Are Local Tax Rates Strategic Complements or Strategic Substitutes?

Raphaël Parchet*

University of Lausanne and University of Basel

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Abstract

The identification of strategic interactions among local governments is typically plagued by endogeneity problems. This paper proposes to identify strategic personal income tax setting by Swiss municipalities making use of the multi-tier federal system. State (cantonal) borders spatially bound the effects of canton-level fiscal reforms across areas that are otherwise highly integrated. Fiscal reforms at the canton level provide an exogenous source of variation in municipal tax rates, and thus offer instruments for tax rates of neighboring municipalities on the other side of cantonal borders. In contrast to most of the existing empirical literature, I find that, in most settings, tax rates are strategic substitutes. This is compatible with a model of local tax setting in which governments primarily target expenditure rather than tax receipts. However, tax rates are found to be strategic complements in the case of large tax cuts.

JEL classification: H24, H71, H77
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Raphaël Parchet, WWZ, Universität Basel, 4002 Basel, Switzerland. raphael.parchet@unibas.ch

Tax competition is a hot issue in policy debates within as well as among nation states. It is often seen as a constraint on independent jurisdictions to raise revenue. This view is supported by a large body of theoretical literature that details the mechanisms and potential outcomes of tax competition (see, e.g., Wilson, 1999 for a review). Empirical studies often interpret positive spatial correlations in tax rates at the sub-national and international level as a supportive evidence for the "race-to-the-bottom" hypothesis, according to which tax competition is the cause of ever-falling corporate tax rates in the U.S. and in Europe.

Predictions from the theoretical literature are however less clear-cut than most empirical findings suggest. Standard tax competition models predict that, in an attempt to retain its mobile tax base, a jurisdiction will lower its tax rate when tax rates of neighboring jurisdictions fall. Tax reaction functions thus have a positive slope and tax rates are strategic complements. The underlying assumption behind these models is that tax revenues are the objective variable of governments, with expenditures adjusting through the government's budget constraint. Yet, Wildasin [1988] shows that, if governments instead optimize over expenditure levels with tax rates adjusting residually, tax reaction functions have a negative slope and tax rates are strategic substitutes.[1] In this setting, a jurisdiction that faces a decrease in its tax base through a more competitive environment increases its tax rate to maintain its current level of expenditure, even at the expense of an adverse effect on its tax base.

The possibility that tax rates could be strategic substitutes has been largely overlooked for years. Wildasin [1991] shows that governments choose taxes as their objective variable if jurisdictions are symmetric, but possibilities expand greatly in an asymmetric world. In a recent contribution, Koethenbuerger [2011] relates this choice to the structure of federal transfers that incentivizes differently local jurisdictions. Yet, empirical evidence has so far pointed towards positively-sloped tax reaction functions (see, e.g., Allers and Elhorst, 2005 on local tax competition and Devereux et al., 2008 on international tax competition over corporate tax rates). Two studies to date have found negatively-sloped

[1] As Brueckner and Saavedra [2001] note, tax reaction functions are ambiguous in sign even if governments compete in taxes. In fact, the slope of reaction functions depends also on preferences for the public good (relative to the private good). If the marginal utility for the public good is (relatively) small, tax reaction functions have a negative slope and tax rates are strategic substitutes.

tax reaction functions. Rork [2003] finds that U.S. states decrease their personal income tax for any increase in neighboring states' tax rates. He interprets this result as evidence for no mobility of the tax base. Recently, Chirinko and Wilson [2011] find that tax reaction functions for corporate income taxes among U.S. states have a negative slope. They stress the importance to correctly take care of spatially correlated local shocks and to allow for a delay in states' responses.

Most empirical studies of tax competition apply spatial regression models. Identification of strategic interactions in these models is however plagued by the reflection problem (Manski, 1993; see Brueckner, 2003). The main challenge consists in disentangling endogenous strategic interactions from unobserved and spatially correlated characteristics such as preferences, topographical features, or institutions. The standard estimation method is either to assume that the estimated equation fully describes the true data generating process and to use maximum likelihood methods, or to use an instrumental variable approach taking average characteristics of neighboring jurisdictions as instruments. As pointed out by Gibbons and Overman [2012], these methods generally do not offer reliable identification of causal relations. The first approach assumes implausibly that the true data generating process in known. With the second method, instruments are likely to be invalid due to endogenous sorting of the population and non-random assignment of jurisdictions' characteristics. The key for identification is to isolate variations in the tax rate of competing jurisdictions that can be plausibly considered as exogenous. In panel data, the inclusion of jurisdiction and time fixed effects can control for time invariant characteristics and aggregate shocks but is nonetheless unlikely to uncover exogenous variations, especially since local shocks often are spatially correlated.

This paper proposes to overcome these identification issues by making use of a multi-tier federal system. I take advantage of state borders to identify strategic personal income tax setting by local jurisdictions in Switzerland. State (canton) borders spatially bound the effects of state-level fiscal reforms across areas that are otherwise highly integrated. Fiscal reforms at the state level provide an exogenous source of variation in the tax rate levied at the local level (the municipalities). As long as individual municipalities do not significantly affect canton-level tax setting, cantonal tax rates offer a valid instrument for tax rates of jurisdictions located right on the other side of the state border. In contrast to what spatial correlations and results using standard instruments suggest, I find that tax reaction functions have a negative slope and hence that tax rates are strategic substitutes. Decomposing this result according to the sign of the exogenous tax change suggests that tax rates are strategic complements only for large negative shocks.

Papers that are methodologically related to this study include Chirinko and Wilson [2008], Rathelot and Sillard [2008] and Duranton et al. [2011]. These papers use state borders to identify the effect of local taxation on business location in the U.S., in France and in the UK, respectively.[2] They confirm the existence of a tax-induced mobility of the tax base, but they do not analyze strategic interactions among local jurisdictions. Agrawal [2011] explores the spatial pattern of local sales tax rates in the U.S. at state borders where state sales tax rates change discontinuously. His results suggest that local sales taxes are set as a function of the distance to state borders.[3] Eugster and Parchet [2011] use another border to identify strategic interactions among municipalities in Switzerland. Using a discrete and measurable discontinuity in voter preferences between the French-speaking and the German-speaking regions in Switzerland, they find that tax competition does constrain income taxation of municipalities at the language border. In contrast to this paper, their findings suggest that tax rates are strategic complements.[4]

The paper proceeds as follows. Section 1 contains the relevant background information on taxation by municipalities and cantons in Switzerland. Section 2 details the identification of strategic interactions among municipalities located at a cantonal border. Section 3 presents the baseline results and shows that tax rates are strategic substitutes. Section 4 presents some robustness checks and provides evidence that tax rates are strategic complements only for large negative tax changes. Section 5 concludes.

[2] Rathelot and Sillard [2008], concerned by the effect that business decisions may have on local taxes, also use the sum of departement and region tax rates to instrument total tax rates at municipality level in France.

[3] Also departing from estimating a spatial regression model, Lyytikäinen [2011] uses a fiscal reform in Finland that raised the minimum property tax rate affecting only a subset of municipalities to identify tax competition. He finds no evidence for strategic interactions whereas standard instrumental variables techniques indicate a strong and positive one.

[4] I return on the different conclusions of these two papers in Section 5.

1 Setting

Switzerland is a highly decentralized country where the main political units are the 26 cantons and the 2,584 municipalities. The number of municipalities per canton ranges from three to a maximum of 384, and, in 2009, the average population per municipality was approximately 3,000 with a maximum of about 386,600.

1.1 Personal income taxation

Cantons and municipalities enjoy a large fiscal autonomy. About 50% of cantonal and municipal revenue comes from their own taxes. At both levels, the personal income tax is the main fiscal instrument, accounting for 61% of tax revenue at the cantonal level and 68% at the municipal level. Corporate taxes account for 18% (16% for municipalities) and wealth taxes for 8% (9%) of revenues. Personal income taxes are residence based, whereas corporate taxes are source based (with formula appointment).

Cantons choose multiple aspects of their tax system. First, they set deductions and exemptions for the definition of the taxable income as well as a complete statutory tax schedule. Then, they fix annually a multiplier applied to the basic statutory tax rate, thus determining the amount due to the canton. Any change in the tax schedule implies a revision of the fiscal law and is ultimately submitted to a referendum. In contrast, cantonal multipliers are adapted each year by cantonal parliaments to the canton's fiscal needs.

Municipalities take the cantonal tax schedule as given and decide on a municipal tax multiplier that applies to the basic statutory tax rate. Municipal multipliers are fixed annually by municipal parliaments. In a majority of cantons, other entities such as parishes are also allowed to set their own tax multiplier, but these multipliers are in general very low.

The consolidated cantonal, municipal and church tax liability for a taxpayer living in municipality i in canton c can thus be decomposed as

$$T_{ic} \equiv \tau_c \times (M_c + M_{ic} + M_{oc}), \tag{1}$$

where τ_c is the basic statutory tax rate derived from the cantonal tax schedule; M_c, M_{ic} and

M_{oc} are multipliers applied by the canton, the municipality and churches, respectively.[5] If we abstract from church and other secondary local taxes, the consolidated tax liability can be divided into a cantonal tax rate

$$t_c \equiv \tau_c \times M_c$$

and a municipal tax rate

$$t_{ic} \equiv \tau_c \times M_{ic}$$

.

On average, cantonal and municipal taxes account for equal shares of the consolidated tax liability.[6] A convenient feature of this system for my purpose is that municipalities are restricted to a single instrument, their tax multiplier, such that all intra-cantonal variation in the consolidated personal income tax rate is due to municipal tax multipliers.

