms") are setting higher corporate income tax rates, hence confirming the existence of taxable agglomeration rents.

Keywords: agglomeration rents, tax competition, potential of neighboring firms

J.E.L. Classification: C4, H2, R12

1 Introduction

The debate on tax harmonization versus tax competition has been relaunched by the new EU enlargement wave, regardless of the view of the European commission that suggested in 2001 that "a reasonable degree of tax competition within the EU is healthy and should be allowed to operate".[1] This very commission were however proposing in October 1997 a package to tackle harmful tax competition within the Union, arguing that there was a need for action at the European level in order to prevent significant losses of tax revenue and to reverse the trend of an increasing tax burden on labour compared to more mobile tax bases.[2] These changing views reflect the emergence of competing theories against the up to then dominant theory of "race to the bottom" that asserts that in an international tax competition context, the mobile factor (capital) bears too little of the tax burden to the disadvantage of the immobile factor (labor): countries lower their tax rates on this mobile factor in their attempt to attract more, while increasing the tax rate on the immobile factor to compensate the lost of revenue induced by their first action. This point was formerly made by Gordon (1983), Mierzkowski and Zodrow (1986) and Wilson (1986) among others.

The competing theories are from three different analytical frameworks: the extension of the neoclassical framework to asymmetric countries, the computable

[1] European Commision (2001), "Future priorities for EU tax policy", Working document prepared for the fourteenth meeting of the taxation Policy Group, 16 March 2001, Doc. TPG\010316.

[2] Communication from the Commission to the council, "Towards tax co-ordination in the European Union", Brussels, 01.10.1997

general equilibrium and the new economic geography framework. The asymmetric tax competition models developed by Bucovetsky (1991), Wilson (1991), Kanbur and Keen (1993) and Krogstrup (2002) claims that larger countries face a lower elasticity of capital to tax rate, and therefore choose a higher tax rate than smaller country. The computable general equilibrium framework describes more complex economies with inter-related economic agents playing rationally. The model is then calibrated on the social accounting matrix of the economy under consideration and different tax policies impacts are simulated (e.g. Sörensen, 2002, and Mendoza and Tesar, 2003). Ottaviano and Ypersele (2002) build a general equilibrium model integrating international externalities, asymmetric sizes, imperfect competition and trade costs providing a full-fledged global welfare analysis of tax competition.

The new economic geography framework is the most flourishing. The basic idea is the existence of agglomeration rents that can be taxed. Ludema and Wooton (1998) show that when trade costs decrease, integration appears to attenuate tax competition. Andersson and Forslid (1999) show that mobile factors may not respond to marginal changes in tax rates if they are locked in by the existence of industrial clusters, hence location economies producing taxable rents. Kind and al. (2000) build a full-fledged model where capital goods and firms are mobile, leading to an outcome of tax competition depending on trade costs and pecuniary externalities.

Baldwin and Krugman (2004) formally derive an equation linking tax differential and agglomeration rents in a Core-Periphery model, indicating that the stronger agglomeration rents, the wider tax differential between the Core and the Periphery. This implies a bell-shaped tax differential since agglomeration rent is shown to be a bell-shaped function of trade costs. Borck and Pflueger (2006) find the same result using a model yielding partial agglomeration equilibria in addition to the Core-Periphery equilibrium, hence generalizing this result.

The aim of this paper is to provide an empirical assessment of this theory-based result. We focus on Switzerland since we have a database of municipalities corporate income tax rates constructed and used by Brülhart and Jametti (2006). In addition, the unique tax system in Switzerland makes it a laboratory for testing various tax competition issues. Indeed, the Swiss tax system is influenced by the federal structure of the country which consists of three tiers of government: a *federation* of 26 *cantons*, each of them constituted by relatively autonomous *municipalities*. For instance, the federal corporate income tax is a flat tax rate of 8.5%, and each canton has its own tax law that sets the framework under which the municipalities belonging to the canton set their own tax rates.[3] Several studies have addressed some specific tax competition issues in Switzerland. Kirchgaessner and Pommerehne (1996) and Feld and Kirchgaessner (2001) find that residence and individuals location decisions are determined by the level of personal income taxes and transfer payment on residence, suggesting a tax competition among cantons and cities to attract wealthier resident. Brülhart and Jametti (2006) study taxation externalities in federations of benevolent governments using a database on local taxes (personal,

[3]Information extracted from http://www.switzerland-4you.com/tax_system.htm

wealth, corporate capital tax rates) in a sample of Swiss municipalities that feature direct-democratic fiscal decision making and find that vertical externalities between different levels of government leads to sub-optimally high tax rates.

