# The Effect of Agglomeration Size on Local Taxes

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**Abstract**

Standard tax competition models predict a 'race-to-the-bottom' of corporate tax rates when firms are mobile. Recent theoretical literature shows that central regions with large clusters of economic activity are able to set positive tax rates without fear of losing firms to peripheral regions as the firms would forego 'rents' from agglomeration economies. We study whether local policy makers effectively tax such agglomeration rents. We test this with data from Swiss municipalities. We find that municipalities in large urban areas indeed set higher tax rates than those in small ones. Within urban areas, however, municipal tax rates are unrelated to the size of economic activity in and around municipalities while they are positively related to the size of the political jurisdiction. We see this result as evidence that the standard tax competition model for asymmetric jurisdictions is at work in the competition of municipalities within an urban area.

*JEL Classification*: R3, H32

*Keywords*: Agglomeration, local taxation, corporate taxes, tax competition

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# 1 Introduction

Standard tax competition models predict a 'race-to-the-bottom' of corporate tax rates when firms are mobile. The new economic geography (NEG) literature has qualified this view by offering a theoretical explanation for why this extreme prediction need not occur: central regions with large clusters of economic activity are able to set positive tax rates without fear of losing firms to peripheral regions, as the firms would forego 'rents' from agglomeration economies such as market access, supplier proximity or knowledge spillovers. In this paper, we study whether local policy makers effectively tax agglomeration rents, and whether this effect is strong enough to have a noticeable impact on the evolution of statutory corporate tax rates across Swiss urban areas and municipalities.

The NEG prediction can be tested by showing that small regions exhibit lower tax rates than bigger ones. Although this test seems straightforward to implement, there is a series of challenges. First, the standard tax competition model with asymmetric jurisdiction size also predicts that small locations (tax havens) have lower tax rates than large ones, but the economic implications are very different. To separate the two predictions we make a clear difference between the political and the economic size of a location. To identify the two effects separately, we take advantage of the fact that small and medium sized municipalities can be found both in the centre and the periphery of an urban area. Second, unobserved and unobservable local characteristics could have an important effect on local tax rates. We therefore control for observable location characteristics in our *cross-section analysis*. Furthermore, we control for unobserved local characteristics by including municipality fixed effects in our *panel analysis*. Third, the size of local jurisdictions is likely affected by local tax rates and therefore endogenous. We instrument for location size with a set of variables based on 19th century population, initially available land reserves and initial sector composition.

We base our estimations on data for *Switzerland*. The Swiss federation consists of three government layers (federal, cantonal and municipal), with each jurisdictional level collecting a roughly similar share of total tax revenue. Cantons and municipalities enjoy vast autonomy in the determination of their tax rates, and, as a consequence, we observe large variations in tax burdens even within the small area covered by Switzerland. The Swiss fiscal system therefore provides a laboratory well-suited to examining our research question.

The remainder of this paper is structured as follows. In section 2, we discuss the related theoretical and empirical literature. Section 3 explains our empirical strategy. In section 4, we describe data and variables used for the estimations. The results of the main analysis are reported in section 5. In section 6, we test the results for robustness. Section 7 concludes.

## 2 Theoretical Background and Empirical Literature

The implications of agglomeration economies for strategic tax setting have been studied in a number of theoretical contributions, including Ludema and Wooton (2000), Kind et al. (2000), Andersson and Forslid (2003), and Baldwin and Krugman (2004). See Baldwin et al. (2004, chapters 15 and 16) for a comprehensive overview of New Economic Geography (NEG) literature. The key insight of this literature is that agglomeration forces make the world 'lumpy': when capital (or any other relevant production factor) is mobile and trade costs are sufficiently low, agglomeration forces lead to spatial concentrations of firms. In most versions of the model, so-called core-periphery equilibria will emerge where all firms are concentrated in one location (the core). In such agglomerated equilibria, agglomeration forces lead to higher productivity and finally positive profits in the core. Higher corporate tax rates in the core – up to a certain threshold – will therefore not lead to an outflow of firms from the core to the periphery. In short, agglomeration externalities create rents that can in principle be taxed by the jurisdiction hosting the agglomeration. Borck and Pflüger (2006) show that this basic logic also applies to situations without full agglomeration, i.e. situations in which the periphery attracts some of the firms in equilibrium. Ottaviano and van Ypersele (2005) have shown that in the presence of agglomeration economies tax competition can be second-best welfare-enhancing, as it may mitigate a tendency towards excessive spatial concentration of firms.

NEG models are typically highly abstract and we need to distill their general message before we can take them to the data. First, the only agglomeration force in the basic NEG models is market access. The core offers a larger consumer market than the periphery. We think of market access merely as shorthand for agglomeration forces in general. Examples of agglomeration forces are input sharing, labour market pooling, labour market sharing, knowledge spillovers and market access. Agglomeration forces may be city specific ("urbanisation economies") or industry specific ("localisation economies"). Duranton and Puga (2004) provide theoretical micro-foundations for these different types of agglomeration effects. Rosenthal and Strange (2004) summarise their empirical relevance. Second, the basic NEG models feature only two locations with some distance between them. Models with more than two locations in a two-dimensional space have proven almost intractable (see Fujita, Krugman and Venables 1999, chapter 11). In reality, we face a multitude of locations with some distinct geography between them. In our empirical application with municipal data, there are a multitude of adjacent jurisdictions. We think that the essence of the NEG model of strategic tax setting is the following: locations which can benefit from agglomeration economies of all sorts offer an agglomeration rent for firms that locate there. This rent can potentially be taxed by the local jurisdiction. Agglomeration economies do not depend on the political borders of local jurisdictions, but extend beyond political borders. If an economic cluster is divided into many jurisdictions, all of them can benefit – to some extent – from the agglomeration rent. This implies that the relevant measure for the "size" of the location is the "size" of the economic cluster the jurisdiction has access to. We operationalise this by taking the distance-weighted sum of employment in and around the jurisdiction (see section 4.3). In the robustness section we explicitly allow for the distinction between urbanisation economies and localisation economies.

This prediction of the NEG literature contrasts with results from the standard tax competition literature, where mobile factors such as capital lead to inefficiently low tax rates because of competition among local governments. The standard tax competition literature goes back to Oates (1972), who already describes how jurisdictions lower tax rates to attract business investment. The first formalised models were developed by Zodrow and Mieszkowski (1986) and Wilson (1986). These papers find that local governments set capital tax rates and the level of public spending inefficiently low because of tax competition. In an extension to the standard tax competition literature, Bucovetsky (1991) and Wilson (1991) introduce asymmetric fixed endowments (labour). They find that the smaller country with less labour will set lower tax rates in equilibrium, and is therefore a tax haven. The basic mechanism behind what we refer to as the *asymmetric tax competition mechanism* is as follows: starting from identical tax rates, a unilateral reduction in the tax rate leads to an inflow of capital. The size of this inflow is exactly the same whether the country is small or large. For a small country, this capital inflow is relatively larger than in the large country with respect to the fixed endowment or with respect to the capital stock (the tax base). This higher elasticity of the tax base is the key asymmetry between small and large countries. In the Nash equilibrium between two countries, both countries lower their tax rates until the marginal benefit from the attracted capital is equal to the losses from lower tax rates. This trade-off is balanced at lower tax rates for the small country. In the simple case of revenue maximising governments, the trade off is simply between new tax revenue from attracted capital vs. lost tax revenue on existing capital. Bucovetsky (1991) and Wilson (1991) show that this logic continues when the governments are utility maximising and the lower tax rates lead to a higher capital to labour ratio in the small country. Hence, both the New Economic Geography model and the tax haven model can predict a positive correlation between jurisdiction size and tax rates; though the economic mechanisms and implications are very different.

Standard tax competition models are also not directly applicable to the competition of municipalities within countries. First, the asymmetric tax competition model assumes mobile capital and immobile labour endowment. This is clearly violated within countries with free mobility of both capital and labour. Second, the asymmetric tax competition model is only analysed for two jurisdictions. In reality, we see a multitude of jurisdictions of various sizes within countries and urban areas. We think that the essence of the asymmetric tax competition model is the following: "small" jurisdictions, i.e. jurisdictions with a small tax base face a higher elasticity of this tax base with respect to changes in their tax rate. Their optimal tax rate will therefore be lower than for "large" jurisdictions with a large tax base. This implies that the relevant measure for the "size" of the location is the "size" of its tax base. We operationalise this by taking employment within the political borders of the jurisdiction.

Hünerbein and Seidel (2010) combine the NEG and the standard tax competition literature. They start with a NEG framework with two countries and agglomeration effects taking place at the country level. They then divide each country into two regions hence adding a standard tax competition motive into each country. The four regions are ex-ante identical. The result is a race to the bottom of capital income taxes as in the standard model of symmetric tax competition, i.e. the tax competition mechanism prevails within countries. Apart from the assumption of initial symmetry and the extreme prediction of zero tax rates, this model seems an adequate description of a country with several independent urban areas each divided into several local jurisdictions (municipalities).

Brülhart, Jametti and Schmidheiny (2012) have studied whether the main mechanism behind the NEG prediction is at work, i.e. whether firms are less sensitive to local tax rates in the presence of agglomeration economies. Drawing on a firm-level dataset for Switzerland and employing fixed-effects count-data estimation techniques, they found that firm births on average react negatively to corporate tax burdens, but that the deterrent effect of taxes is weaker in sectors that are more spatially concentrated. Firms in sectors with an agglomeration intensity at the twentieth percentile of the sample distribution are up to 50 percent more responsive to a given difference in corporate tax burdens than firms in sectors with an agglomeration intensity at the eightieth percentile.