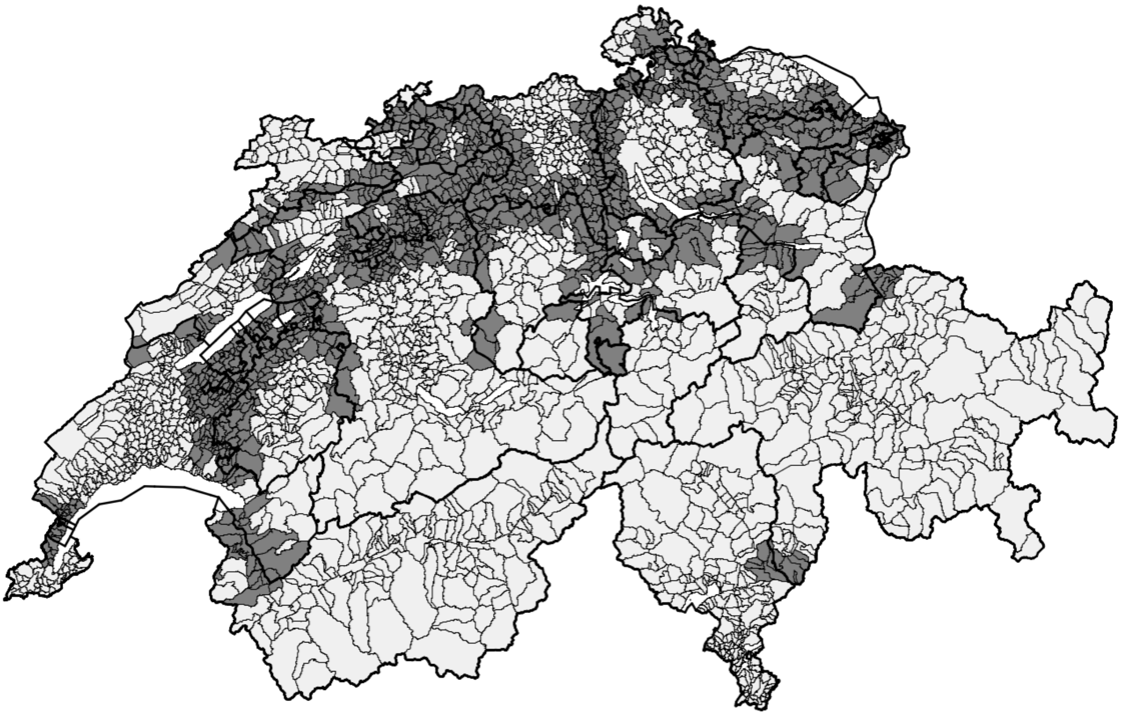
1.2 Cantonal borders

I concentrate on the consolidated municipal and cantonal tax rate for the personal income tax in municipalities close to a cantonal border. Figure 1 shows the 1,096 border municipalities in Switzerland, defined as having at least one neighbor within a road distance of a maximum of 10 kilometers that is located in another canton. All municipalities for which cantonal borders correspond to topographical particularities like the Alps in the South/South-East are thus not considered. Cantonal borders mostly do not coincide with language borders nor do they divide functional labor markets or other economic institutions. They do not deter mobility either. According to migration data, 30% of people arriving in or moving out border municipalities in my sample change their canton of residence (roughly two percent of the corresponding municipal population). Moreover, 15% of all employed individuals residing in these border municipalities commute daily to another canton, with an average commuting distance of 17 kilometers (Federal Population Census

[5]This decomposition can easily be adapted to each particular cantonal systems. In the canton of Valais, for example, municipalities have a different, but common, tax schedule from the canton. In the canton of Uri, before the fiscal reform of 2009, municipalities fixed their own proportional income tax rate.

[6]Important variations across cantons exist. The cantonal share of the consolidated tax liability ranges from 25% in the canton of Schwyz to 95% in the canton of Glarus.

Figure 1: Municipalities within 10 km from a cantonal border



Note: Municipalities in grey have at least one municipality within a road distance of maximum 10 km that is located in another canton. Cantonal borders are in bold. The canton of Basel-Stadt (3 municipalities) is not used in the sample (see Section 3.1). Road distances are taken from the on-line route planner search.ch.

2000).[7]

Table 1 compares population characteristics (nationality, age, income, education), economic activity (employment shares by sector, unemployment, tourist destination) and geographic features (urban area, area, altitude, lake shore) of border and non-border municipalities. It appears from column (3) that differences between the two samples are statistically significant for a majority of background variables. Yet these differences are economically small. Column (4) reports these differences in percentage deviation from their mean. The most important difference is found for the variable "tourist destination" and reflect the location of most tourist resorts in the Alps. This is also explains the difference in altitude. Other differences are small and I do not expect my conclusions to be driven by special features of border municipalities selected in my sample.[8]

[7] This proportion rises to 33% when considering only individuals who work in different municipality from their municipality of residence.

[8] Moreover, As table 2 shows, coefficients measuring spatial correlation in tax rates for all municipalities and for border municipalities are very similar.

Table 1: Background characteristics of border and non-border municipalities

	Border municipalities	Non-border municipalities	Difference	
				in mean deviation
	(1)	(2)	(3)	(4)
Population	2,325.49	2,806.33	−480.84	−18.50%
% Foreigners	9.82	11.94	−2.12***	−19.22%
% Young (≤ 20)	22.16	21.23	0.93***	4.30%
% Old (≥ 65)	13.12	14.34	−1.22***	−8.83%
% Primary sector	7.82	7.13	0.69***	9.29%
% Secondary sector	17.37	15.38	1.99***	12.26%
% Tertiary sector	21.88	23.02	−1.14***	−5.06%
Urban area	0.35	0.36	−0.00	0.00%
Center of urban area	0.03	0.03	−0.00	0.00%
Tourist destination	0.01	0.09	−0.09***	−150.00%
Lake shore	0.13	0.18	−0.05***	−31.25%
Altitude (m.a.s.l.)	536.53	689.14	−152.61***	−24.48%
Productive area (km^2)	530.09	480.19	49.90***	9.95%
% top 10% income	7.90	7.57	0.34	4.41%
% bottom 50% income	54.75	57.97	−3.22***	−5.69%
Gini index	0.32	0.34	−0.02***	−6.06%
% High education (tertiary)	12.87	12.96	−0.09	−0.70%
% Intermediate education	64.80	71.10	−6.31***	−9.23%
% No education	3.45	3.38	0.08	2.35%
Unemployment rate	1.23	1.45	−0.22***	−16.18%
No. of municipalities	1096	1453		

Note: *** p<0.01, ** p<0.05, * p<0.10. Border municipalities are defined as having at least one municipality within a road distance of maximum 10 km that is located in another canton. Urban area, center of urban area, tourist destination, and lake shore are binary variables. Source: Swiss Federal Statistical Office. Productive area is the total area minus forest, water and alpine areas. Source: Swiss Federal Statistical Office. Top 10% income are taxpayers with a taxable income in the highest decile. Bottom 50% income are taxpayers with a taxable income below the median. In 1983, the top decile includes all taxpayers with a taxable income over CHF 62,000 (115,000 in 2008) and the median income is CHF 29,000 (53,000 in 2008). Income shares and the Gini index are computed using the Federal Income Tax statistics from 1983 to 2008. These statistics do not cover low-income taxpayers that do not pay a Federal Income Tax (those with a taxable income under CHF 17,000 in 2008). Source: Swiss Federal Tax Administration, Bern. Other data from the Swiss Federal Census of 1980, 1990 and 2000. Source: Swiss Federal Statistical Office. Standard errors are clustered two-ways, by municipality and by year.

2 Identification strategy

2.1 The estimating equation

My starting point is the following standard regression:

$$T_{ic,t} = \alpha \overline{T}_{-i,t} + \beta' \mathbf{X}_{ic,t} + \gamma_i + \delta_{c,t} + \varepsilon_{ic,t} \ , \tag{2}$$

where $T_{ic,t}$ is the consolidated cantonal and municipal personal income tax rate levied in municipality i of canton c at time t, and $\overline{T}_{-i,t}$ is the weighted average of neighboring municipalities' tax rate

$$\overline{T}_{-i,t} = \sum_{j \neq i}^{N} w_{ij} T_{j,t} \ ,$$

where w_{ij} are ex ante chosen weights. $\overline{T}_{-i,t}$ is not restricted to municipalities within the same canton and may include municipalities across the canton border.[9] $\mathbf{X}$ is a vector of

[9] For this reason, the variable of interest is the consolidated cantonal and municipal tax rate at the municipality level, and not municipal tax multipliers that are not comparable across cantons.

controls and β the corresponding vector of coefficients. γ_i and $\delta_{c,t}$ are municipality and canton-year fixed effects, respectively. α is the coefficient of interest designed to measure strategic interactions among municipalities. $\varepsilon_{ic,t}$ is a stochastic error term. As a baseline specification, I use uniform weights defined as

$$w_{ij}^{U} = \begin{cases} \frac{1}{N} \text{ if } d_{ij} \leq D \text{ km} \\ 0 \text{ otherwise} , \end{cases} \tag{3}$$

where d_{ij} is the shortest road distance between municipalities i and j, $N = \sum \mathbf{1}_{d_{ij} \leq D \text{ km}}$ and $D = 10$ km.[10]

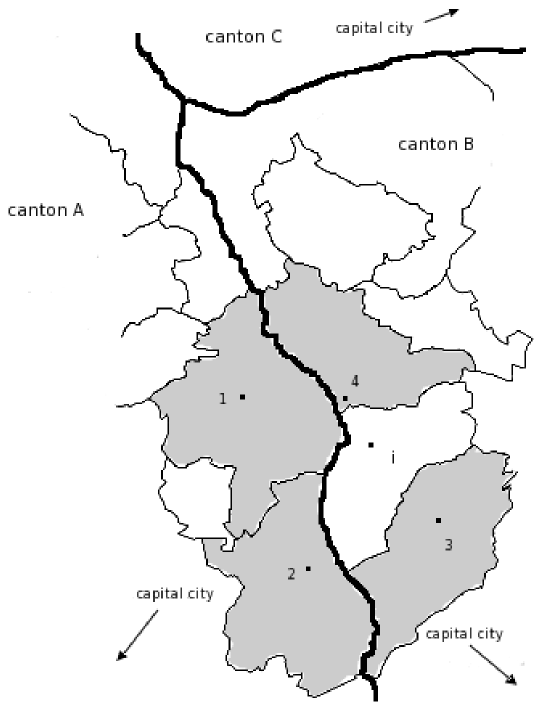
Municipality fixed effects control for all unobservable time-invariant and municipality-specific features. Hence, the identification of α stems from the comparison of different time-varying patterns in taxes. The major challenge is therefore not to confound strategic interactions with simultaneous responses to common shocks or spatially correlated changes in the economic and political background. Canton-year fixed effects control for all events at the cantonal level that affect all municipalities in one canton simultaneously and identically. Yet, these fixed effects do not capture all time-varying confounding factors that can lead to spurious correlations between $T_{ic,t}$ and $\overline{T}_{-i,t}$. This paper proposes to isolate exogenous variations of $\overline{T}_{-i,t}$ through the effect of canton-level fiscal reforms of neighboring cantons on the consolidated tax rate of municipalities located in these cantons. To take into account any remaining correlations in the error term not captured by fixed effects, standard errors in all estimations are clustered two-ways, by municipality and by year.