However, none of these studies use this genuine tax system to assess the new economic geography result of the existence of taxable agglomeration rents. This paper fills in this gap by using the available data on municipalities corporate income tax rates, firms location and municipalities geographical location to test this theory-based result of taxable agglomeration rents. Our estimations indicate that municipalities with higher agglomeration rents (measured as the number of firms plus the "potential of neighboring firms") are setting higher corporate income tax rates, hence confirming the existence of taxable agglomeration rents.[4]

The paper is organized as follows. In section 2, we describe the theoretical model linking tax differential to agglomeration rents. Section 3 explores the relevant econometric issues raised by the model and the estimation results are presented in Section 4. Section 5 concludes the paper.

2 The model

Baldwin and Krugman (2004) and Borck and Pflueger (2006) provide the up-to-date theoretical base to analyze tax competition under the existence of agglomeration rents. The first paper is based on the Core-Periphery framework,

[4] What we mean by "potential of neighboring firms" is thoroughly described in Section 3.

while the second uses a model yielding partial stable agglomeration in addition to the Core-Periphery outcome. Both studies come to the conclusion that tax differential between alternative locations is explained by the difference in their agglomeration pattern. In this section, we summarize the model developed by Baldwin and Krugman (2004), which can be easily reformulated in a testable empirical relation.

Let consider a federation of two countries having identical preferences and technologies but setting independently their tax rates. We assume that the level of trade costs induces a Core-Periphery structure, that is one country is the Core and the other is the Periphery, as in Baldwin and Krugman (2004). There are two sectors(Agriculture (A) and Manufacture (M)) and two production factors (Entrepreneurs (K) and Workers (L)). Entrepreneurs are mobile while workers are immobile. The agricultural sector produces an homogeneous good using only workers according to constant returns to scale technology under perfect competition: the competitive wage is w and the unit input coefficient is a_A. The manufacture sector is monopolistically competitive and faces increasing returns to scale. Trade is costless in the homogeneous sector, while we assume an iceberg transport cost τ in the monopolistic sector.

2.1 Consumers side

Let us focus on the Core country. The representative consumer has the following Cobb-Douglas preference:

$$U = C_M^{\mu} C_A^{1-\mu}\ ,\ C_M = \left(\int_{i\in\{1,\ldots,n+n^*\}} c_i^{\frac{\sigma-1}{\sigma}}\, di \right)^{\frac{\sigma}{\sigma-1}} \tag{1}$$

where C_M is a CES composite of all varieties of the manufactured good and C_A is the consumption of the agricultural good A, n and n^* are the number of varieties produced respectively in the Core and the Periphery, μ is the expenditure share on the manufactured good M and σ (σ>1) is the constant elasticity of substitution between varieties.

The Cobb-Douglas preference implies that the optimal level of consumption of a good is proportional to the budget share addressed to this good, and the optimal demand of a differentiated good is now a standard result. We have the following demand functions:

$$c_j = \frac{p_j^{-\sigma}}{\int_{i\in\{1,\ldots,n+n^*\}} p_i^{1-\sigma} di} \mu E\ ,\ C_A = (1-\mu)\,\frac{E}{p_A} \tag{2}$$

where p_j is the price of a typical variety j, p_A is the price of the homogenous good and E is the consumption expenditure in the Core country.

2.2 Producers side

On the supply side, it is assumed that the production of a typical variety of a manufactured good involves the services of one entrepreneur, representing the fixed cost, and a_M units of labor for each unit of output produced. The total cost of producing x units of a variety is thus $\pi + wa_M x$, where π is the reward to entrepreneurs. Free trade in the A good equalizes prices across countries and thus equalizes the wage rate of workers in both countries: $p_A = w = w^* = 1$.[5] In the monopolistic sector, firms charge prices equal to $\sigma a_M / (\sigma - 1)$ in their local market and to $\tau \sigma a_M / (\sigma - 1)$ in their export market. If we make the normalization $a_M = (\sigma - 1)/\sigma$, their profits are just $1/\sigma$ times their sales. Using equation (2) the prices yields the following profit function for the Core and the Periphery countries:

$$\pi = \frac{\mu}{\sigma}\left(\frac{s_E}{n+\phi n^*} + \frac{\phi(1-s_E)}{\phi n + n^*}\right)E^W \tag{3}$$

$$\pi^* = \frac{\mu}{\sigma}\left(\frac{\phi s_E}{n+\phi n^*} + \frac{1-s_E}{\phi n + n^*}\right)E^W \tag{4}$$

where E^W is the level of world expenditure, s_E is the Core country share of E^W, n (respectively n^*) is the number of active firms in the Core (respectively Periphery) country and $\phi \equiv \tau^{1-\sigma}$ measures trade "freeness": $\phi = 0$ corresponds to autarky and $\phi = 1$ corresponds to free trade.