Charlot and Paty (2007), Jofre-Monseny (2013) and Koh, Riedel and Böhm (2013) are the first attempts to directly test whether agglomeration rents are taxed, by showing that local taxes are positively correlated with local agglomeration economies. Charlot and Paty (2007) assess the effect of agglomeration (measured as market access) on local taxation. Using panel data for French municipalities, they find a positive effect of market access on taxation and mimic behaviour in tax setting across municipalities. Jofre-Monseny (2013) focusses on the effect of urbanisation economies, localisation economies and market potential on the Spanish municipal business tax rate. Using a cross-section of Spanish municipality level data, he finds that all of the above factors have a positive effect on tax rates. Koh, Riedel and Böhm (2013) determine the tax effect of urbanisation and localisation economies, and investigate whether differentiation from neighbouring economies has an effect on business tax rates. Using pooled panel data for local business tax rates in Germany, they find a positive impact of agglomeration and differentiation on tax rates.

Our paper is complementary to these three studies but offers new perspectives in several dimensions. First, we explicitly address and operationalise the important distinction between the political and economic size of local jurisdictions. Second, we analyse data for Switzerland where local business tax differentials are substantial. Third, we study the evolution of local tax rates over a longer time horizon (20 years) than previous research. Our paper has therefore the potential to cover substantial changes in the size of local jurisdictions. And last, in contrast to previous studies, we do *not* find evidence that local jurisdictions within urban areas really tax agglomeration rents.

# 3 The econometric model

We estimate the following relationship at the municipality level:

$$Tax_i = \beta_0 + \beta_1 \log(Empl_i^{muni}) + \beta_2 \log(Empl_i^{dist}) + \beta_3 X_i + u_i \tag{1}$$

where $Tax_i$ is the corporate income tax rate, $Empl_i^{muni}$ is the location size within the political borders of municipality $i$, $Empl_i^{dist}$ is the distance-weighted size of the economically relevant area in and around municipality $i$ and $X_i$ is a vector of control variables.

Although we use a set of control variables, it is still possible that there are unobserved and unobservable local characteristics with an important effect on taxation. We use the long difference (20 years) between 1985 and 2005 to control for omitted factors with a difference-in-difference strategy. In addition, we include time fixed effects to capture time trends in the data. The estimated panel equation is

$$Tax_{it} = \beta_0 + \beta_1 \log(Empl_{it}^{muni}) + \beta_2 \log(Empl_{it}^{dist}) + \beta_3 X_{it} + \delta_t + c_i + u_{it} \tag{2}$$

where $c_i$ are municipality fixed effects. As there are only two data waves, the fixed effects estimator will be identical to the estimation in first differences

$$\Delta Tax_{it} = \alpha + \beta_1 \Delta \log(Empl_{it}^{muni}) + \beta_2 \Delta \log(Empl_{it}^{dist}) + \beta_3 \Delta X_{it} + v_{it} \tag{3}$$

where $\Delta Tax_{it} = Tax_{it} - Tax_{i,t-1}$, $\Delta \log(Empl_{it}) = log(Empl_{it}/S_{i,t-1})$ and $v_{it} = \Delta u_{it}$.

We have to take into account that the size of local jurisdictions is likely endogenous. First, locations with low tax rates are likely to attract – ceteris paribus – more firms and hence are larger than locations with high tax rates. This leads to endogeneity from reversed causality. Second, there may be omitted variables that explain both tax rates and location size. We therefore estimate equations (1) to (3) using instrumental variables. See sections 4.5 and 4.6 for a description of the instruments used.

# 4 Data and Variables

We base our estimations on data for Switzerland. For a number of reasons, the Swiss fiscal system provides a laboratory well-suited to examining our research question.

The Swiss federation consists of three government layers (federal, cantonal and municipal), with each jurisdictional level collecting a roughly equal share of total tax revenue. Cantons and municipalities enjoy vast autonomy in the determination of their tax rates, and, as a consequence, we observe large variations in tax burdens even within the small area covered by Switzerland. Cantons and municipalities collect around 65 percent of the corporate income and capital tax revenue, the remaining 35 percent being raised by the federal government. Corporate income taxes account for about 14% of municipal revenue and 16% of cantonal revenue. The most important source of local government receipts is personal income tax (municipality 69%, canton 60%). [1] The revenues from local corporate taxes flow into the general budget of the municipality. They are not earmarked for specific expenditures. The main local expenditure in Switzerland are education (22% of municipality budget, 29% of cantonal budget), followed by health (18%, 26%), welfare (17%, 17%) and security (5%, 11%).[2] For example, municipalities pay for primary and middle schools, while cantons pay for universities and high schools. Profit taxes account for about 14% of municipal revenue and 16% of cantonal revenue.

## 4.1 Geographical Definitions

Switzerland was divided into 3022 municipalities in the year 1985.[3] This number shrank to 2758 by the year 2005 due to mergers of small municipalities. We combine the municipality data with historic geographic coordinates to measure the distance between municipalities as described in section 4.3.[4]

The Swiss Federal Statistical Office identified 55 urban areas in the year 2000. Urban areas are defined similarly to metro- and micropolitan statistical areas (MSA) in the U.S. They include a densely populated central city and its adjacent municipalities with high commuting flows to the centre.[5] The largest urban area in the year 2000 was Zurich with

[1]Source: Eidgenössische Finanzverwaltung, Öffentliche Finanzen der Schweiz 2007.

[2]Source: Eidgenössische Finanzverwaltung, öffentliche Finanzen der Schweiz 2007.

[3]Historical lists of Swiss municipalities are provided in an online tool by the Swiss Federal Statistical Office at `http://www.bfs.admin.ch/bfs/portal/de/index/infothek/nomenklaturen/blank/blank/gem_liste/02.html`.

[4]Geographic coordinates mark the centre of municipalities, typically the church tower or main square. Coordinates for 2005 are available online from the Federal Statistical Office at `http://www.bfs.admin.ch/bfs/portal/de/index/infothek/lexikon.html`; data for 1985 was directly provided by the Swiss Federal Statistical Office.

[5]The exact definition is given in Schuler, Joye, and Dessemontet (2005), Eidgenössische Volkszählung 2000: Die Raumgliederungen der Schweiz. Swiss Federal Statistical Office, Neuenburg.

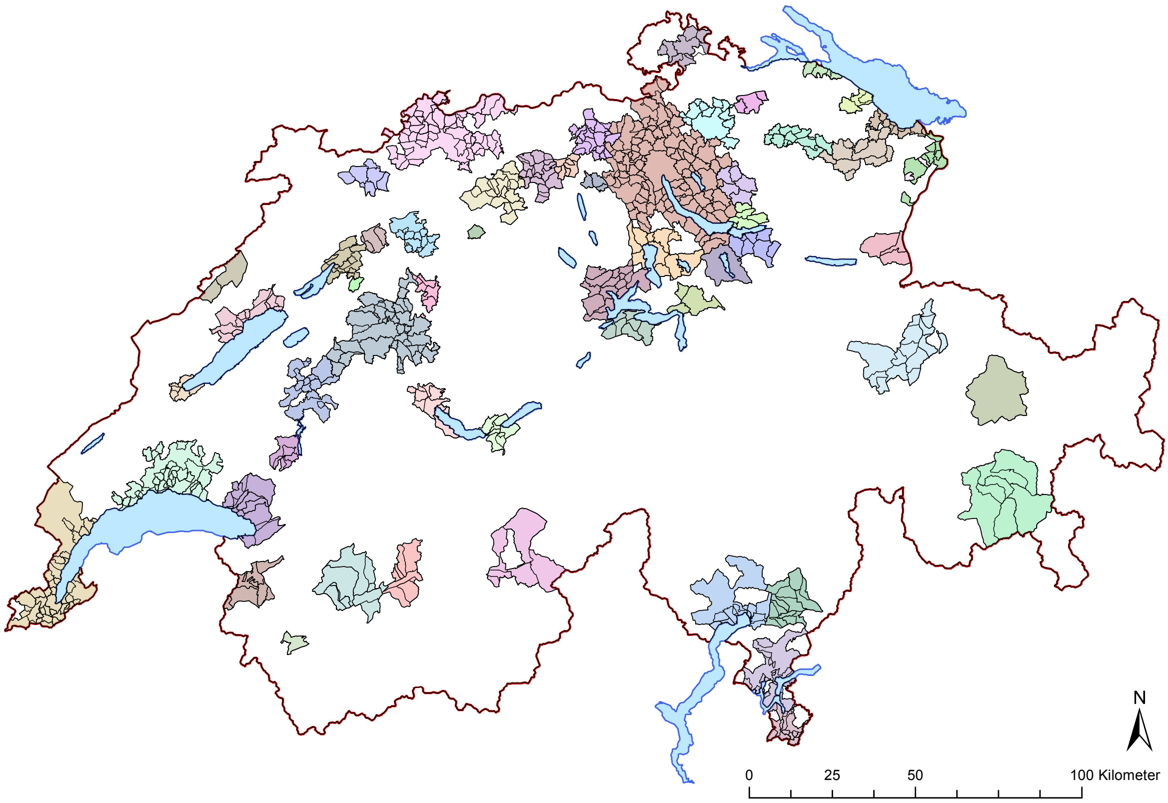


Figure 1: 55 urban areas across Switzerland and their individual municipalities.

a population of 1,080,728 living in 132 municipalities; the smallest is St. Moritz with a population of 15,757 living in 8 municipalities.[6] We use the definition for urban areas for the year 2000 and the corresponding list of municipalities throughout, including historical data from 1985 and 1850. Figure 1 shows a map of the 55 urban areas in Switzerland.