2.2 The instrument

Cantonal borders bound spatially the effects of canton-level fiscal policies across areas that are otherwise highly integrated. From expression (1), any change in the cantonal tax rate in one canton triggers a mechanical change in the consolidated municipal and cantonal tax rate of municipalities in the same canton. The tax rate of municipalities in other cantons will not be affected by such a change, unless municipalities interact strategically. Thus, the effect of tax reforms in one canton on the tax rate of municipalities in another canton identifies the existence and the nature of strategic interactions among municipalities.

[10] Section 4.1 presents results with alternative specifications of spatial weights.

Figure 2: Neighboring municipalities across a cantonal border



Note: This illustrative map represents municipalities at the cantonal border between Bern, Aargau and Luzern. Cantonal borders are in bold. Points represent municipalities' main town. Neighboring municipalities of municipality i are in grey. They are selected according to a maximum road distance of 5 kilometers.

Furthermore, canton-level tax policies offer valid instruments for the average tax rate of neighboring jurisdictions $\overline{T}_{-i,t}$ in equation (2).

Figure 2 illustrates the setting. It represents a municipality i and its four neighbors across a cantonal border between two cantons, A and B. I shall instrument the average tax rate of municipalities 1 to 4, $\overline{T}_{1-4,t}$ by the cantonal tax rate of canton A, t_A. The canton-year fixed effect $\delta_{c,t}$ in equation (2) implies that α is identified through the differential response of municipality i to changes in t_A compared to other municipalities in B that share a border with canton other than A. This strategy allows me to control for confounding shocks that affect simultaneously all municipalities in the same canton, at the price of discarding from the identifying set all cantons that share a border with only one other canton.[11]

To be a valid instrument, canton-level tax reforms have to be orthogonal to unobserved

[11] These represent only 30 of 1,096 municipalities (for a maximum distance to a cantonal border of 10 kilometers).

determinants of taxation of municipalities located on the other side of the cantonal border, that is t_A has to be orthogonal to $\varepsilon_{iB,t}$. This requires the absence of a formal link between two levels of governments located in different cantons, a condition which is satisfied in the Swiss setting. A second condition is that canton-level fiscal reforms in A should not be driven by a shock that also affects municipality i and its neighbors. Canton-year fixed effects capture all shocks affecting simultaneously and identically all municipalities in one canton, and hence control for (correlated) shocks affecting two or more cantons. Concerns arise if cantons substitute for fiscal decisions of municipalities located at one particular cantonal border, that is, e.g., if canton A responds to a shock that affects municipalities 1, 2 and i. Yet, as canton-level fiscal decisions apply equally to all municipalities in that canton, it is unlikely that cantons adopt fiscal policies in response to the situation of some border municipalities, provided the population living in these municipalities amounts to a sufficiently small share of the cantonal population.[12] In terms of Figure 2, the exogeneity assumption requires that the capital city of canton A be located "far away" from municipalities 1 and 2, such that their fiscal decisions are independent. Note also that fiscal decisions driven by common shocks are likely to be positively correlated, thus biasing my estimates of α upward.

A second key element of an instrumental variable (IV) strategy is its "first stage". Canton-level fiscal reforms should imply economically and statistically significant variations of $\overline{T}_{-i,t}$. If this condition were not satisfied, the instrument would be "weak" and α would be imprecisely measured and too high (in absolute value). This paper analyzes 28 years of cantonal and municipal personal income taxation showing important variations of the cantonal tax rate, both between cantons and over time (see Appendix Figure A.1). The effect of these canton-level tax reforms on $\overline{T}_{-i,t}$ depends first on the reaction of municipalities located in the same canton that initiated the reform (canton A). Brülhart and Jametti [2006] show that vertical interactions between municipalities and cantons play a significant role in the determination of local tax rates in Switzerland. These (within-

[12]This is clearly not the case in the canton of Basel-Stadt where the entire population is living in border municipalities. Moreover, in that canton, the tax rate of the main municipality, Basel, is included directly into the cantonal tax rate. For these two reasons, the canton of Basel-Stadt is excluded from the analysis. Looking at all canton pairs, the average share of the cantonal population living in border municipalities is 20%. In four small cantons, Appenzell Innerrhoden, Appenzell Ausserrhoden, Basel-Landschaft, and Schaffhausen, this share is more than 75%. In these cantons, the exogeneity assumption may not be plausible. See Section 4.1 for some robustness checks.

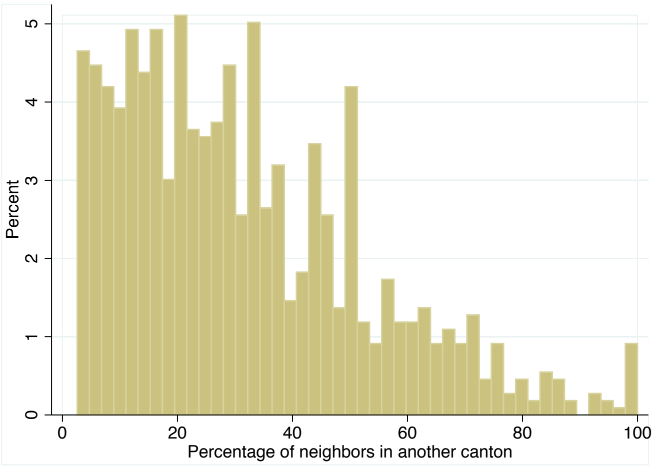
canton) vertical interactions are even more likely to arise at cantonal borders, where the common tax base may presumably easily relocate to and from another canton. The net effect of tax reforms at the canton level on the consolidated tax rate of municipalities in the same canton cannot be predicted, since the sign of vertical interactions is ambiguous [Keen and Kotsogiannis, 2002]. Nevertheless, the identification strategy of this paper requires no prior on this sign. All I need is that municipalities (1 and 2) do not completely offset changes in the cantonal tax rate (t_A). This can be tested by a first-stage F-test on the instrument.

Second, the first-stage estimation depends on the reaction of municipalities located on the other side of the cantonal border (municipalities 3 and 4). This reaction is likely to vary with the distance to the cantonal border. w_{ij} can pick up municipalities that are further away from the border than i, thus reacting potentially less to changes in t_A. The sign of the tax reaction function also matters. If tax rates are strategic substitutes, municipalities 3 and 4 will decrease their tax rates to any increase in T_{1A} and T_{2A} that follows an increase in t_A. Thus, the average tax rate of municipalities 1 to 4 may not vary, even if strategic interactions are strong.

Overall, the total effect of canton-level fiscal reforms on $\overline{T}_{-i,t}$ depends crucially on the share of neighboring municipalities directly affected by these reforms. I follow the strategy used in the peer-effects literature and multiply the instrument by the share of neighboring municipalities located in another canton than the canton of municipality i (see Moffit, 2001; Lalive and Cattaneo, 2009). This strategy recognizes the fact that tax reforms in neighboring cantons will affect municipalities on the other side of the cantonal border only if they affect the tax rate of a sufficient number of competing municipalities. $\overline{T}_{-i,t}$ in equation (2) is thus instrumented by $t_{-c,t} \times S_{ic}$ where $S_{ic} = \frac{N_{-c}}{N}$ and $N_{-c} = \sum \mathbf{1}_{d_{ij} \leq D \text{ and } j \notin c}$. If municipalities have neighbors in more than one canton, the instrument becomes $\bar{t}_{-c,t} \times S_{ic}$ where $\bar{t}_{-c,t}$ is constructed with the same weights as in (3).

Figure 3 presents the distribution of S_{ic} for $D = 10$ km. As expected, most municipalities have a majority of neighbors in the same canton. Nevertheless, the percentage of municipalities with a high number of neighbors in another canton is far from negligible.

Figure 3: Distribution of the percentage of neighboring municipalities located in another canton



Note: Municipalities have at least one neighboring municipality within a road distance of 10 kilometers that is located in another canton

3 Results

3.1 Data

My variable of interest is the consolidated cantonal and municipal personal income tax rate at the municipal level between 1983 and 2010.[13] Consolidated tax rates at the municipal level are published by the Swiss Federal Tax Administration for the 813 largest municipalities (646 in 1983). These tax rates are defined as shares of the consolidated cantonal, municipal and church tax liability in gross annual income for different categories of taxpayers (unmarried, married without children, married with two children, retired) and income classes (from CHF 10,000 to CHF 1,000,000).

