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# Culture and Taxes: Towards Identifying Tax Competition

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Culture and Taxes:

Towards Identifying Tax Competition[1]

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**Abstract**

We propose a difference-in-differences strategy to identify the existence of interjurisdictional tax competition, and to estimate its spatial reach. Our strategy rests on differences between desired tax levels, determined by culture-specific preferences, and equilibrium tax levels, determined by interjurisdictional fiscal externalities as well as by preferences. While fiscal preferences differ systematically and demonstrably between French-speaking and German-speaking Swiss regions, we find that local income tax burdens do not change discretely at the language border but exhibit smooth spatial gradients. The slope of these gradients implies that tax competition constrains tax choices of jurisdictions with a preference for higher taxes up to a distance of around 20 kilometers. Hence, tax competition does constrain income taxation by local governments but its effect is confined to a small spatial scale.

**Keywords**

Tax competition, fiscal federalism, culture.

**JEL Classification**

H31, H71, Z10.

Tax competition over mobile resources is a theoretically well understood mechanism. Yet, rigorous research allowing this mechanism to be identified empirically remains comparatively scarce. We employ a quasi-experimental design using measurable and discrete spatial differences in voter preferences as a means to search for evidence of tax competition. The related empirical literature has traditionally treated cultural differences as an exogenous covariate simply to be controlled for. We claim instead that systematic differences in voter preferences among jurisdictions offer a unique opportunity for identifying the existence of tax competition as well as for estimating its spatial reach.

For resource-flow tax competition to arise, two conditions need to hold. First, tax bases have to be mobile in response to tax differentials. This aspect has been extensively studied, and a negative relationship between taxation and the location of individuals and firms is well documented (see, e.g., Hines, 1996; Devereux and Griffith, 1998, for the U.S., and Feld and Kirchgässner, 2002, for Switzerland).

The second condition is that jurisdictions set tax rates strategically with respect to the mobile tax base. Prior empirical research has sought to identify such strategic policy making by estimating spatial tax reaction functions. However, this approach is inevitably plagued by the reflection problem (Manski, 1993; see also Brueckner, 2003).[1] A way to overcome this problem is to compare different time patterns of tax rates among neighboring jurisdictions. However, identification relies on the strong assumption that changes in tax rates of neighboring jurisdictions are exogenous, and that all other sources of spatial tax correlations are fully controlled for. Furthermore, this approach typically relies on the existence of substantial strategic variations in tax rates, whereas in fact spatially equalized tax rates need not imply the absence of tax competition. Rather, their level could be the long-term equilibrium outcome of tax competition capturing also general equilibrium effects.

We thus propose that the empirical study of tax competition be rethought along different lines. We use a discrete and measurable discontinuity in voter preferences among proximate jurisdictions located at the Swiss language border that separates two cultural

[1] Brueckner (2003) surveys the empirical literature on strategic interactions among jurisdictions and points to three main challenges to the identification of tax competition. First, the variable of interest (tax rates of neighbors) is endogenous by definition. Second, correlations between jurisdictional characteristics and the error term may arise e.g. from endogenous sorting of households. Finally, omitted variables can cause spatial error dependence that biases upwards the inferred intensity of policy interactions.

regions within the same institutional setting. Consider two jurisdictions between which a historically determined cultural break leads to a sharp, persistent and measurable difference in preferences over publicly provided goods. We expect jurisdictions with a higher valuation for these goods to opt for higher taxes.[2] However, if these jurisdictions are spatially close, tax competition might constrain tax choices and reduce observed tax differentials relative to their desired levels. We propose a difference-in-differences approach to identify the existence of tax competition and its spatial reach by comparing preference-related tax differentials between jurisdictions that share a common border at which preferences change discontinuously, and between jurisdictions with the same differences in preferences, but that are further apart and thus less likely to compete with each other.