## 4.2 Local Business Taxes

We use data on corporate income taxes created by Brülhart and Jametti (2006) for the 1985 cross-section and by Bacher and Brülhart (2013) for the 2005 cross-section.[7] This data reports statutory tax rates for the 213 largest municipalities in 1985 and the 845 largest municipalities in 2005. These 845 sampled municipalities account for 90% of all employment in Switzerland. 553 out of them are in urban areas and account for 96% of urban area employment. 292 sampled municipalities are outside urban areas and account for 11% of all employment in Switzerland.

[6]The composition of urban areas in the year 2000 are available online from the Swiss Federal Statistical Office at `http://www.bfs.admin.ch/bfs/portal/de/index/regionen/11/geo/analyse_regionen/04.html`.

[7]These variables are based on statutory tax data from the official compendium of cantonal tax laws (Steuern der Schweiz, editions 2001- 2005), and on cantonal and municipal tax multipliers obtained from the 26 cantonal tax authorities by the authors.

Our dependent variable is the local tax rate for firms. $ProfitTax_i$ is the corporate profit tax rate in location $i$ as percentage of a firm's profit. We use the tax rate for a firm with median profits (9% of turnover in our sample). $ProfitTax_i$ is the tax rate in municipality $i$ plus the respective cantonal tax rate.

Table 1 reports descriptive statistics for the local tax burden across municipalities. The variance of the corporate tax burden is large: the combined municipal and cantonal profit tax rate was on average 17.7% across the 845 municipalities in 2005. The highest tax rate, at 23.4%, was more than double the lowest rate, at 11.5%. Decomposing the total variance into within and between variance in the 1985-2005 panel shows that business tax rates vary almost as much over time as across locations. Table 1 also shows that there is substantial variation both within urban areas and between urban areas.

## 4.3 Location Size

The main explanatory variable is the "size" of the location. We measure the size of the location by its employment. Local employment figures are generated from firm-level data in the Swiss Business Census provided by the Swiss Federal Statistical Office.[8] This dataset contains information on location, sector of activity and number of employees for the universe of about 300,000 firms located across Switzerland in 1985 and 2005.

A main contribution of this paper is to make a clear distinction between the political and economic definitions of location size. The political definition refers to the legal borders of the local jurisdiction whereas the economic definition includes the relevant neighbouring jurisdictions. We use the following variables in the municipality level analysis:

$EmplMuni_i$ is the number of full-time jobs within the legal borders of municipality $i$. Part-time jobs are added as full-time equivalents.

$EmplDist_i$ is the number of full-time jobs in the economically relevant area in and around municipality $i$. It is the sum of the municipality's own employment and the employment of all other Swiss municipalities weighted by the inverse distance:

$$EmplDist_i = \sum_{j=1}^{J} \frac{EmplMuni_j}{Dist_{ij}}$$

where $EmplMuni_i$ is employment in municipality $i$ and $J$ is the number of municipalities in the country. We include all of the roughly 3,000 municipalities in this calculation and not just the 845 for which tax data is available in 2005. $Dist_{ij}$ is the Euclidean distance between two municipalities $i$ and $j$. The so-called 'own distance' of municipality $i$ is calculated as

$$Dist_{ii} = \frac{2}{3}\sqrt{\frac{AreaBuilt_i}{\pi}}$$

[8]Confidential access to the universe of the Swiss Business Census was granted by the Swiss Federal Statistical Office under contract 09325.

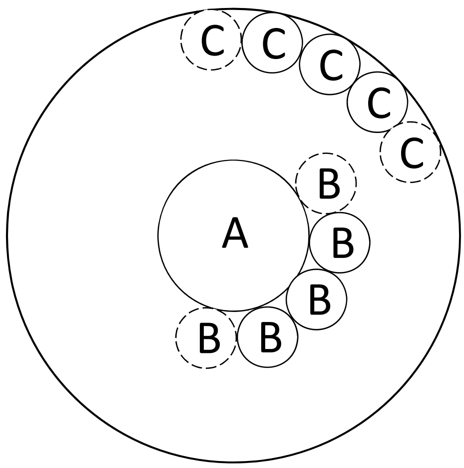


Figure 2: Urban area with large central municipality (A) and both small central (B) and small peripheral (C) municipalities.

where $AreaBuilt_i$ is built-up land area in the municipality. The own distance is the average distance to the municipal centre assuming a circular municipality of the same size. The own distance acknowledges that firms are on average farther away from each other in large municipalities than in small ones. It also guarantees that our variable $EmplDist_i$ is invariant to the units in which distance is measured.

Figure 2 illustrates how the different measures of location size differ for different types of municipalities. It shows a prototypical urban area consisting of a large central municipality (A) and both small central (B) and small peripheral (C) municipalities. The central municipality will have large values both for its own employment $EmplMuni$ as well as for the employment including its neighbours $EmplDist$. Small central municipalities have a low value for $EmplMuni$ but high values for $EmplDist$ because of their proximity to the centre. Small peripheral municipalities have low values for $EmplMuni$ as well as for $EmplDist$. In regressions including both variables, the identifying variation that allows discriminating the effects of the two variables will stem from small and mid-size municipalities that can be found in the centre as well as the periphery of urban areas.

Table 1 reports descriptive statistics for the different measures of location size. Location sizes measured by $EmplMuni_i$ and $EmplDist_i$ vary greatly across locations. Municipal employment ($EmplMuni$) ranges from 52 to 275,864 across the 845 municipalities in 2005. However, different locations are not growing at very different rates, leading to within variances that are 8 to 18 times smaller than the corresponding between variances.

## 4.4 Further Location Characteristics

We also include the following control variables:

*French or Italian Speaking* is a dummy variable which equals 1 if the population in municipality $i$ is on the whole French- or Italian-speaking. Historically, French- and Italian-speaking Swiss jurisdictions have higher tax rates than German-speaking ones.[9]

*Centre of Urban Area* is a dummy variable which equals 1 if municipality $i$ is the central place of the urban area it belongs to. *Capital of Canton* is a dummy variable which equals 1 if municipality $i$ is the capital of a canton. These variables capture the additional revenue needs of central places and capital cities, respectively.

We also use socio-demographic control variables for the large 2005 cross-section from the decennial census 2000. *Share of Foreigners* is the share of non-Swiss residents in municipality $i$. *Share Unemployed* is the fraction of the municipal population that is not employed but actively searching for jobs. *Share Population Aged* $<$ *15* and *Share Population Aged* $\geq$ *65* is the fraction of children and elderly residents, respectively. *Share Low Education* is the fraction of the adult population with no formal degree and *Share High Education* the fraction with a degree from a university or university of applied sciences ("Fachhochschule"); reference group are adults that finished compulsory schooling, an apprenticeship training and/or high school.

## 4.5 Instruments for Cross-section Analysis

We seek to explain local tax rates with the size of the location. There is obvious concern about the exogeneity of this variable. First, locations with low tax rates are likely to attract – ceteris paribus – more firms and hence are larger than locations with high tax rates. This leads to endogeneity from reversed causality. Second, there may be omitted variables that explain both tax rates and location size. Our proposed instrumental variables mainly seek to eliminate the bias from reversed causality.

In the 2005 cross-sectional analysis, we use population figures from 1850, the first census after the founding of modern Switzerland, as instruments. Historical population figures for 1850 are from the Swiss Federal Statistical Office.[10]

The variable $PopMuni_{i,1850}$ is the population in municipality $i$ in 1850. The variable $PopDist_{i,1850}$ is defined analogously to $EmplDist_i$. It is the sum of the municipality's own population and the distance-weighted population of all other municipalities:

$$PopDist_{i,1850} = \sum_{j=1}^{J} \frac{PopMuni_{j,1850}}{Dist_{ij}}$$

[9]Crivelli, Filippini and Mosca (2006) document higher public health spending in French-speaking cantons. Eugster and Parchet (2011) use a regression discontinuity approach to show that the French culture causes higher tax rates and public expenditure in Swiss municipalities around the language border.

[10]We obtained the data through its (now decommissioned) online platform "Statweb". Historical population figures are reported for present-day municipalities taking into account potential mergers and split-ups of municipalities.

where $Dist_{ij}$ is the Euclidean distance between municipalities $i$ and $j$. This calculation is based on all of the roughly 3,000 Swiss municipalities.

Descriptive statistics for all instruments are also reported in Table 1. Municipal population ($PopMuni$) in 1850 ranged from 56 to 41,585 across the 845 municipalities included in the analysis. The employment size of municipalities in present-day Switzerland is very strongly correlated to the historical population figures 150 years ago: the correlation between 1850 population and 2005 employment is 0.88 across the 845 municipalites. Historical population figures obviously rule out reverse causality and easily fulfil the requirement of instrument relevance.