I expand these data to all municipalities in Switzerland by using the fact that intra-cantonal differences in consolidated tax rates are almost entirely due to municipal tax multipliers. I collected the municipal tax multipliers M_{ic} for all municipalities between 1983 and 2010. The different components of T_{ic} in expression (1) can be accurately extrapolated from a linear regression of T_{ic} on a constant and M_{ic} over those municipalities

[13] There were 2,584 municipalities in Switzerland in 2010. The canton of Basel-Stadt (3 municipalities) is dropped because its tax system plausibly violates the exclusion restriction required by the identification strategy of this paper. The district of Laufen (13 municipalities) and one municipality in the canton of Jura are dropped because they changed canton during the sample period. If municipalities merge, the average value of previous jurisdictions is reported for the new jurisdiction according to the list of municipalities as of December 31, 2010. If municipalities split, the average value of the new jurisdictions is reported for the previous jurisdictions. This is the case for six existing municipalities that are not included in the dataset.

for which I know T_{ic}. I performed separate regression for each canton, year, and type of taxpayer. Consolidated tax rates for the remaining municipalities are then inferred using only their tax multiplier.[14]

The advantage of this method is that the constant in such regressions offers a convenient measure of t_c as any change in M_c or τ_c will be reflected in it. The quality of these predictions can be checked for 2010, as, for that year, consolidated tax rates are published by the Swiss Federal Tax Administration for all municipalities. Appendix Figure A.2 plots for each canton the 2010 actual consolidated tax rate along with predicted values using only municipalities included in the official statistics of 2009.[15] The fit is satisfactory as deviations between actual and predicted values are due to church tax rates. 99% of these deviations are below 0.85 percentage points (in absolute value) while the maximum is 1.35 percentage points.[16]

Predicted values are used for all municipalities with the exception of the cantons of Neuchâtel (before 2001) and Soloturn (before 1986) where municipalities could set their own tax schedule. For these cases, predicting consolidated tax rates is not possible, nor is the estimation of the cantonal tax rate. Values for these cantons are reported as missing.[17] To avoid any variation in $\overline{T}_{-i,t}$ when these cantons appear in the sample, values of neighboring municipalities are also set to missing.

The control vector $\mathbf{X}$ in equation (2) contains municipality characteristics including population, the percentage of foreigners, the percentage of young and old people, and the percentage of employees in the primary, the secondary and the tertiary sectors. These are census data available for 1980, 1990 and 2000. Average values of these variables for neighboring municipalities are also included in $\mathbf{X}$. Spatial weights are identical to those applied to tax rates. Other municipality characteristics listed in Table 1 show no or very little variation over time. They are captured by municipality fixed effects and thus are not included.

[14] Some data are available since 1970 but only 244 municipalities were listed in the sample of the Swiss Federal Tax Administration, resulting in a weaker quality of predictions. Section 4.1 provides results using data from 1970 to 2010 for a subset of cantons.

[15] In the cantons of Vaud and Luzern, a maximum tax rate produces a kink in linear regressions. Values of the kink are inferred directly from the data.

[16] Church tax multipliers are not available for all years and their jurisdictional borders sometimes do not coincide with municipal borders.

[17] This is also the case for the canton of Appenzell Innerrhoden for which municipal tax multipliers are not available before 2001.

3.2 Baseline results

In the subsequent analysis, the dependent variable is the consolidated tax rate for an unmarried taxpayer with a gross annual income of CHF 1,000,000. This is the top income listed in official statistics and refers presumably to the most mobile tax base.[18] Results for other categories of taxpayers are presented in Section 4.1.

Table 2 presents results based on equation (2) using the standard approach in the literature. In column (1), the variable of main interest is the average tax rate of all neighboring municipalities within a road distance up to 10 kilometers, irrespective of the canton they belong to. In column (2), I consider only municipalities that have at least one neighbor located in another canton. These two columns are estimated by ordinary least squares. OLS estimates are however not consistent as the tax rate of neighboring municipalities is endogenous, biasing the estimates upward (Brueckner, 2003). Column (3) follows the state-of-the-art approach in spatial econometrics and instruments the tax rate of neighboring municipalities with the average background characteristics of these jurisdictions. It thus assumes that background characteristics of neighboring jurisdictions are orthogonal to unobserved determinants of taxation of municipality i.

All three columns show positive and statistically significant spatial correlations in tax rates. The first two columns show no difference between border and non-border municipalities, and coefficients are comparable to those found in previous studies. The instrumental variable strategy presented in column (3) does not qualitatively change compared to OLS. The coefficient is even larger. This is probably due to a weak instrument problem, as suggested by a first-stage F-test, reported at the bottom the column, that is below the critical value of Stock and Yogo [2002].

These results are typical for the empirical tax competition literature. The positive and statistically significant coefficient is interpreted as evidence for the existence of tax competition that takes the form of a race to the bottom. Yet, it is hard to be convinced that instruments commonly used in the literature are truly exogenous as background

[18] This corresponds to the top 0.1% income in 2008. Between 1983 and 2008, cumulative inflation is 60%. Cantons adjust their tax schedule for inflation on a regular basis. Theses adjustments are not a cause of concern as long as their are exogenous to municipal tax decisions. Only in the canton of Valais, municipalities fix their own adjustment level.

Table 2: Spatial correlations in tax rates

	All municipalities	Border municipalities	
	OLS	OLS	IV
	(1)	(2)	(3)
Tax rate of neighboring municipalities	0.454***	0.425***	0.749***
	(0.032)	(0.047)	(0.253)
First-stage F-test on instruments			6.236
No. of observations	67,535	28,705	28,705
No. of municipalities	2507	1096	1096
No. of years	26.90	26.20	26.20

Note: Standard errors in parentheses. *** p<0.01, **p<0.05, *p<0.10. The dependent variable is the consolidated cantonal and municipal tax rate on personal income for an unmarried taxpayer with a gross annual income of CHF 1,000,000. Neighboring municipalities are municipalities within a maximum road distance of 10 kilometers ($D \leq 10$ km). Border municipalities have at least one neighboring municipality located in another canton. All estimations include population, % of foreigners, % of young and old people, % of employees in the primary, secondary and tertiary sectors as controls. Average values of neighboring municipalities are also included as controls. Spatial weights are uniform. All estimations include municipality and canton-year fixed effects. Instruments in column (3) are average value of controls in neighboring municipalities. Standard errors are clustered two-ways, by municipality and by year.

characteristics of neighboring municipalities are likely to be affected by spatially correlated shocks that also affect the taxation decision of municipality i.

Table 3 presents results of the novel instrumental variable strategy proposed in this paper. Cantonal tax rates of neighboring cantons ($t_{-c,t}$), multiplied by the share of municipalities located in these cantons (S_{ic}), are used to instrument the average tax rate of neighboring municipalities for border municipalities within a road distance up to 10 kilometers from the cantonal border. The first column reports the IV estimate. The second and third columns decompose the IV estimates between the effect of the respective instrument on the tax rate of municipality i ("reduced-form") and on the endogenous average tax rate of neighboring municipalities ("first-stage"), respectively.

The baseline result of this paper is shown in the first column.The IV estimate indicates that a 10 percentage point increase in the average tax rate of neighboring municipalities leads a municipality to *decrease* its tax rate by 3 percentage points.[19] The coefficient may appear somewhat weak as it statistically significant only at a level of 10%. However, the reduced-form coefficient presented in column (2) is statistically significant at a more conventional level, and thus confirms the existence and the nature of strategic interactions. The first-stage coefficient is statistically significant and the F-test is well above the critical

[19] The average value of the dependent variable, the consolidated cantonal and municipal tax rate for an unmarried taxpayer with a gross annual income of CHF 1,000,000 is 25.3%.

Table 3: Strategic interactions in tax rates: IV strategy

	IV (T_{ic}) (1)	Reduced-form (T_{ic}) (2)	First-stage ($\overline{T}_{-i}$) (3)
Tax rate of neighboring municipalities	-0.306*		
	(0.163)		
Cantonal tax rate of neighb. cantons x share of municipalities		-0.091**	0.296***
		(0.046)	(0.047)
First-stage F-test			40.07
No. of observations	28,705	28,705	28,705
No. of municipalities	1096	1096	1096
No. of years	26.20	26.20	26.20

Note: Standard errors in parentheses. *** p<0.01, **p<0.05, *p<0.10. The dependent variable is the consolidated cantonal and municipal tax rate on personal income for an unmarried taxpayer with a gross annual income of CHF 1,000,000. Neighboring municipalities are municipalities within a maximum road distance of 10 kilometers ($D \leq 10$ km). Municipalities have at least one neighboring municipality located in another canton. All estimations include population, % of foreigners, % of young and old people, % of employees in the primary, secondary and tertiary sectors as controls. Average values of neighboring municipalities are also included as controls. Spatial weights are uniform. All estimations include municipality and canton-year fixed effects. Standard errors are clustered two-ways, by municipality and by year.

value.[20]

The properly identified results presented in Table 3 contrast with those presented in Table 2 and lead to the opposite conclusion on the nature of the strategic tax setting among neighboring municipalities. Tax reaction functions are found to have a negative slope and tax rates are thus strategic substitutes rather than strategic complements. Hence, positive spatial correlations found in Table 2 seem to reflect simultaneous changes in tax rates due to common shocks or correlated changes in local conditions instead of strategic decisions. It also suggests that instrumenting the average tax rate of neighboring municipalities by the characteristics of these municipalities does not provide the exogenous source of variation required for a proper identification.

3.3 A pairwise approach

An alternative, and potentially even more rigorous strategy is to estimate a pairwise model. Under this approach, equation (2) is estimated for all pairs of border municipalities that are located in different cantons. It is thus redefined as:

$$T_{ic,t} = \alpha T_{-ic,t} + \beta' \mathbf{X}_{ic,t} + \gamma_p + \delta_{c,t} + \varepsilon_{ic,t} \ , \qquad (4)$$

[20] Multiplying the cantonal tax rate of neighboring cantons by the share of municipalities located in these cantons turns out to be crucial for the relevance of the first-stage estimation. Without this multiplication, the first-stage coefficient is null and the F-test is far below the critical value. Results available upon request.