2.3 Tax authorities side

The third side of this model is the tax game by tax authorities. We focus on a reduced-form of the governments of the Core and the Periphery welfare: $G = G(n, t)$ and $G^* = G^*(n^*, t^*)$ where t and t^* are the tax rates set by the respective tax authorities. Baldwin and Krugman (2004) assume a three-stage game: in the first stage, the Core country sets its tax rate t, then the Periphery

[5] It is assumed that both countries produces some A good.

country sets its tax rate t^* and finally migration and production occurs in the third stage. Agglomeration rents in the Core country are defined as follows:

$$\Omega = \frac{\pi/P}{\pi^*/P^*}$$

where $P = (n + \phi n^*)^{\mu/(\sigma-1)}$ and $P^* = (\phi n + n^*)^{\mu/(\sigma-1)}$ are price indices.

Entrepreneurs move to the country which affords them the highest post-tax real reward and governments set tax rates that permit them to keep their industrial sector. Since the Core country government is the first mover in the tax game, it will set a limit tax that hinders the Periphery country to be more attractive to firms. In such a situation, the Periphery country set its unconstrained tax rate, t_u^*, which is the tax rate maximizing its welfare G^*conditional on being the periphery. The location condition of the Core-Periphery outcome is thus:

$$(1-t)\,\Omega = \left(1 - t^{*nd}\right) \tag{5}$$

where t is the limit tax set in the core, t^{*nd} is the non-delocation tax rate which makes firms located in the Core country just indifferent about moving to the Periphery country and Ω is agglomeration rents in the Core country. The equilibrium tax rate in the Core country (t) appears to be linked to the Periphery's non-delocation tax rate (t^{*nd}) rather than the unconstrained tax rate (t_u^*) set by the Periphery tax authority. Baldwin and al. (2003) propose an approximation of the tax rate gap between the Core and the Periphery ($t -$

t_u^*) using a log-linear approximation of $(t - t^{*nd})$ and an approximation of the periphery welfare function around the non-delocation tax rate:

$$\Delta t = t - t_u^* \approx \Omega - \left(\frac{\partial G^*}{\partial n^*} / \frac{\partial G^*}{\partial t_u^*}\right) - 1. \tag{6}$$

This relation indicates that the equilibrium tax rate in the Core country is the unconstrained tax rate of the Periphery country plus the agglomeration rents minus the relative variation of the Periphery country's welfare due to changes in n^* and t_u^*. By approximating the welfare function of the Periphery country G^* by a quadratic function of its number of firms n^* and its tax rate t_u^*, we can derive the following marginal welfare functions:

$$\frac{\partial G^*}{\partial n^*} = \alpha \ , \ \frac{\partial G^*}{\partial t_u^*} = \beta + 2\gamma t_u^* \tag{7}$$

and use them to compute the relative term in equation (9). Finally, the tax rate gap between the Core and the Periphery can be rewritten as:

$$\Delta t \approx \Omega - \frac{\alpha}{\beta + 2\gamma t_u^*} - 1. \tag{8}$$

In order to have a linear formulation, we compute the second order polynomial expansion of equation (8), which yields:

$$\Delta t \approx \Omega - \frac{\alpha}{\beta} + \frac{2\alpha\gamma}{\beta^2} t_u^* - \frac{4\alpha\gamma^2}{\beta^3} \left(t_u^*\right)^2 - 1. \tag{9}$$

To empirically assess this relation, we need to reformulate it in a multi-region framework and propose some relevant proxy to measure agglomeration rents and tax rates. The following section deals with these points.

3 Econometric issues

Firstly, let us deal with the measure of tax rates to be used in the empirical exercise. Baldwin and Krugman (2004) focus on capital and labor tax rates that are assumed identical. This is not true in real world, in any case not in Switzerland as can be seen in Table 1.