## 4.6 Instruments for Panel Data Analysis

In the 1985-2005 panel data analysis, fixed effects will take care of a large part of potential omitted variables. However, there remains the concern about reversed causality. Locations with less increase (or even a decrease) in tax rates will – ceteris paribus – attract more firms and hence exhibit higher employment growth. We therefore instrument employment growth from 1985 to 2005. We propose two sets of variables as instruments:

$LandReserve_i$ is the fraction of land that had not been built-up by 1985 and could potentially be used for buildings in the subsequent 20 years.[11] It is calculated as

$$LandReserve_i = 1 - \frac{AreaBuilt_i}{AreaTotal_i}$$

where $AreaBuilt_i$ is the land area used for housing, businesses and traffic; $AreaTotal_i$ is the total land area excluding rivers, lakes, mountains, etc. Our definition is entirely based on the physical characteristics of the location and ignores zoning restrictions. We think that 1985 zoning restrictions were not binding over the 20 subsequent years, as they could be relaxed by the political economy in locations with strong demand for land. We expect that this variable is positively correlated with future growth in locations close to the centre of urban areas where space constraints are most severe. Land reserves in 1985 differ dramatically across the 207 municipalities included in the panel analysis: they range from almost entirely built-up municipalities with land reserves of 2.4% to almost empty municipalities with 97% of land which can be potentially built-up.

$PredEmpl_i$ is the predicted employment in location $i$ based on its initial 1985 sector composition and the sectoral growth rates from 1985 to 2005 in Germany[12]. The calculation assumes that employment in each sector grows at a sector-specific rate

[11] Land use for 2005 is from the Federal Statistical Office, Arealstatistik der Schweiz 2004/09. Historical data for the period 1979/1985 using historical definitions of municipalities were directly provided by the Swiss Federal Statistical Office.

[12] Sector level data for the German economy are from the EU KLEMS Growth and Productivity Centre (2008)

$Growth_{s,1985-2005}$ which is independent of the location. We use the growth rate in Germany, $Growth^D_{s,1985-2005}$, as an exogenous measure of sector-specific growth:

$$PredEmplMuni_{i,2005} = \sum_{s=1}^{S} EmplMuni_{is,1985} \cdot (1 + Growth^D_{s,1985-2005})$$

where $EmplMuni_{is,1985}$ is employment in location $i$ and sector $s$ in 1985 and $Growth^D_{s,1985-2005}$ is the discrete growth rate of employment is sector $s$ in Germany between 1985 and 2005. We expect higher growth potential in locations with a large initial share of employment in sectors that turned out to grow fast over the subsequent 20 years. Our predicted employment is independent of the actual employment growth in Swiss municipalities and sectors over the period 1985-2005, hence ruling out reversed causality. The mean of $PredEmplMuni$ as well as overall, within and between variance are similar to the realised values in $EmplMuni$.

$PredEmplDist_{i,2005}$ is the predicted employment in the economically relevant area in and around municipality $i$. This is analogously defined to $EmplDist_i$. We calculate this measure by summing over the location's own predicted employment and the distance-weighted predicted employment of all other municipalities:

$$PredEmplDist_i = \sum_{j=1}^{J} \frac{PredEmplMuni_j}{Dist_{ij}}$$

where $Dist_{ij}$ is the Euclidean distance between municipalities $i$ and $j$.

We also use the geographic location within the urban area as an instrument. $DistCentre_i$ is the distance of each municipality to the centre of the urban area. Municipalities that do not belong to any urban area are assigned the distance to the nearest urban area centre.

# 5 Results

The results for the 2005 cross-section of the municipality level analysis are given in Table 2. Column [1] reports the results from a regression of the local profit tax rate on local employment within municipal borders (*EmplMuni*) and control variables across 845 Swiss municipalities. The estimated effect is positive but not statistically significant. Column [2] regresses local tax rates on employment in and around the municipality (*EmplDist*) and the same set of control variables. The estimated effect is positive and highly significant. See section 4.3 for a description of the two measures and the identifying differences. Column [3] includes both measures of location size simultaneously. The estimated effect for the economically relevant area (*EmplDist*) is still significantly positive, while the effect of the political size (*EmplMuni*) is virtually zero and insignificant. This first set of results suggests that the NEG mechanism rather than the asymmetric tax competition mechanism is at work.

As discussed in section 4.5, we are concerned about bias from reverse causality in columns [1] to [3]. We therefore instrument both the political size of the location ($EmplMuni$) and its economic size ($EmplDist$). We use historical population figures from 1850 ($PopMuni_{1850}$ and $PopDist_{1850}$) as instruments as described in section 4.5. Columns [4] to [6] report the instrumental variables (IV) estimates. First stage results are reported in Table A1 in the appendix. The instruments are highly significant predictors for the corresponding employment variable. The F-tests for weak instruments are 114 and above and show that the instruments are very strong.[13] The IV point estimate in columns [6] for the effect of $EmplMuni$ is now positive and significant, while the effect of $EmplDist$ is almost halved compared to column [3]. The effect of a one-percent increase in the economically relevant area $EmplDist$ is still larger than the effect of the political size $EmplMuni$. However, the effect of a one-standard-deviation increase is larger for $EmplMuni$ ($0.0094 \cdot 1.066 = 0.01$) than for $EmplDist$ ($0.0153 \cdot 0.319 = 0.005$). These first IV results suggest that both the asymmetric tax competition mechanism and the NEG mechanism are at work in the competition of municipalities within and across urban areas.

The estimated effects in columns [1] to [6] are based on the variation both *across* and *within* urban areas. We therefore concentrate next on the variation *within* urban areas by adding urban area fixed effects. Urban area fixed effects also help to control for all confounding factors which are constant within urban areas.

Columns [7] to [12] in Table 2 include a fixed effect for each urban area.[14] This analysis relies fully on the variation of location sizes *within* urban areas and ignores the differences *across* urban areas. Including urban area fixed effects fundamentally changes our results: neither political ($EmplMuni$) nor economic size ($EmplDist$) have a significant effect in any of the specifications in columns [7] to [9]. This is not the consequence of a lack of identifying variation, as the confidence bounds are small and rule out effects of the magnitude reported in columns [1] to [6]. The significantly positive effects of $EmplDist$ in columns [1] to [6] are therefore driven by differences across urban areas.[15]

Columns [10] to [12] in Table 2 include urban area fixed effects as well as instrumental variables. The results of the first stage regressions are reported in Table A1. 1850 popu-

[13] We use the Kleibergen-Paap (2006) rank F-Test for simultaneously testing the two instruments in column [6]. This F-statistic is a generalisation of the Cragg-Donald (1993) statistic that allows for heteroscedastic errors. While calculating the test statistic is straightforward, there are no corresponding critical values. The currently best practice is to compare robust test statistics to critical values developed for the Cragg-Donald statistic by Stock and Yogo (2005).

[14] Municipalities not belonging to an urban area were assigned to the urban area whose central place is closest to them.

[15] The working paper version (CEPR Discussion Paper 8344) documents the significant positive relationship between total employment and average tax rates of the urban area.

lation within jurisdictional borders ($PopMuni_{1850}$) and distance weighted ($PopDist_{1850}$) are significant predictors for 2005 employment and pass the test against weak instruments (Kleibergen-Paap $F = 59.7$ for the simultaneous test on both instruments in column [12]). Controlling for reverse causality mainly affects the effect of political size ($EmplMuni$). This effect is now positive and significant, while the effect of the economic size ($EmplDist$) remains close to zero and insignificant. So *within* urban areas, it is the political size of the municipality that affects local tax rates while the economic size does not matter: small municipalities set lower tax rates than large ones whether they are in the centre of the economic activity in the urban area or at its periphery. We see this result as evidence that the asymmetric tax competition mechanism rather than the New Economic Geography (NEG) mechanism is at work in the competition of municipalities within a given urban area.

Table 3 reports the results using a panel with 1985 and 2005 data. Column [1] estimates the pooled 1985 and 2005 cross-sections with random effects and reiterates the findings from Table 2, column [3]. Column [2] controls for municipality fixed effects, i.e. for all time-invariant characteristics including urban area fixed effects. This fixed effects (FE) estimator is equivalent to the first difference estimator (FD), which regresses 20-year changes in tax rates on the growth rate of local employment. Unfortunately, there is very little time variation that we can exploit and the large confidence intervals neither detect significant effects nor rule out effects as estimated in the cross-section. Column [3] additionally includes year specific urban area effects leading to negative though insignificant size effects.

Column [4] in Table 3 tackles the potential reversed causality of changes in tax rates on employment growth by instrumenting employment growth of both the political and the economic definition of the location. See section 4.6 for a description of the instruments used. Most of our 5 instruments are highly significant in both first stage regressions (see Table A1 in the appendix), though the joint analysis of both equations with the Kleibergen-Paap (2006) F-statistics shows that the instruments are rather weak. The estimates in column [4] are therefore at best indicative.

Summing up the cross-section results in Table 2 we find that municipalities in large urban areas set higher tax rates than municipalities in small urban areas. This is consistent with either the New Economic Geography (NEG) prediction or the asymmetric tax competition prediction. Within urban areas, however, the size of the economically relevant area in and around a municipality is unrelated to its tax level, while the size within its political borders is positively related. This result is robust to controlling for reverse causality by using instrumental variables. We see this result as evidence that the asymmetric tax competition mechanism rather than the NEG mechanism is at work in the competition of municipalities within an urban area. Controlling for fixed effects in the panel analysis of Table 3 is non-informative and neither supports nor contradicts these findings.

# 6 Robustness

As discussed in section 2, the basic New Economic Geography (NEG) literature typically considers only urbanisation economies, and neglects varying intensities in agglomeration economies across sectors. So far we have followed this simplification in our empirical analysis in section 5. In this section we consider additional measures which take into account the structure of the economy at the local level.