Table 4: Cross-border interactions: a pairwise approach

	IV (T_{ic}) (1)	Reduced-form (T_{ic}) (2)	First-stage (T_{-ic}) (3)
Tax rate of paired municipality	-0.257***		
	(0.055)		
Cantonal tax rate of paired canton		-0.082***	0.317***
		(0.015)	(0.043)
First-stage F-test on instrument			53.26
No. of observations	160,052	160,052	160,052
No. of pairs	6050	6050	6050
No. of years	26.50	26.50	26.50

Note: Standard errors in parentheses. *** p<0.01, **p<0.05, *p<0.10. The dependent variable is the consolidated cantonal and municipal tax rate on personal income for an unmarried taxpayer with a gross annual income of CHF 1,000,000. The sample contains all pairs of municipalities located in two different cantons and within a maximum road distance of 10 kilometers. Each pair appears (at least) twice. All estimations include population, % of foreigners, % of young and old people, % of employees in the primary, secondary and tertiary sectors as controls. Values of the paired municipality are also included as controls. All estimations include pair and canton-year fixed effects. Standard errors are clustered two-ways, by pair and by year.

where $T_{-ic,t}$ is the tax rate of a neighboring municipality located in another canton and within a road distance of 10 kilometers, and γ_p is a pair fixed effect. Each pair appears twice, with a given municipality being once on the left-hand side and once on the right-hand side of the equation. The tax rate of the municipality on the right-hand side of the equation is instrumented by the cantonal tax rate of the canton the municipality belongs to. Identification relies specifically on cross-border strategic interactions and discards from the analysis the reaction of municipality i to how municipalities located in the same canton and sharing the same cantonal border themselves react to a tax change in the neighboring canton. If tax rates are strategic substitutes, the municipality i decreases its tax rate for any increase in the tax rate of a competing municipalities on the other side of the cantonal border. But it decreases less if other municipalities in the same canton also decrease their tax rate. The pairwise approach does not control for these "feedback" effects. Thus, the estimate of strategic interactions should be higher (closer to zero if taxes are strategic substitutes) provided these effects have the same sign as cross-border interactions.

Table 4 presents results for the 6,050 municipality pairs based on a maximum road distance of 10 kilometers. These estimates confirm the existence and the nature of strategic interactions among municipalities where taxes are strategic substitutes. Column (2) shows that the first-stage coefficient is statistically significant and higher than the coefficient presented in Table 3. Conversely, the IV estimate is lower (in absolute value) than the estimate in Table 3.

These two approaches can be seen as two bounds for the estimation of the magnitude of strategic interactions: a 10 percentage points increase in the tax rate of the reference group leads to a decrease in tax rate between 2.6 and 3 percentage points.

4 Robustness checks and extensions

4.1 Robustness

The validity of my identification strategy depends crucially on the exogeneity of the instrument. Canton-level fiscal reforms have to be orthogonal to unobserved determinants of taxation of municipalities located on the other side of the cantonal border. Concerns arise mainly if cantons substitute for fiscal decisions of some municipalities located at a cantonal border and facing a common shock with municipalities located on the other side of the border. This could be an issue especially in small cantons where a high share of the cantonal population live in border municipalities.

Table 5 presents results of the IV strategy for a subset of “big” cantons. The share of the cantonal population living in border municipalities is computed for each canton pair. In column (1), cantons in which 50% or more of the cantonal population reside in municipalities located at one particular cantonal border are dropped. In column (2), the maximum population share is raised to 70%. This excludes from the analysis six cantons in column (1) and four cantons in column (2).[21] All municipalities sharing a border with these cantons are also discarded.

The first line in Table 5 reports IV estimates while the second reports reduced-form estimates. The IV coefficient is negative and statistically significant at the 10%-level in column (1) and negative but not statistically significant in column (2). Both reduced-form coefficients are negative and statistically significant. Point estimates of the IV and the reduced form are higher (in absolute value) in column (1) than baseline results presented in table 3 and slightly lower in column (2). Overall results are similar to baseline results and suggest that small cantons do not drive the interpretation.

[21] These cantons are Appenzell Innerrhoden, Appenzell Ausserrhoden, Basel-Landschaft and Schaffhausen in column (2). In column (1), Zug and Solothurn are also dropped.

Table 5: Strategic interactions in big cantons

	Maximum population share at one cantonal border	
	50%	70%
	(1)	(2)
Tax rate of neighboring municipalities	-0.359*	-0.243
	(0.203)	(0.151)
Reduced form		
Instrument	-0.113*	-0.086*
	(0.061)	(0.052)
First stage F-test on instrument	43.25	41.73
No. of observations	19,626	24,836
No. of municipalities	726	935
No. of years	27	26.60

Note: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.10. In column (1), in which 50% of the cantonal population lives in municipalities located at one particular cantonal border are dropped. In column (2), only cantons in which 70% of their population live in municipalities at one particular border are dropped. In column (2), Appenzell Innerrhoden, Appenzell Ausserrhoden, Basel-Landschaft, Schaffhausen are dropped. In column (1), Zoug and Solothurn are also dropped. The dependent variable is the consolidated cantonal and municipal tax rate on personal income for an unmarried taxpayer with a gross annual income of CHF 1,000,000. The instrument is the cantonal tax rate of neighboring cantons multiplied by the share of neighboring municipalities located in these cantons. Neighboring municipalities are municipalities within a maximum road distance of 10 kilometers ($D \leq 10$ km). Municipalities have at least one neighboring municipality located in another canton. All estimations include population, % of foreigners, % of young and old people, % of employees in the primary, secondary and tertiary sectors as controls. Average values of neighboring municipalities are also included as controls. Spatial weights are uniform. All estimations include municipality and canton-year fixed effects. Standard errors are clustered two-ways, by municipality and by year.

In Table 6, I explore alternative specifications of spatial weights w_{ij}. Column (1) repeats for convenience the baseline result of Table 3. Column (2) follows the assumption that interactions are stronger the closer municipalities are in terms of road distance. Thus, inverse-distance weights are defined as

$$w_{ij}^{D} = \begin{cases} \dfrac{\frac{1}{d_{ij}}}{\sum \frac{1}{d_{ij}}} \text{ if } d_{ij} \leq D \text{ km} \\ 0 \text{ otherwise .} \end{cases} \quad (5)$$

Spatial weights in column (3) are defined according to relative population. If big municipalities act as "leader", more weight should given to neighboring municipalities that are bigger in terms of population:

$$w_{ij}^{P} = \begin{cases} \dfrac{\frac{pop_j}{pop_i}}{\sum \frac{pop_j}{pop_i}} \text{ if } d_{ij} \leq D \text{ km} \\ 0 \text{ otherwise .} \end{cases} \quad (6)$$

Table 6: Alternative spatial weights

	Spatial weights			
	Uniform w^U	Distance w^D	Population w^P	Minimum w^M
	(1)	(2)	(3)	(4)
Tax rate of neighboring municipalities	-0.306*	-0.479**	-0.213	-0.492*
	(0.163)	(0.192)	(0.143)	(0.284)
Reduced form				
Instrument	-0.091**	-0.132***	-0.068	-0.070***
	(0.046)	(0.048)	(0.045)	(0.025)
First-stage F-test on instrument	40.07	41.75	42.03	10.45
No. of observations	28,705	28,705	28,705	28,705
No. of municipalities	1096	1096	1096	1096
No. of years	26.20	26.20	26.20	26.20

Note: Standard errors in parentheses. *** p<0.01, **p<0.05, *p<0.10. The dependent variable is the consolidated cantonal and municipal tax rate on personal income for an unmarried taxpayer with a gross annual income of CHF 1,000,000. In column (1), the instrument is the cantonal tax rate of neighboring cantons multiplied by the share of neighboring municipalities located in these cantons. In columns (2) and (3), the cantonal tax rate is multiplied by the share of total distance, respectively population, represented by municipalities in neighboring cantons. In column (4), the instrument is the lowest cantonal tax rate among neighboring cantons. Neighboring municipalities are municipalities within a maximum road distance of 10 kilometers ($D \leq 10$ km). Municipalities have at least one neighboring municipality located in another canton. All estimations include population, % of foreigners, % of young and old people, % of employees in the primary, secondary and tertiary sectors as controls. Average values of neighboring municipalities are also included as controls. Spatial weights are uniform. All estimations include municipality and canton-year fixed effects. Standard errors are clustered two-ways, by municipality and by year.

A last specification assumes that jurisdictions react not to the average tax rate of neighboring municipalities but to the lowest tax rate:

$$w_{ijt}^M = \begin{cases} 1 \text{ if } T_{jt} = \min(T_{kt}) \; \forall k, \, d_{ik} \leq D \text{ km} \\ 0 \text{ otherwise} . \end{cases} \tag{7}$$

In columns (2) and (3), newly defined average tax rates of neighboring municipalities are instrumented with the cantonal tax rate of neighboring cantons, multiplied the share of the total distance, respectively population, represented by municipalities in these cantons. In column (4), the instrument is the minimum cantonal tax rate of neighboring cantons.

The estimates suggest that strategic interactions are more intense among municipalities that are geographically close. Both IV and reduced-form estimates are higher (in absolute value) in column (2) than the baseline of column (1). Coefficients are however not statistically significant in column (3), where large municipalities are assumed to be dominant players. The sign of strategic interactions is nevertheless still negative and both IV and reduced-form coefficients are only slightly lower (in absolute value) than in the baseline. In the last column, municipalities are found to react to the lowest tax rate among their neighboring municipalities. The first-stage F-test however indicates that instruments are rather weak leading to an upward biased (in absolute value) and more imprecise IV estimate. The weak instrument problem in this case arises because the lowest consolidated tax rate is not necessarily found in the neighboring canton with the lowest cantonal tax rate.

So far, my dependent variable has been the consolidated cantonal and municipal tax rate on personal income for an unmarried taxpayer with a gross annual income of CHF 1,000,000. Table 7 presents results for unmarried taxpayers, married taxpayers with two children, married taxpayers without children, each with a gross annual income of CHF 50,000, 100,000, 500,000 and 1,000,000.[22] In addition, the last three columns present results for unmarried taxpayers with a gross annual income of CHF 50,000, CHF 100,000 and CHF 500,000 over a longer time span (1970-2010).[23]

I find that strategic interactions are indeed identified for high-income unmarried taxpayers but not for other income classes. IV estimates are negative for all categories (except one) but statistically significant only for taxpayers with a gross income of CHF 1,000,000, as well as for unmarried taxpayers with a gross annual income of CHF 500,000. This suggests that municipalities react to changes in the cantonal tax schedule that affect top-income taxpayers but not to changes affecting other income classes. IV estimates for taxpayers in the income class of CHF 1,000,000 are higher (in absolute value) for unmarried taxpayers, who presumably are more mobile, than for married taxpayers with two children, and married taxpayers without children.