Specifically, we take advantage of the fact that, in Switzerland, fiscal preferences differ systematically and demonstrably at the language border between French-speaking and German-speaking regions within bilingual cantons (states), whereas other characteristics and policies determined at the cantonal level are identical on either side of that border. We show that voting patterns in German-speaking municipalities consistently reflect lower valuations for publicly provided goods. Hence we expect these jurisdictions, other things equal, to choose lower local tax rates than their French-speaking counterparts. Comparing municipalities located further away from the language border, and controlling for various municipality characteristics, we indeed find that culture-specific preferences are reflected in statistically significant differences in tax levels, with taxes in French-speaking municipalities being some 0.4 standard deviations higher.

In the absence of strategic interactions among municipalities, we would expect local income tax rates to jump discretely at the language border. We find, however, that tax rates do not change discretely at the border but exhibit smooth spatial gradients as one moves away from the border. The slope of these estimated gradients implies that tax competition significantly constrains tax choices of the jurisdictions with a preference for higher taxes up to a distance of around 20 kilometers. This finding is consistent

[2] Alesina and Angeletos (2005) and Benabou and Tirole (2006) provide a theoretical model that links different beliefs to different tax rates. In these models multiple equilibria arise, where one equilibrium type is characterised by a belief that luck determines success, high taxes and high levels of redistribution ("Europe"), whereas the other is characterized by a belief that effort pays off, low taxes and low redistribution ("U.S."). To our knowledge, there exists no empirical literature that estimates the effect of beliefs on tax levels empirically.

with competition among municipalities over a mobile tax base, and it fits moving and commuting patterns in Switzerland.

This paper relates closely to empirical studies that exploit discontinuities at state borders. Chirinko and Wilson (2008), Rathelot and Sillard (2008), Duranton et al. (2011), and Thompson and Rohlin (2012) use state borders to identify the effect of local taxation on the location of manufacturing and employment, respectively in the U.S., in France and in the UK. Their findings confirm the mobility of the tax base and the attractiveness of low tax rates, but say nothing about the existence of strategic interactions among local jurisdictions. Agrawal (2012) investigates the spatial pattern of local sales tax rates in the U.S. at state borders where state sales tax rates change discontinuously. He finds that local tax rates are a function of the distance to the border. This provides a first test for the existence of strategic interactions among local jurisdictions.

Our study adds to this literature along two dimensions. First, we exploit a cultural discontinuity within the same state and thus are not limited by the use of state borders where other policies can be discontinuous. This allows us to derive a difference-in-differences approach to identify the existence of tax competition.[3] Second, culture-related tax differentials provide an interesting benchmark to assess the intensity of tax competition. To our knowledge, we are the first study to explore empirically the interplay among preferences, tax levels and strategic tax setting.

An alternative explanation of strategic tax interactions among local jurisdictions is "yardstick competition", where voters inform themselves about the quality of their politicians by comparing the performance of their government with the one of neighboring jurisdictions. Rent-seeking governments are then disciplined by the threat of non-election by their voters, even without mobility of the tax base (Besley and Case, 1995). Both resource-flow tax competition and yardstick competition lead to "tax mimicking" among jurisdictions. Investigating mobility patters and financial ratings of municipalities, we provide evidence that it is not yardstick competition that drives our results.

The paper proceeds as follows. Section 1 presents a stylized tax competition model

[3]Within-state tax differentials alone identify the existence of tax competition but provide a biased estimate of its intensity (which equals the sum of tax differentials on both sides of the border). The difference-in-differences approach has the advantage of providing directly one unbiased estimate of tax competition.

allowing for different preferences for a publicly provided good in neighboring jurisdictions, and it develops our strategy to identify tax competition. Section 2 provides relevant background on tax setting in Switzerland and establishes the existence of systematic differences in preferences and taxation between the two main language regions. Section 3 contains the econometric analysis of the existence of tax competition and its spatial reach. Section 4 discusses the results in light of commuting and moving patterns, location of top-income taxpayers in equilibrium, and yardstick competition. Section 5 concludes.