Table 1: Tax rates in Swiss municipalities in 1995

	Tax rates (in %)		
Tax bases	Average	Standard Errors	Coefficient of Variation
Private capital stock	0.22	0.11	1.90
Single workers' income	4.20	1.09	3.86
Married workers' income	3.59	1.14	3.16
Low profitability firms' income	3.62	1.64	2.21
Medium profitability firms' income	5.15	1.93	2.67
High profitability firms' income	7.43	2.88	2.58

Source: Brülhart and Jametti (2006) database and author's own calculations.

The Swiss data indicate a lower variability of capital tax rates compared to labor and corporate income tax rates. Deriving a tax differential equation assuming that capital and labor tax rates are different is beyond the scope of this paper in which we aim to the evaluate empirically equation (9). Brülhart and Jametti (2006) provide a nice evaluation of Swiss municipalities corporate income taxes, which are based on firms profitability measured as the ratio between firms profits and their capital stock. They collected corporate tax rates for median-capital firms with low (2%), medium (9%) and high (32%) profitability over 210 municipalities covering 24 of the 26 Swiss cantons. Since corporate income tax impacts on the whole firm and not on production factors like capital and labor tax rates, we will assume that Δt in equation (9) rather represents the differential in corporate income tax rates between the Core and the Periphery. To check the sensitivity of our results with regard to this typology, we also consider the average of these three tax rates in the empirical estimation.

Secondly, the Core-Periphery framework used in Baldwin and Krugman (2004) is clearly unrealistic since any location with relatively significant population (cities or towns) appear to attract some manufacturing firms. However, as demonstrated by Borck and Pflueger (2006), the tax competition outcome derived in Baldwin and Krugman (2004) can be generalized to the case of partial stable agglomeration: higher tax rates are set in locations with larger manufacturing sectors. In this partial agglomeration framework, we can set a threshold number of firms to partition the locations between partial Cores (receiving more than the threshold number of firms) and partial Peripheries (receiving less than the threshold).

Our first attempt to do such partition was to consider the clusters of municipalities defined as “agglomerations” by the Swiss Federal Office of Statistics as the Core locations and the other municipalities as the peripheral ones. The “agglomerations” are bigger municipalities formed by a central municipality and many contiguous municipalities forming a unique economic center. However, the tax differential between these “agglomerations” and the other municipalities appeared to be not that clear-cut as can be seen in Figure 1.

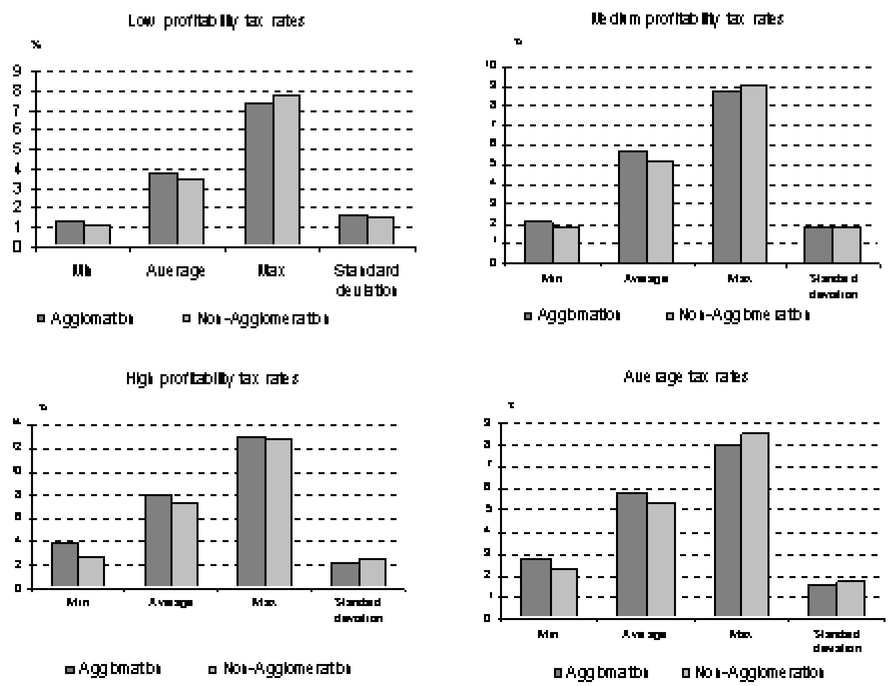

Figure 1: Tax differential between "agglomerations" and other municipalities in Switzerland

Figure 1 shows that corporate income tax rates are not unambiguously higher in the “agglomerations”. Indeed, except for higher profitability firms’, the maximum tax rates are rather set in the non-“agglomerations” municipalities.