The analysis modelled by equation (2) concentrates on contemporaneous reactions to changes in the average tax rate of neighboring municipalities. This may not capture the full effect of strategic interactions if municipalities respond with a delay. Table 8 presents therefore results for two dynamic versions of equation (2). Columns (1) and (2)

[22] A gross annual income of CHF 50,000 corresponds approximately to the median income over the period 1983-2010. A gross annual income of CHF 100,000 corresponds to the top 10%, a gross annual income of CHF 500,000 to the top 0.5% and a gross annual income of CHF 1,000,000 to the top 0.1%.

[23] As noted in Section 3.1, data quality for the period 1970-1982 is lower because of the small number of municipalities listed in the official statistics and used to infer cantonal and consolidated tax rates for all municipalities. Therefore, only cantons for which at least 5% of their municipalities are listed in official statistics are included in columns (13) to (15). For the period 1983-2010 used in baseline results, all cantons satisfy this condition.

Table 7: Strategic interactions in tax rates for different categories of taxpayers

	Unmarried taxpayer with gross annual income of CHF				Married taxpayer with 2 children with gross annual income of CHF				Married taxpayer without children with gross annual income of CHF					(1970-2010)	
	50,000	100,000	500,000	1,000,000	50,000	100,000	500,000	1,000,000	50,000	100,000	500,000	1,000,000	50,000	100,000	500,000
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Tax of neighb. mun.	-0.193	-0.009	-0.232*	-0.306*	0.019	-0.055	-0.120	-0.241*	-0.066	-0.091	-0.175	-0.276*	-0.050	-0.021	-0.136
	(0.255)	(0.177)	(0.139)	(0.163)	(0.082)	(0.117)	(0.119)	(0.126)	(0.094)	(0.147)	(0.167)	(0.159)	(0.169)	(0.233)	(0.109)
Reduced-form															
Instrument	-0.032	-0.002	-0.075*	-0.091**	0.005	-0.013	-0.041	-0.085**	-0.020	-0.022	-0.050	-0.084*	-0.010	-0.004	-0.053
	(0.041)	(0.043)	(0.044)	(0.046)	(0.021)	(0.029)	(0.041)	(0.043)	(0.029)	(0.037)	(0.047)	(0.047)	(0.034)	(0.043)	(0.042)
First-stage F-test	12.08	20.36	47.07	40.07	41.04	32.88	50.55	48.37	32.90	29.59	40.81	47.43	21.45	9.690	29.46
No. of observations	28,705	28,705	28,705	28,705	28,705	28,705	28,705	28,705	28,705	28,705	28,705	28,705	32,621	32,621	32,067
No. of municipalities	1096	1096	1096	1096	1096	1096	1096	1096	1096	1096	1096	1096	1096	1096	1096
No. of years	26.20	26.20	26.20	26.20	26.20	26.20	26.20	26.20	26.20	26.20	26.20	26.20	29.80	29.80	29.30

Note: Standard errors in parentheses. *** p<0.01, **p<0.05, *p<0.10. The instrument is the cantonal tax rate for the specific category of taxpayers multiplied by the share of neighboring municipalities located in these cantons. Neighboring municipalities are municipalities within a maximum road distance of 10 kilometers ($D \leq 10$ km). Municipalities have at least one neighboring municipality located in another canton. All estimations include population, % of foreigners, % of young and old people, % of employees in the primary, secondary and tertiary sectors as controls. Average values of neighboring municipalities are also included as controls. Spatial weights are uniform. All estimations include municipality and canton-year fixed effects. Standard errors are clustered two-ways, by municipality and by year.

Table 8: Strategic interactions in the long run

	Autoregressive Distributed Lag Model		Distributed Lag Model				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent variable (t-1)	0.896***	0.936***					
	(0.012)	(0.013)					
Dependent variable (t-2)		-0.048***					
		(0.015)					
Tax rate of neighb. mun. (t)	-0.030	-0.009	-0.189	-0.087	-0.086	-0.108	-0.167
	(0.046)	(0.046)	(0.178)	(0.158)	(0.192)	(0.199)	(0.181)
Tax rate of neighb. mun. (t-1)	-0.021	0.006	-0.175	-0.066	0.033	0.097	0.122
	(0.055)	(0.083)	(0.217)	(0.231)	(0.231)	(0.228)	(0.251)
Tax rate of neighb. mun. (t-2)		-0.066		-0.310	-0.173	-0.025	0.066
		(0.082)		(0.259)	(0.410)	(0.355)	(0.361)
Tax rate of neighb. mun. (t-3)					-0.304	-0.530	-0.386
					(0.465)	(0.674)	(0.596)
Tax rate of neighb. mun. (t-4)						0.027	-0.185
						(0.605)	(0.672)
Tax rate of neighb. mun. (t-5)							-0.049
							(0.591)
Reduced-form							
Instrument (t)	-0.008	-0.004	-0.051	-0.031	-0.022	-0.023	-0.024
	(0.013)	(0.013)	(0.039)	(0.038)	(0.037)	(0.038)	(0.039)
Instrument (t-1)	-0.008	0.000	-0.057	-0.018	-0.009	-0.000	0.004
	(0.014)	(0.019)	(0.042)	(0.042)	(0.043)	(0.042)	(0.045)
Instrument (t-2)		-0.017		-0.080*	-0.053	-0.043	-0.039
		(0.017)		(0.047)	(0.047)	(0.046)	(0.045)
Instrument (t-3)					-0.059	-0.062	-0.058
					(0.046)	(0.053)	(0.056)
Instrument (t-4)						-0.024	-0.030
						(0.053)	(0.058)
Instrument (t-5)							-0.021
							(0.051)
First-stage F-test	15.23	8.645	16.33	9.202	1.864	0.952	0.922
No. of observations	27,609	26,513	27,609	26,513	25,417	24,321	23,225
No. of municipalities	1096	1096	1096	1096	1096	1096	1096
No. of years	25.20	24.20	25.20	24.20	23.20	22.20	21.20
Long-term effect of tax rate of neighb. mun.	-0.490	-0.623	-0.364	-0.464	-0.530	-0.540	-0.599
Test long-term effect = 0 (pval)	0.231	0.201	0.0547	0.0450	0.0538	0.0727	0.0825
Long-term effect of instrument	-0.144	-0.163	-0.109	-0.130	-0.143	-0.153	-0.169
Test long-term effect = 0 (pval)	0.187	0.154	0.0443	0.0332	0.0347	0.0401	0.0393

Note: Standard errors in parentheses. *** p<0.01, **p<0.05, *p<0.10. The dependent variable is the consolidated cantonal and municipal tax rate on personal income for an unmarried taxpayer with a gross annual income of CHF 1,000,000. The instrument is the cantonal tax rate of neighboring cantons multiplied by the share of neighboring municipalities located in these cantons. Neighboring municipalities are municipalities within a maximum road distance of 10 kilometers ($D \leq 10$ km). Municipalities have at least one neighboring municipality located in another canton. All estimations include population, % of foreigners, % of young and old people, % of employees in the primary, secondary and tertiary sectors as controls. Average values of neighboring municipalities are also included as controls. Spatial weights are uniform. All estimations include municipality and canton-year fixed effects. Implied long-run coefficients are computed as the sum of coefficients on the respective variable, divided by one minus the sum of coefficients on the lagged dependent variable in columns (1) and (2). Standard errors are clustered two-ways, by municipality and by year.

show the estimation of an autoregressive distributed lag (ADL) model with one and two lags respectively. ADL models augment equation (2) by including the lagged dependent variable and lagged independent variables on the right-hand side. These models nest the most widely used dynamic processes but cannot be consistently estimated by fixed-effects OLS estimators.[24] Columns (3) to (7) report distributed lag models up to five lags. These models do not include the lagged dependent variable and thus can be consistently estimated. Note that the autoregressive model in column (1) is nested in a distributed lag model with an infinite number of lags.

[24]The size of the bias shrinkes, however, with the number of time periods [Nickell, 1981].

Implied long-run IV coefficients are computed as the sum of coefficients on the tax rate of neighboring municipalities, divided by one minus the sum of coefficients on the lagged dependent variable for autoregressive distributed lag models in columns (1) and (2). Long-run reduced-form coefficients are computed analogously. They are reported at the bottom of Table 8 together with their associated statistical significance levels. Baseline results are confirmed. Long-run coefficients are always negative and larger (in absolute value) than the baseline. They are statistically significant at conventional levels for the distributed lag model but not for the autoregressive model that is less precisely estimated.

4.2 The spatial reach of strategic interactions

Table 9 explores the spatial reach of strategic interactions, that is the distance up to which municipalities interact strategically in their tax setting. Columns (1) to (4) show how municipalities located at different distances from a cantonal border react to changes in the cantonal tax rate of neighboring cantons. For this analysis, the cantonal tax rate of neighboring cantons is not multiplied by the share of municipalities located in these cantons. Panels A to D present the associated maximum road distance D used to select neighboring cantons in the four distance bandwidths.

Results suggest that municipal tax decisions interact more the closer the municipalities are located to the cantonal border. The effect is the highest (in absolute value) between 0 and 5 kilometers from the border, decreases rapidly between 5 and 10 kilometers, and increases again between 10 and 15 kilometers. Note that this pattern is consistent with tax rates being strategic substitutes. Municipalities between 15 and 20 kilometers do not react to fiscal reforms of neighboring cantons suggesting that strategic interactions are bound spatially. The spatial reach of strategic interactions can thus be estimated to be of some 15 kilometers.[25]

4.3 Heterogeneity of strategic interactions

In Table 10, I investigate the strategic substitutability of tax rates in relation to two main dimensions. Columns (1) to (4) explore whether municipalities react differently to

[25] This result is in line with the findings of Eugster and Parchet [2011].