In the real world, different industrial sectors exhibit different degrees of agglomeration rents. In our setting, local jurisdiction cannot exploit this heterogeneity as statutory tax rates apply identically to all sectors. A jurisdiction can potentially tax agglomeration rents if three conditions are met: (1) it hosts an industrial cluster of a sector, (2) this sector is an important fraction of the local economy and (3) this sector is characterised by important agglomeration economies. This applies for example to the watch-making industry, an industry characterised by high agglomeration economies which satisfies condition (3). Consider Le Locle, a rural town in the Jura region. Le Locle hosts one of the largest concentrations of watch manufacturers in Switzerland, accounting for the majority of local employment (over 45% in 2005). Now consider Geneva, the second largest city in Switzerland. Geneva hosts another main cluster of the watch-making industry, yet it does not account for a significant part of the local economy (only 1.5% of local employment in 2005), and therefore does not satisfy condition (2) above.

We propose the following index to measure the importance of industrial clusters in the local economy:

$$ClusterIntensity_i = \sum_{s=1}^{S} \frac{EmplMuni_{is}}{Empl_s} \cdot \frac{EmplMuni_{is}}{EmplMuni_i} \cdot \gamma_s$$

where $Empl_s$ is total employment in sector $s$. $EmplMuni_{is}/Empl_s$ is the fraction of employment in sector $s$ located in municipality $i$; a high number indicates that the municipality hosts an important industrial cluster. The second multiplier $EmplMuni_{is}/Empl_i$ is the fraction of employment in municipality $i$ belonging to sector $s$; a high number indicating that the sector is important for the local economy. The third multiplier $\gamma_s$ is a measure of the agglomeration economies in sector $s$.

To measure agglomeration economies we use the Ellison and Glaeser (1997) index:[16]

$$\gamma_s = \frac{\frac{\sum_i (z_{is}-x_i)^2}{1-\sum_i x_i^2} - H_s}{1 - H_s}$$

where $z_{is} = EmplMuni_{is}/Empl_s$ and $x_i = EmplMuni_i/Empl_{tot}$, $Empl_{tot}$ denoting total national employment. $H_s$ is an index measuring the concentration of an industry as $H_s = \sum_k^K \psi_k^2$, where $\psi_k$ is the share of each plant in industry employment, and $K$ the total number of industry plants. The Ellison and Glaeser (1997) index is constructed to take into account the possibility of industry agglomeration by pure chance, unrelated to any agglomeration economies.

Jofre-Monseny (2013) also uses a cluster measure as explanatory variable. He constructs a dummy variable which takes the value 1 if a municipality hosts a minimum share of the nationwide industry employment (above 1%) in any geographically concentrated industry (industries with an Ellison-Glaeser index above 0.02). Formally this can be expressed as

$$Cluster_i = \max_s \left\{ I\left[\frac{EmplMuni_{is}}{Empl_s} > 0.01\right] \cdot I\left[\gamma_s > 0.02\right] \right\}$$

where $I[.]$ is an indicator function that takes the values 1 if the argument is true or 0 otherwise. This measure meets our conditions (1) and (3) in a discrete fashion.

Koh, Riedel and Böhm (2013) use a continuous version of Jofre-Monseny's cluster measure. Their localisation measure is the sum of all local employment in industries which are agglomerated (for comparison we will use an Ellison-Glaeser index above 0.02[17]) and which have an important share of nationwide employment in the municipality (above 0.5[18]). Formally this can be expressed as

$$Localisation_i = \sum_{s=1}^{S} \left\{ EmplMuni_{is} \cdot I\left[\frac{EmplMuni_{is}}{Empl_s} > 0.005\right] \cdot I\left[\gamma_s > 0.02\right] \right\}$$

This measure also meets our conditions (1) and (3).

Table 4 reports the results using the three localisation measures. We add the three measures to our baseline "size" variable $EmplMuni$, i.e. employment within jurisdictional borders. First, note that adding any of the three localisation measures does not change the effect of the baseline size measures in any relevant way. Second, the localisation measures

[16] Duranton and Overman (2005) propose an alternative index which avoids the border problem of the Ellison-Glaeser index. Unfortunately, we cannot use this index as we lack information on the exact geographic location of firms in our data.

[17] Koh, Riedel and Böhm (2013) use the Duranton and Overman (2005) index to measure agglomeration economies. They treat all industries with significant spatial clustering according the the Duranton-Overman index as concentrated.

[18] See footnote 17 in Koh, Riedel and Böhm (2013)

by Jofre-Monseny and Koh, Riedel and Böhm are not significant while the cluster intensity index is highly significant. This suggests that all three conditions mentioned above are important. Note, however, that our measure $ClusterIntensity$ is not substantial: a one-standard deviation increase in $ClusterIntensity$ leads to a $0.00062 \cdot 0.4695 = 0.029$%-points increase in tax rates.

This robustness section shows that ignoring localisation does not explain the differences between our results and the ones of Jofre-Monseny (2013) and Koh, Riedel and Böhm (2013). However, the estimates of this section are at best indicative. The proposed measures are not easily generalised to capture the importance of neighbouring economic activity as in our size measure *EmplDist*. Furthermore our instruments used in Section 5 are not credible to instrument the alternative measures.

# 7 Conclusion

In this paper we study whether local policy makers effectively tax agglomeration rents, as predicted by the New Economic Geography (NEG) literature. To test this mechanism we use data from a panel of Swiss municipalities. We face several challenges in bridging the gap between theoretical model and empirical evaluation. The standard tax competition model with asymmetric jurisdiction size also predicts that small locations (tax havens) have lower tax rates than large ones, but the economic implications are very different. To separate the two effects we make a clear difference between the political and economic size of a location by developing a measure for each definition of size.

We find that municipalities in large urban areas exhibit higher tax rates than small ones. This is consistent with both the NEG and the asymmetric tax competition prediction. Within urban areas, however, the size of the economically relevant area in and around a municipality is unrelated to its tax level while the size within its political borders is positively related. We see this result as evidence that the tax haven mechanism rather than the NEG mechanism is at work in the competition of municipalities *within* an urban area.

The two competing models (NEG and asymmetric tax competition) do not adequately describe federal systems with many individual jurisdictions *within* the same economic cluster, i.e. the urban area. Intuitively, the existence of a multitude of small competing jurisdictions in close proximity to the core of economic activity introduces *competition* into the NEG setup. Firms locating in jurisdictions around the centre can in principle almost fully profit from the agglomeration economies in the centre. However, the municipalities cannot exploit this because there are alternatives: if a municipality close to the centre raises its tax rate, firms can move to *other* municipalities close to the centre without losing the agglomeration rent. By the logic of the asymmetric tax competition model, the *small* jurisdictions among them therefore set low tax rates in equilibrium. This is the spirit of the argument formalized by Hünerbein and Seidel (2010). It is also exactly what we observe in the data for the competition among municipalities within Swiss urban areas. We think that more theoretical research into the competition of jurisdictions with asymmetric size and with a distinct geography among them is required to improve the understanding of their interactions.

There could be important unobserved and unobservable local characteristics not controlled for by our set of socio-demographic variables. We intended to address this problem by including municipality fixed effects to control for omitted variables. However, despite the 20 year lag in the data there is very little time variation we can exploit. The large confidence intervals neither detect significant effects nor rule out the positive effects estimated in the cross-section. The size of local jurisdictions is likely affected by local tax rates and therefore endogenous. We instrument 2005 employment with 1850 population figures and 1985 to 2005 employment growth with a set of variables based on initially available land reserves and initial sector composition. Our instruments turn out to be very strong for the cross-section analysis but rather weak for the panel analysis. Our cross-section results are robust to controlling for reverse causality. As a robustness check we add localisation measures which capture the varying intensities in agglomeration economies across sectors.

# References


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

[2] Bacher H.U. and Brülhart M. (2013). Progressive Taxes and Firm Births. International Tax and Public Finance, 20(1), 129-168, 2013.

[3] Baldwin, R., R. Forslid, P. Martin, G. Ottaviano, and F. Robert-Nicoud (2003). Economic Geography & Public Policy. Princeton University Press.

[4] Baldwin, R. and P. Krugman (2004). Agglomeration, Integration and Tax Harmonisation. European Economic Review, 48,1-23.

[5] Borck, R. and M. Pflüger (2006). Agglomeration and Tax Competition. European Economic Review, 50,647-668.

[6] Brülhart M. and M. Jametti (2006). Vertical versus Horizontal Tax Externalities: an Empirical Test. Journal of Public Economics, 90(10-11), 2027 2062.

[7] Brülhart, M., M. Jametti and K. Schmidheiny (2007). Do Agglomeration Economies Reduce the Sensitivity of Firm Location to Tax Differentials? Economic Journal 122 (563), 1069-1093.

[8] Bucovetsky, S. (1991). Asymetric Tax Competition. Journal of Urban Economics, 30, 167-181.

[9] Charlot, S. and S. Paty (2007). Market Access Effect and Local Tax Setting: Evidence from French Panel Data. Journal of Economic Geography, 7, 247-263.

[10] Cragg, J. G. and S. G. Donald (1993). Testing Identifiability and Specification in Instrumental Variable Models. Econometric Theory, 9(2), 222-240.