We therefore decided to use the municipality with the lowest corporate income tax rate as the Periphery and the others as the alternative locations providing higher agglomeration rents. This suggests that in equation (9), all the terms including t_u^* will be constant, which writes now as:

$$\Delta t_{ij} = a.\Omega_{ij} + b + \varepsilon_{ij} \tag{10}$$

where Δt_{ij} is the corporate income tax rate differential between any of the 209 Swiss municipalities (index i) and the municipality with the lowest tax rate (index j), Ω_{ij} is the agglomeration rents differential between any of the 209 Swiss municipalities (index i) and the municipality with the lowest tax rate (index j), b is a constant term and ε_{ij} is the error term.

We then have to propose an empirical evaluation of agglomeration rents. Ciccone and Hall (1996) and Ciccone (2002) have used different measures of density to assess the impact of agglomeration on firms’ productivity. However, by using density measures as proxies for agglomeration in our framework, we implicitly require all agglomeration forces to work through the number of firms or workers per hectare, without capturing any backward and forward linkages spanning over neighbor locations. We thus need an alternative agglomeration measure taking into account this aspect.

The simplest and straightforward measure of agglomeration is the number of firms in a specific location. Indeed, the higher the number of firms in a given location, the higher the agglomeration rents should be there, otherwise at least some of them would have relocated in the alternative most attractive location. In a multi-region framework, the accessibility of a location is an additional source of attractiveness that should be included in the measure of agglomeration rents. We combine these two ideas to propose the following proxy for the agglomeration rents:

$$\Omega_{ij} = \left(n_i + \sum_{k,k \neq i} \frac{n_k}{Dist_{ik}} \right) - \left(n_j + \sum_{k,k \neq j} \frac{n_k}{Dist_{jk}} \right) \tag{11}$$

where the index k represents all the 210 Swiss municipalities, n_k is the number of firms located in municipality k, and $Dist_{ik}$ is the distance between municipalities i and k. $Dist_{ik}$ is computed using the Cartesian coordinates (x, y, z) of the municipalities provided by the Swiss Federal Office of Statistics:

$$Dist_{ik} = \sqrt{(x_i - x_k)^2 + (y_i - y_k)^2 + (z_i - z_k)^2}. \tag{12}$$

Since Switzerland is a quite small country, this is a reasonable approximation of the great-circle distance that should be considered because of spheric form of the Earth.

Then, we have to include a set of relevant control variables that affects tax rates in our framework, otherwise, the estimated coefficient will be misleading because of omitted variables problem. Because of the tax system in Switzerland where each canton defines its tax base and tax rates in the cantonal tax laws that have to be used by their municipalities to set their own tax rates, the natural set of control variables is a set of dummy variables specifying each of the 24 cantons covered by the data available. We end up with the following equation to be estimated :

$$\Delta t_{ij} = a.\Omega_{ij} + b + \sum_{m=1}^{24} c_m.Canton_m + \varepsilon_{ij}. \tag{13}$$

The last econometric issue is the endogeneity of agglomeration in a framework departing from the pure Core-Periphery structure. Indeed, in a partial agglomeration equilibrium structure, tax rates depends on agglomeration, but agglomeration also depends on tax rates. Our agglomeration rents proxy Ω_{ij} is therefore endogenous and OLS is no longer the adequate estimation method of equation (13). If we are able to find a set of instruments variables that are clearly related to the number of firms but clearly not related to the corporate income tax rates, we can use the Instrumental Variable estimation technique to overcome this problem. We propose two instruments that seem to be good candidates. In the empirical estimation section, we perform some diagnostic tests to validate the choice of these instruments.

The first instrument is the population of the municipalities (P_i). In the new economic geography literature, firms' location decision is clearly linked to the presence of a potential demand (forward linkages). The population of the municipalities is a good proxy for the local market potential. In addition, this variable is clearly not related to the corporate income tax rates set by the municipalities. Indeed, there is no reason that a dormitory municipality for instance set a higher corporate income tax because of the local population dwelling there since this will increase the incentive of the few firms still located there to relocate in the economic center where the dormitory municipality inhabitants go to work.