Table 9: Strategic interactions in tax rates for different distance bandwidths

	Distance to cantonal border			
	0-5 km	5-10 km	10-15 km	15-20 km
	(1)	(2)	(3)	(4)
Panel A: D = 5 km				
Cantonal tax rate of neighboring cantons	-0.144***			
	(0.044)			
No. of observations	13,247			
Panel B: D = 10 km				
Cantonal tax rate of neighboring cantons	-0.142***	-0.047*		
	(0.042)	(0.028)		
No. of observations	13,157	15,548		
Panel C: D = 15 km				
Cantonal tax rate of neighboring cantons	-0.160***	-0.073**	-0.120**	
	(0.045)	(0.032)	(0.049)	
No. of observations	12,905	15,227	9,476	
Panel D: D = 20 km				
Cantonal tax rate of neighboring cantons	-0.170***	-0.081**	-0.121**	-0.001
	(0.044)	(0.034)	(0.052)	(0.031)
No. of observations	12,551	15,002	9,284	6,834
No. of municipalities	500	596	359	270

Note: Standard errors in parentheses. *** p<0.01, **p<0.05, *p<0.10. The dependent variable is the consolidated cantonal and municipal tax rate on personal income for an unmarried taxpayer with a gross annual income of CHF 1,000,000. Neighboring cantons are selected such that at least on neighboring municipality is located in these cantons. Neighboring municipalities are municipalities within a maximum road distance of 5, 10, 15, and 20, respectively. All estimations include population, % of foreigners, % of young and old people, % of employees in the primary, secondary and tertiary sectors as controls. Average values of neighboring municipalities are also included as controls. Spatial weights are uniform. All estimations include municipality and canton-year fixed effects. Standard errors are clustered two-ways, by municipality and by year.

a positive and a negative change in the tax rate of neighboring cantons. Any increase (decrease) in the cantonal tax rate of neighboring cantons, and thus in the average tax rate of municipalities located in these cantons, implies a positive (negative) revenue shock for municipalities located on the other side of the cantonal border. Columns (2) and (3) present results for negative, respectively positive changes, while columns (1) and (4) concentrates on the 25% most negative (positive) changes.

Results show that municipalities react differently to positive and negative tax rate changes by neighbors. According to column (3), municipalities decrease their tax rate if competing municipalities increase their tax rate .[26] Results in column (1) and (2) show that municipalities on average do not react to negative shocks, except for large ones. Interestingly, in this case, tax rates are not strategic substitutes but strategic complements. This indicates that strategic interactions among municipalities are asymmetric. Municipalities, overall, adjust residually their tax rate to keep their expenditure fixed, even at the expense of an adverse effect on their tax base. However, if they experience a large

[26]Small and statistically insignificant coefficients in column (4) may be due to the small sample size.

Table 10: Heterogeneity of strategic interactions

	Tax change in neighboring canton				Share of top 10% income taxpayers			
	25% Most negative (1)	Negative (2)	Positive (3)	25% Most positive (4)	25% Lowest (5)	50% Low (6)	50% High (7)	25% Highest (8)
Tax rate of neighboring municipalities	0.321**	-0.143	-0.634**	-0.053	-0.036	0.047	-0.568**	-0.938**
	(0.135)	(0.185)	(0.308)	(0.350)	(0.345)	(0.171)	(0.259)	(0.386)
Reduced form								
Instrument	0.171**	-0.066	-0.141*	-0.016	-0.005	0.011	-0.225**	-0.411***
	(0.078)	(0.084)	(0.075)	(0.108)	(0.052)	(0.042)	(0.088)	(0.133)
First-stage F-test on instrument	11.79	34.33	9.145	6.277	4.800	16.06	30.95	17.38
No. of observations	5,148	21,519	7,186	1,815	7,297	14,345	14,360	7,282
No. of municipalities	189	804	292	96	274	548	548	274
No. of years	27.20	26.80	24.60	18.90	26.60	26.20	26.20	26.60
% Top 10% income at quartile					3.338	5.595	5.595	8.454
Population	3493	2724	2694	2848	645.6	1084	4440	5516
% in urban area	46.56	40.05	33.12	35.12	8.260	14.56	57.56	74.24
% center of urban area	4.760	2.990	2.580	2.840	0.140	0.150	5.450	5.180
% with lake shore	20.11	11.19	17.72	17.76	7.680	10.31	21.40	25.19

Note: Standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.10$. Tax change in neighboring cantons is the average yearly growth rate of cantonal tax rates over the sample period. The share of top 10% income taxpayers is an average over the before-sample period 1973-1982. The dependent variable is the consolidated cantonal and municipal tax rate on personal income for an unmarried taxpayer with a gross annual income of CHF 1,000,000. The instrument is the cantonal tax rate of neighboring cantons multiplied by the share of neighboring municipalities located in these cantons. Neighboring municipalities are municipalities within a maximum road distance of 10 kilometers ($D \leq 10$ km). Municipalities have at least one neighboring municipality located in another canton. All estimations include population, % of foreigners, % of young and old people, % of employees in the primary, secondary and tertiary sectors as controls. Average values of neighboring municipalities are also included as controls. Spatial weights are uniform. All estimations include municipality and canton-year fixed effects. Standard errors are clustered two-ways, by municipality and by year.

negative shock, they primarily target tax revenue and lower their tax rate to retain their tax base.

Columns (5) to (8) present a second decomposition of the baseline result and classify municipalities according to the share of top 10% income taxpayers residing in these municipalities *before* the sample period (i.e. for years 1973 to 1982). This decomposition summarizes differences among municipalities in terms of other important background characteristics. Statistics reported at the bottom of the table show that municipalities with a high share of top 10% income taxpayers tend to be big municipalities located in urban areas and/or enjoying attracting amenities, in this case a lake shore. Negative and statistically significant coefficients are found only in columns (7) and (8), suggesting that strategic interactions exist among municipalities with a high share of rich residents, presumably the most mobile ones.

5 Concluding discussion

I propose a novel method for identifying strategic interactions among local tax policies. Using exogenous variations in the tax rate of Swiss municipalities due to canton-level tax reforms, I can identify strategic interactions among municipalities across a cantonal border. In contrast to most of the existing findings, my results indicate that municipal tax reaction functions mostly have a negative slope, and that taxes rates are therefore strategic substitutes. This is consistent with a model of local tax setting where governments primarily target expenditure and adjust their tax rate residually, even at the expense of an adverse effect on the tax base.

Chirinko and Wilson [2011] provides similar evidence for corporate income tax competition among U.S. states. Interestingly, Koethenbuerger [2011] notes that the fiscal capacity equalization scheme subsidizing local taxation in Switzerland, together with municipal tax rates being adjusted annually, should provide an incentive for municipalities to adjust their taxes residually while keeping their expenditure fixed.

My result contrasts in particular with the findings of Eugster and Parchet [2011] who identify the existence of tax competition among Swiss municipalities through a discrete and measurable change in preferences for publicly provided goods at the language border between the French-speaking and the German-speaking regions. They show that French-speaking municipalities have stronger revealed preferences for publicly provided goods, but are constrained in their tax setting when they compete at the language border with low-tax, low-preference German-speaking municipalities. This identifies the existence of strategic interactions among Swiss municipalities and is consistent with a model where local governments primarily target tax revenues and lower their tax rates to retain mobile (lucrative) taxpayers.

Through their setting, Eugster and Parchet [2011] identify equilibrium outcomes of tax competition, and hence long-run strategic interactions among municipalities. By contrast, strategic interactions in this paper are identified by canton-level fiscal reforms and thus short-term responses to exogenous change in tax rates of neighboring municipalities.[27] Results of the dynamic specification suggest that tax rates are strategic substitutes even in the medium/long-run. However, this paper also shows the existence of a differential response of municipalities to negative and positive tax changes.

The hypothesis that emerges is that municipalities have their expenditure fixed and they adjust residually their tax rates for small revenue shocks, even this affects negatively their tax base. This reflects probably the most common situation since, in the short run, tax rates can be more easily adjusted than public spendings. However, municipalities engage in tax competition if they face large negative shocks. In this paper, these shocks are the tax cuts that occur in some cantons, while in Eugster and Parchet [2011] they are the preference differential at the language border (about 25% of their preference measure). This suggests the existence of a threshold for negative revenue shocks above which local governments primarily target the preservation of their tax base. Further research might integrate this hypothesis in the explanation of the decision by local governments of their public policy.

[27] In this paper, preferences are controlled through municipality fixed effects and most cantonal borders do not coincide with language borders.