[11] Crivelli, L., Filippini, M. and Mosca, I. (2006). Federalism and Regional Health Care Expenditures: an Empirical Analysis for the Swiss Cantons. Health Economics 15(5): 535-541.

[12] Duranton, G. and D. Puga (2000). Diversity and Specialisation in Cities: Why, Where and When does it Matter? Urban Studies, 37(3), 533-555.

[13] Duranton, G. and D. Puga (2004). Micro-Foundations of Urban Agglomeration Economies. In: J. V. Henderson, and J. F. Thisse (eds.), Handbook of Regional and Urban Economics, pp. 2063-2117.

[14] Duranton, G. and H. Overman (2005). Testing for Localisation using Micro-Geographic Data. Review of Economic Studies, 72(4), 1077-1106.

[15] Eugster Beatrix and Raphael Parchet (2011). Culture and Taxes: Towards Identifying Tax Competition. Mimeo, University of Lausanne.

[16] Ellison, G. and E. L. Glaeser (1997). Geographic Concentration in the U.S. Manufacturing Industry: A Dartboard Approach. Journal of Political Economy, 105(5), 889-927.

[17] Fujita, M., P. Krugman and A.J. Venables (1999). The Spatial Economy: Cities, Regions, and International Trade Masahisa. MIT Press, Cambridge, Massachusetts.

[18] Groningen Growth and Development Centre (2008). EU KLEMS Growth and Productivity Accounts. www.euklems.net.

[19] Hühnerbein, O. and T. Seidel (2010). Intra-Regional Tax Competition and Economic Geography. The World Economy, 33(8), 1042-1051.

[20] Jofre-Monseny, J. (2013). Is Agglomeration Taxable? Journal of Economic Geography, 13(1), 177-201.

[21] Kind, H. J., K. H. Midelfart Knarvik, and G. Schjelderup (2000). Competing for Capital in a 'Lumpy' World. Journal of Public Economics, 78, 253-274.

[22] Kleibergen, F. and R. Paap (2006). Generalized Reduced Rank Tests using the Singular Value Decomposition. Journal of Econometrics, 133(1), 97-126.

[23] Koh, H.-J., N. Riedel and T. Böhm (2013). Do Governments Tax Agglomeration Rents? Journal of Urban Economics, 75, 92-106.

[24] Ludema, R. D. and I. Wooton (2000). Economic Geography and the Fiscal Effects of Regional Integration. Journal of International Economics, 52, 331-357.

[25] Oates, W. E. (1972). Fiscal Federalism. Harcourt Brace Jovanovich, New York, New York.

[26] Ottaviano, G. and T. van Ypersele (2005). Market Size and Tax Competition. Journal of International Economics, 67, 25-46.

[27] Rosenthal, S. S., and W. C. Strange (2004). Evidence on the Nature and Sources of Agglomeration Economies. In: J. V. Henderson, and J. F. Thisse (eds.), Handbook of Regional and Urban Economics, pp- 2119-2172.

[28] Stock, J.H. and Yogo, M. (2005). Testing for Weak Instruments in Linear IV Regression. In: D.W.K. Andrews and J.H. Stock (Eds). Identification and Inference for Econometric Models: Essays in Honor of Thomas Rothenberg. Cambridge University Press, 80-108.

[29] Wilson, J. D. (1986). A theory of Interregional Tax Competition. Journal of Urban Economics, 19, 296-315.

[30] Wilson, J. D. (1991). Tax Competition with Interregional Differences in Factor Endowments. Regional Science and Urban Economics, 21, 423-451.

[31] Zodrow, G. R. and P. Mieszkowski (1986). Pigou, Tiebout, Property Taxation, and the Underprovision of Local Public Goods. Journal of Urban Economics, 19, 356-370.

Table 1: Descriptive Statistics

| | Cross-section 2005 | | 1985-2005 Panel | |
|---|---|---|---|---|
| Estimator[1] | Mean | Std. Dev.[1] | Mean | Std. Dev.[1] |
| *ProfitTax* | 0.177 | 0.028 *(o)* | 0.165 | 0.028 *(o)* |
| | | 0.025 *(b)* | | 0.021 *(b)* |
| | | 0.014 *(w)* | | 0.019 *(w)* |
| Log(*EmplMuni*)[2] | 7.25 | 1.066 *(o)* | 8.56 | 0.90 *(o)* |
| | | 0.330 *(b)* | | 0.90 *(b)* |
| | | 1.031 *(w)* | | 0.12 *(w)* |
| log(*EmplDist*)[3] | 10.98 | 0.319 *(o)* | 11.10 | 0.33 *(o)* |
| | | 0.285 *(b)* | | 0.33 *(b)* |
| | | 0.142 *(w)* | | 0.03 *(w)* |
| Log(*PredEmplMuni*) | | | 8.60 | 0.92 *(o)* |
| | | | | 0.91 *(b)* |
| | | | | 0.08 *(w)* |
| Log(*PredEmplDist*) | | | 11.16 | 0.34 *(o)* |
| | | | | 0.33 *(b)* |
| | | | | 0.08 *(w)* |
| Log(*PopMuni 1850*) | 7.013 | 0.862 *(o)* | | |
| Log(*PopDist 1850*) | 10.640 | 0.257 *(o)* | | |
| *Land Reserves 1985* | | | 0.680 | 0.210 *(o)* |
| *Distance to Centre* | | | 6.467 | 6.445 *(o)* |
| *Cluster Dummy*[4] | 0.071 | 0.257 *(o)* | | |
| *Localisation*[4] | -1.360 | 2.622 *(o)* | | |
| *Cluster Intensity*[4] | 0.000071 | 0.00062 *(o)* | | |
| *French or Italian Speaking* | 0.260 | 0.439 *(o)* | 0.237 | 0.426 *(o)* |
| *Centre of Urban Area* | 0.065 | 0.247 *(o)* | 0.256 | 0.437 *(o)* |
| *Capital of Canton* | 0.031 | 0.173 *(o)* | 0.126 | 0.332 *(o)* |
| *Share Foreigners* | 0.178 | 0.092 *(o)* | | |
| *Share Unemployed* | 0.041 | 0.017 *(o)* | | |
| *Share Population Aged < 15* | 0.182 | 0.028 *(o)* | | |
| *Share Population Aged ≥ 65* | 0.144 | 0.035 *(o)* | | |
| *Share Low Education* | 0.047 | 0.016 *(o)* | | |
| *Share High Education* | 0.170 | 0.066 *(o)* | | |
| N Urban Areas | 55 | | 53 | |
| N Municipalities | 845 | | 207 | |
| Waves | 1 | | 2 | |

[1] Standard deviation. (o) = overall, (b)=between, (w)=within. In the cross-section (w) and (b) mean within and between urban areas, respectively; in the panel, (w) and (b) mean between municipalities and over time, respectively.

[2] Employment in municipality.

[3] Sum of employment in municipality and neighboring municipalities weighted by inverse distance.

[4] See definitions in section 6.