The second instrument is the extension of the first to a multi-region context. When other potential consumers are located close to a big municipality (big in terms of population), this increases the incentive of firms to locate there. We can proxy the potential of neighboring population of a municipality by this simple measure:

$$Ppop_i = \sum_{k \neq i} \frac{P_k}{Dist_{ik}} \tag{14}$$

where $Ppop_i$ is the potential of neighboring population of municipality i, P_k is the population of municipality k, and $Dist_{ik}$ is the distance between municipality i and k. We can then differentiate P_i and $Ppop_i$ with the values in the peripheral municipality. We finally use a two-stage least square method to estimate the relation between tax and agglomeration as follows:

$$\Omega_{ij} = \alpha_1.\Delta P_{ij} + \alpha_2.\Delta Ppop_{ij} + \alpha_3 + \epsilon_{ij} \tag{15}$$

$$\Delta t_{ij} = a.\Omega_{ij} + b + \sum_{m=1}^{24} c_m.Canton_m + \varepsilon_{ij}. \tag{16}$$

We have now a testable relation: a positive and significant value of coefficient a will confirm the existence of taxable agglomeration rents.

4 Empirical estimation

We use data on Swiss municipalities corporate income tax rates and firms' location to empirically test the existence of taxable agglomeration rents. We have in fact three different databases: one containing information on municipalities tax rates, one containing information of firms and last containing the Cartesian coordinates of Swiss municipalities. We first match these databases using the municipalities codes before computing the proxies described in the previous section.

4.1 Description of the data

The first database we use is the Swiss municipalities tax database built by Brülhart and Jametti (2006) containing among others corporate income tax rates and some geographical variables such as the municipalities' population on 210 Swiss municipalities for various years.

The second database we use is the Federal Statistics Office database on Swiss firms containing non-public firms, their employment and the municipalities where these firms are located for various years. Since the coding system of municipalities used by these two databases are exactly identical only for the year 1995, we restrict on this year for the sake of consistency.

The third database we use is the Federal Statistics Office database on municipalities Cartesian coordinates. For each municipality, the central coordinate (x, y) is manually determined on a map using the most important church of this municipality as the reference point. These coordinates are then used in a topographical model to evaluate the altitude z. We thus have for each Swiss municipality these Cartesian coordinates (x, y, z) called the "Kirchspitz" coordinates (referring to "church coordinates").

We match these three databases using the coding system of Swiss municipalities and end up with a unique database containing tax, firms, population and geographical information. We can then compute the distance, agglomeration rents, and potential of neighboring population proxies defined in the previous section.

4.2 Estimation results

Since our database includes three types of corporate income tax rates depending on the profitability of the firms, the peripheral municipality will not necessarily be the same depending on the tax measure used as can be seen in Table 2:

Table 2: Municipalities with lowest tax rates

	Low profitability	Medium profitability	High profitability	Average
Municipality	Freienbach	Chene-Bougeries	Gelterkinden	Chene-Bougeries
Canton	Schwitz	Geneva	Basel Land	Geneva
Tax rate	1,15%	1,80%	2,76%	2,30%

Sources: Brülhart and Jametti (2006) and author own calculations.

The average corporate income tax rates are simply the arithmetic mean of the tax rates and are included to check the robustness of the results with regard to the typology of tax rates used proposed by Brülhart and Jametti (2006).

Before running the model, let us glance at the correlation matrix of the key variables used in the model.

Table 3: Correlation matrix

	ΔP_{ij}	$\Delta Ppop_{ij}$	Ω_{ij}	Δt_{ij}
ΔP_{ij}	1.00			
$\Delta Ppop_{ij}$	-0.05	1.00		
Ω_{ij}	0.99	-0.05	1.00	
Δt_{ij}	0.04	-0.05	0.05	1.00

Table 3 uses the average tax rates as the corporate tax measures, though the results are hardly different when using the other tax measures. It shows that the municipality population and its measure of agglomeration rents are perfectly correlated which is an illustration of the backward and forward linkages described in the new economic geography literature. The negative correlation between municipalities' population and their potential of neighboring population depicts these two locations as alternative locations competing to attract final consumers.