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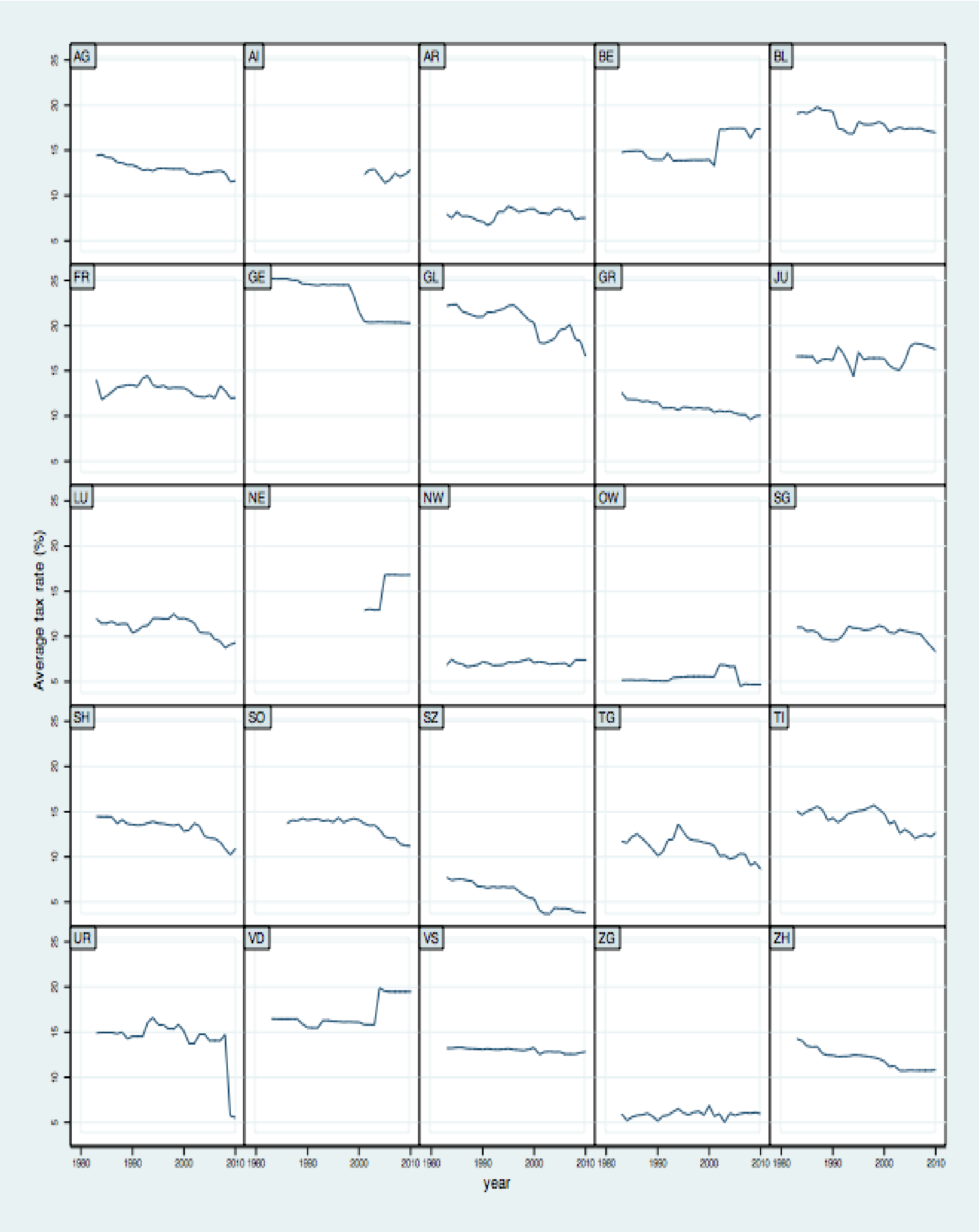
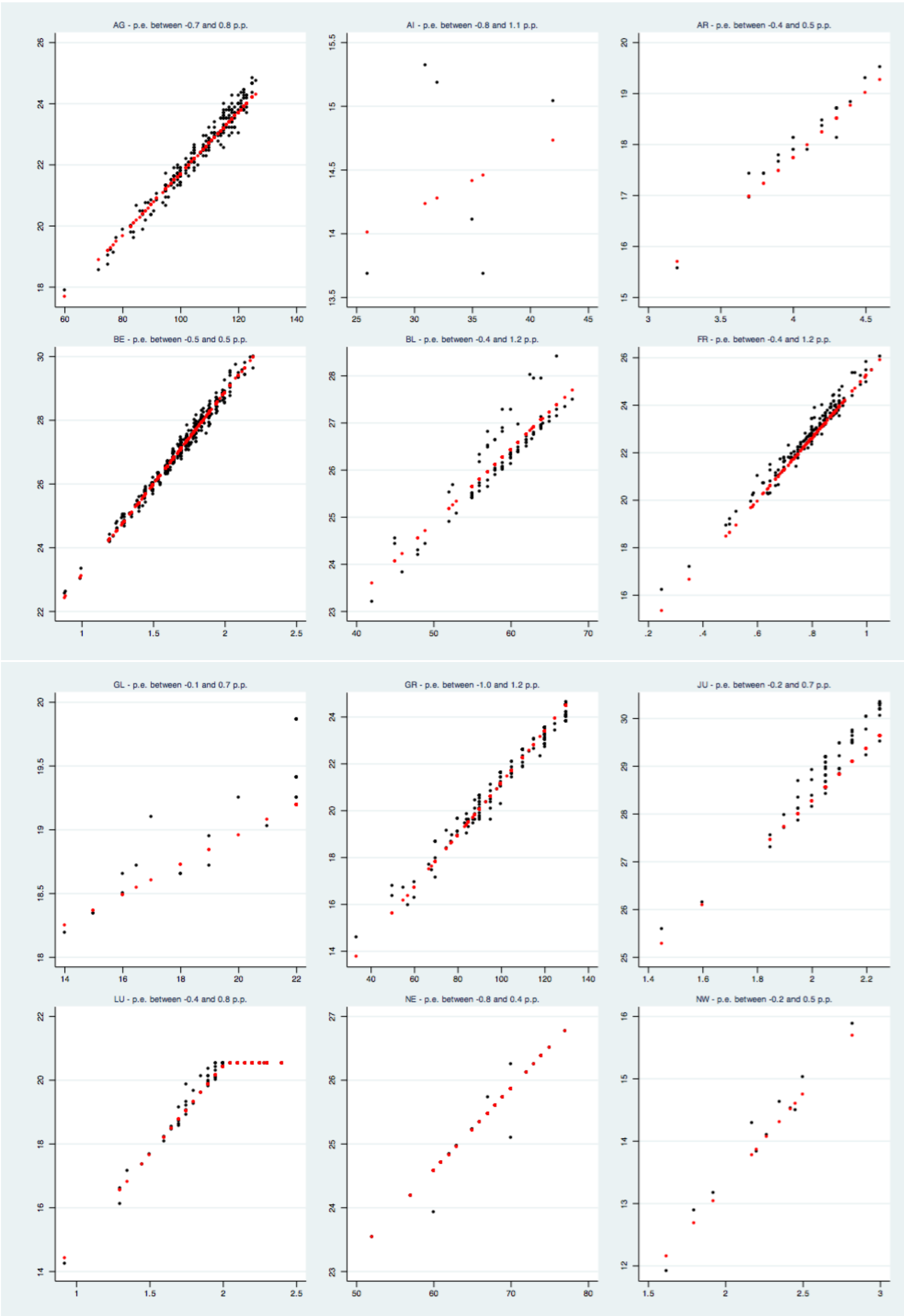
A Appendix

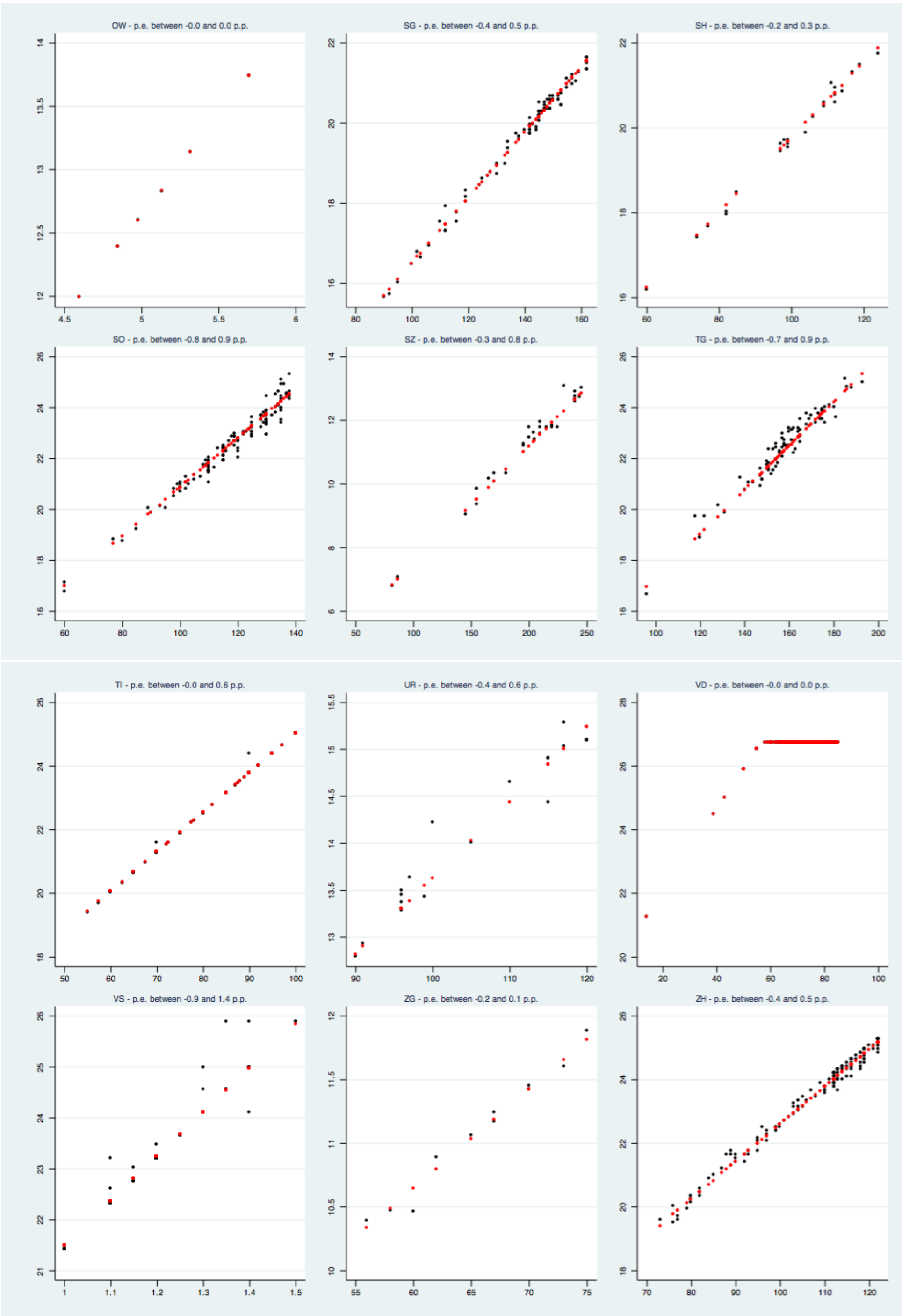
Figure A.1: Evolution of the cantonal personal income tax rate for an unmarried taxpayer with gross annual income of CHF 1,000,000



Note: The cantonal tax rate is computed using the methodology described in Section 3.1. For full canton names, see Table ??.

Figure A.2: Actual and predicted consolidated tax rate for an unmarried taxpayer with a gross annual income of CHF 1,000,000





Note: Points in black are actual average tax rate for all municipalities for 2010 from the Swiss Federal Tax Administration. Predicted tax rates using tax multipliers for the sample of municipalities in 2009 are in red. The canton of Geneva is not included in this Figure (no prediction error).