Table 2: Cross-section 2005

| | | | | | | | Urban Area Fixed Effects | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Estimator[1] | OLS | OLS | OLS | IV | IV | IV | LSDV | LSDV | LSDV | IVDV | IVDV | IVDV |
| | [1] | [2] | [3] | [4] | [5] | [6] | [7] | [8] | [9] | [10] | [11] | [12] |
| log(*EmplMuni*)[2] | 0.0016 | | -0.0007 | 0.0103*** | | 0.0094*** | 0.0001 | | -0.0003 | 0.0041** | | 0.0042** |
| | (0.0012) | | (0.0012) | (0.0023) | | (0.0023) | (0.0006) | | (0.0007) | (0.0017) | | (0.0018) |
| log(*EmplDist*)[3] | | 0.0283*** | 0.0290*** | | 0.0195*** | 0.0153*** | | 0.0064 | 0.0071 | | 0.0138 | 0.0079 |
| | | (0.0034) | (0.0035) | | (0.0043) | (0.0047) | | (0.0048) | (0.0055) | | (0.0094) | (0.0089) |
| *French or Italian Speaking* | 0.0129*** | 0.0235*** | 0.0234*** | 0.0169*** | 0.0200*** | 0.0226*** | 0.0039 | 0.0044 | 0.0044 | 0.0055 | 0.0051 | 0.0063 |
| | (0.0032) | (0.0036) | (0.0036) | (0.0033) | (0.0037) | (0.0039) | (0.0046) | (0.0045) | (0.0045) | (0.0043) | (0.0041) | (0.0040) |
| *Centre of Urban Area* | -0.0134*** | -0.0092** | -0.0082* | -0.0246*** | -0.0098** | -0.0223*** | -0.0023 | -0.0025 | -0.0022 | -0.0076** | -0.0029 | -0.0081** |
| | (0.0042) | (0.0040) | (0.0042) | (0.0051) | (0.0040) | (0.0052) | (0.0020) | (0.0020) | (0.0021) | (0.0032) | (0.0021) | (0.0034) |
| *Capital of Canton* | 0.0005 | -0.0012 | -0.0005 | -0.0094 | -0.0001 | -0.0103* | 0.0027 | 0.0021 | 0.0024 | -0.0015 | 0.0014 | -0.0024 |
| | (0.0055) | (0.0052) | (0.0053) | (0.0061) | (0.0052) | (0.0060) | (0.0027) | (0.0025) | (0.0026) | (0.0031) | (0.0026) | (0.0034) |
| *Share Foreigners* | 0.0703*** | 0.0924*** | 0.0950*** | 0.0457** | 0.0869*** | 0.0578*** | 0.0314 | 0.0316 | 0.0325 | 0.0200 | 0.0316* | 0.0198 |
| | (0.0177) | (0.0161) | (0.0165) | (0.0190) | (0.0165) | (0.0187) | (0.0197) | (0.0194) | (0.0195) | (0.0178) | (0.0185) | (0.0180) |
| *Share Unemployed* | 0.2386** | 0.0525 | 0.0545 | 0.1581* | 0.1150 | 0.0583 | 0.0451 | 0.0222 | 0.0233 | -0.0007 | -0.0054 | -0.0311 |
| | (0.0939) | (0.0928) | (0.0932) | (0.0937) | (0.0944) | (0.0984) | (0.0796) | (0.0766) | (0.0771) | (0.0785) | (0.0910) | (0.0959) |
| *Share Population Aged < 15* | 0.2702*** | 0.3305*** | 0.3270*** | 0.3320*** | 0.3083*** | 0.3641*** | 0.1594*** | 0.1703*** | 0.1689*** | 0.1917*** | 0.1836*** | 0.2066*** |
| | (0.0470) | (0.0431) | (0.0436) | (0.0508) | (0.0434) | (0.0481) | (0.0435) | (0.0457) | (0.0451) | (0.0453) | (0.0484) | (0.0513) |
| *Share Population Aged ≥ 65* | 0.0019 | 0.0646** | 0.0665** | -0.0036 | 0.0454 | 0.0302 | 0.0769** | 0.0806** | 0.0818** | 0.0660** | 0.0846*** | 0.0700** |
| | (0.0328) | (0.0322) | (0.0325) | (0.0348) | (0.0319) | (0.0342) | (0.0321) | (0.0310) | (0.0313) | (0.0300) | (0.0318) | (0.0314) |
| *Share Low Education* | -0.1735** | -0.2596*** | -0.2574*** | -0.2259*** | -0.2298*** | -0.2719*** | -0.0860 | -0.0792 | -0.0781 | -0.0911 | -0.0715 | -0.0829 |
| | (0.0756) | (0.0784) | (0.0785) | (0.0787) | (0.0770) | (0.0794) | (0.0614) | (0.0621) | (0.0613) | (0.0615) | (0.0614) | (0.0648) |
| *Share High Education* | 0.0926*** | 0.0246 | 0.0229 | 0.0934*** | 0.0458*** | 0.0568*** | -0.0204 | -0.0236 | -0.0249 | -0.0081 | -0.0270 | -0.0114 |
| | (0.0140) | (0.0159) | (0.0164) | (0.0150) | (0.0165) | (0.0180) | (0.0198) | (0.0192) | (0.0200) | (0.0183) | (0.0171) | (0.0165) |
| Constant | 0.0835*** | -0.2197*** | -0.2219*** | 0.02 | -0.1216** | -0.1430*** | | | | | | |
| | (0.0156) | (0.0390) | (0.0390) | (0.0220) | (0.0480) | (0.0512) | | | | | | |
| Number of Instruments[4] | | | | 1 | 1 | 2 | | | | 1 | 1 | 2 |
| Weak Instrument Test[5] | | | | 227.7 | 1774.4 | 114.2 | | | | 174.1 | 89.7 | 59.7 |
| R-squared | 0.301 | 0.348 | 0.348 | 0.249 | 0.343 | 0.281 | 0.767 | 0.768 | 0.768 | 0.758 | 0.767 | 0.756 |
| N Municipalities | 845 | 845 | 845 | 845 | 845 | 845 | 845 | 845 | 845 | 845 | 845 | 845 |
| N Urban Areas | 55 | 55 | 55 | 55 | 55 | 55 | 55 | 55 | 55 | 55 | 55 | 55 |

Dep. Variable: Corporate profit tax rate, sum of municipal and cantonal tax rate, 9% profit level. Standard errors in parentheses, heteroscedasticity-robust, clustered by urban areas for LSDV and IVDV models. Coefficient significant at * p<0.10, ** p<0.05, *** p<0.01.

[1] OLS: ordinarly least squares, IV: Instrumental variables, LSDV: least squares dummy variables, IVDV: Instrumental variables dummy variables.

[2] Employment in municipality.

[3] Sum of employment in municipality and neighbouring municipalities weighted by inverse distance.

[4] Instrumented are log(EmplMuni) and log(EmplDist). Instruments are log of municipality population in 1850 and log municipality population in 1850 with distance weighted neighbours. First stage regression results in Appendix Table A1.

[5] Kleibergen-Paap rank F-statistic in case of more than 1 instrument.

Table 3: Panel Analysis 1985-2005

| | | | Urban Area-Year Fixed Effects | |
|---|---|---|---|---|
| Estimator[1] | RE | FE/FD | FE/FD | FD-IV |
| | [1] | [2] | [3] | [4] |
| log(*EmplMuni*)[2] | 0.0017 | 0.0145 | -0.0038 | 0.0020 |
| | (0.0021) | (0.0125) | (0.0064) | (0.0135) |
| log(*EmplDist*)[3] | 0.0114** | 0.0282 | -0.0267 | -0.0337 |
| | (0.0048) | (0.0801) | (0.0387) | (0.0580) |
| *French or Italian Speaking* | 0.0226*** | | | |
| | (0.0037) | | | |
| *Centre of Urban Area* | -0.0062 | | | |
| | (0.0042) | | | |
| *Capital of Canton* | -(0.0035) | | | |
| | (0.0055) | | | |
| Year Fixed Effects | yes | yes | | |
| Municipality Fixed Effects | | yes | yes | yes |
| Urban Area x Year Effects | | | yes | yes |
| Instruments[4] | | | | 5 |
| Weak Instrument Test[5] | | | | 3.059 |
| N | 414 | 414 | 392 | |
| N Municipalities | 207 | 207 | 196 | 196 |
| N Urban Areas[6] | 53 | 53 | 42 | 42 |

Dep. Variable: Corporate profit tax rate, sum of municipal and cantonal tax, 9% profit level. Standard errors in parentheses, heteroscedasticity-robust, clustered by municipality. Coefficients significant at * p<0.10, ** p<0.05, *** p<0.01.

[1]RE: random effects, FE: fixed effects, FD: first difference, IV: instrumental variables. FE and FD yield identical estimates.

[2] Employment in municipality.

[3] Sum of employment in municipality and neighbouring municipalities weighted by inverse distance.

[4] Instruments are based on 1985 land reserves and industry mix. First stage regression results in Appendix Table A1.

[5] Kleibergen-Paap rank F-statistic.

[6] Data from 11 urban areas is dropped in specifications with urban area effects (columns [3] and [4]) as only one municipality per year is observed.

Table 4: Cross-section 2005, explicit cluster measures

| | | | | | Urban Area Fixed Effects | | | |
|---|---|---|---|---|---|---|---|---|
| Estimator[1] | OLS | OLS | OLS | OLS | LSDV | LSDV | LSDV | LSDV |
| | [1] | [2] | [3] | [4] | [5] | [6] | [7] | [8] |
| log(*EmplMuni*)[2] | -0.0007 | -0.0007 | -0.0008 | -0.0009 | -0.0003 | -0.0004 | -0.0002 | -0.0004 |
| | (0.0012) | (0.0012) | (0.0012) | (0.0012) | (0.0007) | (0.0007) | (0.0007) | (0.0007) |
| log(*EmplDist*)[3] | 0.0290*** | 0.0290*** | 0.0290*** | 0.0289*** | 0.0071 | 0.0070 | 0.0072 | 0.0070 |
| | (0.0035) | (0.0035) | (0.0035) | (0.0035) | (0.0055) | (0.0055) | (0.0055) | (0.0055) |
| *Cluster Dummy*[4] | | -0.0001 | | | | 0.0007 | | |
| | | (0.0034) | | | | (0.0024) | | |
| *Localisation*[4] | | | 0.0000 | | | | -0.0001 | |
| | | | (0.0003) | | | | (0.0002) | |
| *Cluster Intensity*[4] | | | | 1.0275** | | | | 0.4695** |
| | | | | (0.4040) | | | | (0.1848) |
| *French or Italian Speaking* | 0.0234*** | 0.0234*** | 0.0234*** | 0.0234*** | 0.0044 | 0.0043 | 0.0044 | 0.0043 |
| | (0.0036) | (0.0036) | (0.0036) | (0.0036) | (0.0045) | (0.0045) | (0.0045) | (0.0045) |
| *Centre of Urban Area* | -0.0082* | -0.0082* | -0.0082* | -0.0080* | -0.0022 | -0.0022 | -0.002 | -0.0021 |
| | (0.0042) | (0.0043) | (0.0043) | (0.0043) | (0.0021) | (0.0020) | (0.0020) | (0.0021) |
| *Capital of Canton* | -0.0005 | -0.0005 | -0.0005 | -0.0006 | 0.0024 | 0.0023 | 0.0025 | 0.0023 |
| | (0.0053) | (0.0053) | (0.0053) | (0.0053) | (0.0026) | (0.0027) | (0.0027) | (0.0026) |
| *Share Foreigners* | 0.0950*** | 0.0950*** | 0.0950*** | 0.0955*** | 0.0325 | 0.0326* | 0.0323* | 0.0329* |
| | (0.0165) | (0.0165) | (0.0165) | (0.0165) | (0.0195) | (0.0194) | (0.0193) | (0.0195) |
| *Share Unemployed* | 0.0545 | 0.0547 | 0.0536 | 0.0513 | 0.0233 | 0.0224 | 0.0242 | 0.0216 |
| | (0.0932) | (0.0940) | (0.0941) | (0.0935) | (0.0771) | (0.0752) | (0.0765) | (0.0766) |
| *Share Population Aged < 15* | 0.3270*** | 0.3271*** | 0.3269*** | 0.3276*** | 0.1689*** | 0.1690*** | 0.1684*** | 0.1692*** |
| | (0.0436) | (0.0436) | (0.0436) | (0.0436) | (0.0451) | (0.0452) | (0.0452) | (0.0453) |
| *Share Population Aged ≥ 65* | 0.0665** | 0.0665** | 0.0667** | 0.0677** | 0.0818** | 0.0820** | 0.0814** | 0.0823** |
| | (0.0325) | (0.0325) | (0.0326) | (0.0326) | (0.0313) | (0.0314) | (0.0315) | (0.0314) |
| *Share Low Education* | -0.2574*** | -0.2576*** | -0.2572*** | -0.2557*** | -0.0781 | -0.0773 | -0.0782 | -0.0776 |
| | (0.0785) | (0.0788) | (0.0785) | (0.0785) | (0.0613) | (0.0606) | (0.0615) | (0.0611) |
| *Share High Education* | 0.0229 | 0.0229 | 0.0229 | 0.0233 | -0.0249 | -0.0245 | -0.0253 | -0.0247 |
| | (0.0164) | (0.0164) | (0.0164) | (0.0164) | (0.0200) | (0.0193) | (0.0197) | (0.0200) |
| Constant | -0.2219*** | -0.2220*** | -0.2214*** | -0.2202*** | | | | |
| | (0.0390) | (0.0391) | (0.0394) | (0.0390) | | | | |
| R-squared | 0.348 | 0.348 | 0.348 | 0.349 | 0.768 | 0.768 | 0.768 | 0.768 |
| N Municipalities | 845 | 845 | 845 | 845 | 845 | 845 | 845 | 845 |
| N Urban Areas | 55 | 55 | 55 | 55 | 55 | 55 | 55 | 55 |