4.2.1 Preliminary tests

In the econometric issues, we have clearly made the point that the agglomeration rents measure is rather endogenous and we proposed to use Instrumental Variables estimation. However, we still need to empirically corroborate the fact that the agglomeration rents proxy proposed is endogenous. This is easily done with the Durbin-Wu-Hausman endogeneity test described in Davidson and Mackinnon (1993):

i) Estimate the following equation, which is an extension of equation (15) to the control variables included in equation (16):

$$\Omega_{ij} = \alpha_1.\Delta P_{ij} + \alpha_2.\Delta Ppop_{ij} + \alpha_3 + \sum_{m=1}^{24} c_m.Canton_m + \epsilon_{ij}. \qquad (17)$$

ii) Extract the residuals of this regression and include them as a regressor in equation (16):

$$\Delta t_{ij} = a.\Omega_{ij} + \rho.residuals + b + \sum_{m=1}^{24} c_m.Canton_m + \varepsilon_{ij}. \qquad (18)$$

iii) Test for the statistical significance of ρ. If it is significantly different from zero, this confirms the endogeneity of Ω_{ij}.

Table 4 presents the results of this test.

Table 4: Durbin-Wu-Hausman endogeneity test

	1	2	3	4
ρ	-0.0001091	-0.000225	-0.0003669	-0.000367
t-stat	-1.40	-1.86	-1.98	-1.89

In Table 4, Specification 1 uses the corporate income tax rates of low profitability firms as the dependent variable, Specification 2 uses the tax rates of medium profitability firms, Specification 3 uses the tax rates of high profitability firms, and Specification 4 uses the average tax rates. In all the Specifications

ρ appears to be statistically significant at 85%, confirming the endogeneity of Ω_{ij}.

The next step is to test for the validity of the instruments we chose to correct for this endogeneity problem. To test for this, we resort to the Stock and Staiger (1997) approach: regress the instrumented variable on all the instruments and consider the F statistics; if this statistics is greater than 10, we conclude to the validity of the instruments used. Table 5 presents these results.

Table 5: First stage regression results

	Dependent variable: Ω_{ij}			
	1	2	3	4
ΔP_{ij}	0.053^a	0.053^a	0.053^a	0.053^a
$\Delta Ppop_{ij}$	-0.065	-0.084	-0.059	-0.084
Const	-160.287^a	167.648^a	-83.180^a	167.648^a
R^2	0.975	0.975	0.975	0.975
F-stat	481.99	479.91	482.20	479.91
N	209	209	209	209

[a] means significant at 99%.

$\Delta Ppop_{ij}$ does not yield statistically significant coefficients but the F-statistics of the regressions are greater than 10, hence the first-stage regression appears to be relevant. We can now focus on the second-stage regression results.

4.2.2 Analysis of the results

Table 6 presents the results of the two-stage least square estimation. The different specifications use different proxies as dependent variables (the corporate income tax rates) and thus assumes different Periphery municipalities as described in Table 2: in Specification 1 $\triangle t_{ij}$ is the corporate income tax rates of low profitability firms and the Periphery municipality is Freienbach in Schwitz canton, in Specification 2 $\triangle t_{ij}$ is the corporate income tax rates of medium profitability firms and the Periphery municipality is Chene-Bougeries in Geneva canton, in Specification 3 $\triangle t_{ij}$ is the corporate income tax rates of high profitability firms and the Periphery municipality is Gelterkinden in Basel Land canton, and in Specification 4 $\triangle t_{ij}$ is the average of these three corporate income tax rates and the Periphery municipality is Chene-Bougeries in Geneva canton.

In Table 6, a coefficient with an upper index ^{a} is significant at 99%, a coefficient with an upper index ^{b} is significant at 95%, and a coefficient with an upper index ^{c} is significant at 90%. The codes used to represent each of the Swiss cantons dummy variable are described in the Appendix.

Table 6: 2-SLS estimation results[6]

	Dependent variable: $\triangle t_{ij}$			
	1	2	3	4
Ω_{ij}	0.0000193^a	0.0000348^a	0.0000582^a	0.0000369^a
AR	3.462^a	4.653^a	3.657^a	3.924^a
BE	1.531^a	1.950^a	2.505^a	1.995^a
BL	0.222^a	0.854^a	-0.473^a	0.186^a
FR	0.210^c	1.457^a	4.160^a	1.943^a
GE	-0.492^a	-0.618^a	0.460^a	-0.185^b
GL	1.896^a	4.066^a	6.090^a	4.017^a
GR	1.343^a	1.354^a	2.479^a	1.726^a
JU	4.155^a	5.530^a	4.512^a	4.733^a
LU	3.365^a	4.092^a	3.000^a	3.486^a
NE	1.418^a	2.237^a	8.190^a	3.949^a
NW	5.198^a	5.487^a	4.206^a	4.964^a
OW	5.615^a	6.174^a	5.041^a	5.610^a
SG	4.341^a	5.391^a	5.234^a	4.989^a
SH	1.891^a	2.043^a	1.146^a	1.694^a
SO	0.695^a	3.549^a	4.978^a	3.074^a

[6] We correct for any heteroshedasticity problem by using a robust standard error specification under STATA.