Dep. Variable: Corporate profit tax rate, sum of municipal and cantonal tax rate, 9% profit level. Standard errors in parentheses, heteroscedasticity-robust, clustered by urban areas for LSDV and IVDV models. Coefficient significant at * p<0.10, ** p<0.05, *** p<0.01.

[1] OLS: ordinarly least squares, LSDV: least squares dummy variables.

[2] Employment in municipality.

[3] Sum of employment in municipality and neighbouring municipalities weighted by inverse distance.

[4] See definitions in section 6.

Table A1: First Stage Results for Municipality Level

| | 2005 Coss-section | | | | | | | | 1985-2005 Panel | |
|---|---|---|---|---|---|---|---|---|---|---|
| 2nd Stage | Tab 2, col [4] | Tab 2, col [5] | Tab 2, col [6] | Tab 2, col [6] | Tab 2, col [10] | Tab 2, col [11] | Tab 2, col [12] | Tab 2, col [12] | Tab 3, col [4] | Tab 3, col [4] |
| Dep. Variable | log(*EmplMuni*) | log(*EmplDist*) | log(*EmplMuni*) | log(*EmplDist*) | log(*EmplMuni*) | log(*EmplDist*) | log(*EmplMuni*) | log(*EmplDist*) | $\Delta$log(*EmplMuni*) | $\Delta$log(*EmplDist*) |
| Log(*PopMuni 1850*)[2] | 0.5288*** | | 0.5291*** | -0.0307*** | 0.5308*** | | 0.5260*** | -0.0408*** | | |
| | (0.0350) | | (0.0364) | (0.0075) | (0.0402) | | (0.0406) | (0.0082) | | |
| Log(*PopDist 1850*)[3] | | 1.0242*** | -0.0052 | 1.0514*** | | 1.1466*** | 0.1727 | 1.2589*** | | |
| | | (0.0243) | (0.1351) | (0.0247) | | (0.1211) | (0.4606) | (0.1297) | | |
| $\Delta$Log(PredEmplMuni)[1,2] | | | | | | | | | 0.0071 | -0.1209** |
| | | | | | | | | | (0.2386) | (0.0479) |
| $\Delta$Log(PredEmplDist)[1,3] | | | | | | | | | -0.5697 | 0.4638 |
| | | | | | | | | | (1.0974) | (0.3238) |
| $LandReserve_{1985}$ | | | | | | | | | 0.4007*** | 0.0648*** |
| | | | | | | | | | (0.1328) | (0.0199) |
| *Distance to Centre* | | | | | | | | | 0.0155 | 0.0089*** |
| | | | | | | | | | (0.0143) | (0.0021) |
| *Land Reserves 1985* x *Distance* | | | | | | | | | -0.0252 | -0.0097*** |
| | | | | | | | | | (0.0180) | (0.0026) |
| *French or Italian Speaking* | -0.2611*** | -0.0435*** | -0.2628*** | -0.0460*** | -0.2728** | -(0.0354) | -0.2652* | -0.0407 | | |
| | (0.0658) | (0.0150) | (0.0786) | (0.0146) | (0.1347) | (0.0273) | (0.1408) | (0.0255) | | |
| *Centre of Urban Area* | 0.8711*** | -0.0064 | 0.8705*** | 0.0202 | 0.9185*** | 0.0557*** | 0.9229*** | 0.0866*** | | |
| | (0.0909) | (0.0182) | (0.0931) | (0.0191) | (0.1160) | (0.0168) | (0.1146) | (0.0156) | | |
| *Capital of Canton* | 0.4491*** | 0.0274 | 0.4492*** | 0.0649** | 0.3160*** | (0.0055) | 0.3077** | 0.0515 | | |
| | (0.1051) | (0.0309) | (0.1051) | (0.0318) | (0.1119) | (0.0289) | (0.1184) | (0.0317) | | |
| *Share Foreigners* | 3.3677*** | 0.4294*** | 3.3627*** | 0.4260*** | 3.5389*** | 0.2759* | 3.5733*** | 0.2486* | | |
| | (0.4965) | (0.1035) | (0.5231) | (0.1012) | (0.6951) | (0.1389) | (0.6825) | (0.1276) | | |
| *Share Unemployed* | 8.1469*** | 2.8563*** | 8.1677*** | 2.8084*** | 9.4171*** | 1.8104*** | 9.1466*** | 1.7782*** | | |
| | (2.4119) | (0.5433) | (2.5599) | (0.5466) | (2.8554) | (0.5067) | (2.8409) | (0.4963) | | |
| *Share Population Aged < 15* | -10.8028*** | -1.9713*** | -10.8077*** | -1.7412*** | -10.9837*** | -1.6917*** | -10.9405*** | -1.4562*** | | |
| | (1.3179) | (0.2245) | (1.3098) | (0.2243) | (1.6238) | (0.2438) | (1.5573) | (0.2448) | | |
| *Share Population Aged ≥ 65* | -3.4706*** | -1.6265*** | -3.4757*** | -1.3733*** | -1.9018 | -0.6910*** | -1.8826 | -0.3497* | | |
| | (0.9451) | (0.1669) | (0.9489) | (0.1782) | (1.3421) | (0.1924) | (1.3282) | (0.1811) | | |
| *Share Low Education* | 2.1857 | -1.2788*** | 2.207 | -1.1796*** | -2.2403 | -1.2713*** | -2.2427 | -1.0248*** | | |
| | (2.1162) | (0.3815) | (2.1554) | (0.3752) | (2.1497) | (0.3767) | (2.1507) | (0.3225) | | |
| *Share High Education* | 0.1577 | 1.2755*** | 0.1635 | 1.2310*** | -2.3744** | 0.2255 | -2.4158** | 0.1483 | | |
| | (0.4889) | (0.0976) | (0.5217) | (0.0985) | (1.0393) | (0.1999) | (1.0833) | (0.2006) | | |
| Constant | 4.9370*** | 0.3334 | 4.9901*** | 0.1844 | 5.2906*** | -0.9447 | 3.4531 | -1.9282 | -0.0451 | -0.0471 |
| | (0.3788) | (0.2562) | (1.3782) | (0.2528) | (0.5743) | (1.2585) | (4.7474) | (1.3323) | (0.2561) | (0.0556) |
| F-Test excluded instruments | 227.7 | 1774.4 | 114.1 | 931.9 | 174.1 | 89.7 | 87.8 | 48.1 | 2.82 | 9.27 |
| Weak Instrument Test[4] | | | 114.2 | | | | 59.7 | | 3.06 | |
| R-squared | 0.632 | 0.856 | 0.632 | 0.860 | 0.695 | 0.928 | 0.695 | 0.934 | 0.45 | 0.65 |
| N Municipalities | 845 | 845 | 845 | 845 | 845 | 845 | 845 | 845 | 196 | 196 |
| N Urban Areas | 55 | 55 | 55 | 55 | 55 | 55 | 55 | 55 | 42 | 42 |

Standard errors in parentheses, heteroskedasticity-robust. Coefficient significant at * $p<0.10$, ** $p<0.05$, *** $p<0.01$.

[1] Employment growth predicted from 1985 sector composition and 1985-2005 sector growth in Germany.

[2] Employment in municipality.

[3] Sum of employment in municipality and neighboring municipalities weighted by inverse distance.

[4] Kleibergen-Paap rank F-statistic.