SZ	-0.777^a	3.750^a	6.365^a	3.098^a
TG	1.818^a	2.914^a	2.793^a	2.509^a
TI	3.977^a	5.541^a	4.581^a	4.700^a
UR	2.671^a	4.149^a	2.816^a	3.212^a
VD	0.367^a	1.306^a	4.372^a	2.015^a
VS	0.204^a	3.541^a	5.510^a	3.085^a
ZG	0.269^a	0.267^a	1.351^a	0.630^a
ZH	1.305^a	3.420^a	6.480^a	3.735^a
Const	1.042^a	0.974^a	1.129^a	0.648^a
R^2	0.977	0.954	0.939	0.943
Proba	0.000	0.000	0.000	0.000
N	209	209	209	209

^{a} means significant at 99%. ^{b} means significant at 95%. ^{c} means significant at 90%.

The P-values indicate an overall significance of all the four specifications, and all the estimated coefficients are at least significant at 90%. Interestingly, the estimated coefficient of the agglomeration rents proxy is positive and significant at 99% in all the four specifications, indicating that an increase of the agglomeration rents in a municipality induces a higher corporate income tax rate set by its tax authority. For instance, the estimated coefficient in Specification 4 suggests that an increase in the agglomeration rents corresponding to 1,000 more firms (regardless of their level of profitability) induces a corporate income tax increase of 0.0369% on average.

This finding is in line with the prediction of the new economic geography result of the existence of taxable agglomeration rents. Municipalities with a larger corporate income tax base and with a larger "potential of neighboring firms" appear to be aware of the fact that the attractiveness of their location lock-in firms as long as their tax rate is not set beyond a level that can damage firms' profitability. And we know that this limit is not reached since the nationwide competition of Swiss municipalities and cantons necessarily leads to the equilibrium of firms' location observed in the database we use. The estimation results indicate that if a municipality receives more firms, it can slightly increase it corporate income tax rate proportionally to this inflow of firms without inducing a massive relocation of the firms operating there. This additional revenue collected by the municipality is necessary to maintain the level of public service and infrastructure, and consequently maintain the attractiveness of the municipality.

5 Conclusion

The aim of this paper was to empirically evaluate the existence of taxable agglomeration rents by using a theory-based econometric relation. We focused on Swiss data on firms location and tax rates set at the municipality level to estimate the econometric relation derived from the new economic geography literature. Swiss municipalities appear to confirm the existence of taxable agglomeration rents, since the estimated coefficient for the agglomeration rents proxy variable are statistically significant and positive, indicating that municipalities with higher agglomeration rents are setting higher corporate income tax rates.

The new economic geography framework is plausible, and many theoretical papers confirm the existence of taxable agglomeration rents. This paper is an empirical contribution shedding light on this theory-based result. The proxy used for agglomeration rents is straightforward (number of firms) and takes into account the proximity of competing location ("potential of neighboring firms"). The results are robust to different specifications using different corporate income tax rates and thus different peripheral municipalities (defined as the municipality with lowest tax rates). However the paper only focuses on Swiss municipalities, leaving room for further empirical explorations.

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Appendix: Decoding Swiss cantons' codes

Code	Name	Size (km^2)
AR	Appenzel RE	243
BE	Bern	5959
BL	Basel Land	518
FR	Freiburg	1671
GE	Geneva	282
GL	Glarus	685
GR	Graubünden	7105
JU	Jura	838
LU	Luzern	1493
NE	Neuchâtel	803
NW	Nidwalden	276

OW	Obwalden	491
SG	Sankt Gallen	2026
SH	Schaffhausen	299
SO	Solothurn	791
SZ	Schwyz	908
TG	Thurgau	991
TI	Ticino	2812
UR	Uri	1077
VD	Vaud	3212
VS	Valais	5225
ZG	Zug	239
ZH	Zurich	1729

Sources: http://www.about.ch/cantons/