# 1 Identifying tax competition across cultural regions

As a formal underpinning for our empirical strategy, we construct a two-region, two-jurisdiction, Tiebout/tax competition model.[4] Consider two contiguous cultural regions, $A$ and $B$. Populations born in each region are characterized by different valuations of the publicly provided good. We want to explore the strategic tax setting of two jurisdictions located each in one of the two cultural regions. Residents derive their utility from a private consumption good and a publicly provided good financed by a residence-based proportional income tax.[5] In each jurisdiction, a homogeneous majority of residents are immobile and a homogeneous minority are mobile. Mobile workers are more productive, value the publicly provided good less, and can switch jurisdiction at a finite cost.[6] Tax rates in each jurisdiction are set by a majority rule, that is, by immobile workers.[7] The timing is as follows: first, the representative immobile workers of each jurisdiction simultaneously set the tax rate. Second, mobile workers choose where to reside depending on the tax rates of the two jurisdictions and their mobility cost.

[4]In a Tiebout model, mobile taxpayers sort into jurisdictions according to their preferences. Thus, in equilibrium, two communities with different tax rates can coexist. In this tradition, the literature on income sorting points to a spatial segregation of the population according to their income, a conjecture that has some empirical relevance in Switzerland (see, e.g., Schmidheiny, 2006). Here we follow Brueckner (2000) who blends the Tiebout tradition with a standard tax competition model by allowing residents to sort endogenously according to their preferences and jurisdictions to set their tax rate strategically.

[5]Basic ingredients of the income tax competition model are borrowed from Smith and Webb (2001).

[6]High-income taxpayers may have higher or lower preferences for publicly provided goods depending on the nature of the good and fiscal instruments to finance it. In light of evidence presented thereafter in Table 1, we assume henceforth that mobile taxpayers have lower preferences for the publicly provided good. Section 4.1 also shows that high-income (better educated) taxpayers are more mobile. Note that, in our setting, if mobile workers have the same preferences as immobile workers, they would have no incentive to move and thus there would be no inter-jurisdictional spillovers.

[7]With this assumption, we rule out the possibility for mobile workers to decide directly on tax rates. We focus instead on strategic interactions among local governments that arise because of the mobility of a small group of high-income and hence "lucrative" taxpayers.

We consider the case where each jurisdiction hosts a unit mass of immobile workers. Their productivity $w$ is normalized to 1, as is their wage. Furthermore, each jurisdiction initially hosts $x < 0.5$ mobile workers. Mobile workers have productivity $w > 1$ and receive income $w$ according to their productivity. They can switch jurisdiction at a cost $c$ that is assumed to be uniformly distributed between 0 and $\bar{c}$.

We denote workers' utility $U(C, G)$ with $C$ standing for a private consumption good and $G$ for a publicly provided good. Workers fully consume their after-tax wage: $C(t_i) = w(1 - t_i)$, where $i \in \{A, B\}$ stands for the region they live in. $G$ is financed by a residence-based proportional income tax set by the representative immobile worker. $G(t_i, n_i)$ is the publicly provided good produced and consumed in region $i$. It depends on the tax rate $t_i$ and the endogenous number of mobile residents $n_i$ in the respective regions. We further assume that more productive workers, and workers born in region $A$ value the public good relatively less. The culture-specific valuation of the publicly provided good is captured by a parameter $\rho_A$ for region $A$ and $\rho_B$ for region $B$.

Mobile workers take tax rates as given and choose where to live depending on their specific mobility cost. In equilibrium, the mobility cost $c_i^*$ that makes a mobile worker born in region $i$ indifferent between staying or leaving, is implicitly given by:

$$\begin{aligned}
U_A^m\left(C(t_A), G\left(t_A, x\left(\frac{\bar{c}-c_A^*}{\bar{c}} + \frac{c_B^*}{\bar{c}}\right)\right)\right) &= U_A^m\left(C(t_B), G\left(t_B, x\left(\frac{c_A^*}{\bar{c}} + \frac{\bar{c}-c_B^*}{\bar{c}}\right)\right)\right) - c_A^*, \\
U_B^m\left(C(t_B), G\left(t_B, x\left(\frac{c_A^*}{\bar{c}} + \frac{\bar{c}-c_B^*}{\bar{c}}\right)\right)\right) &= U_B^m\left(C(t_A), G\left(t_A, x\left(\frac{\bar{c}-c_A^*}{\bar{c}} + \frac{c_B^*}{\bar{c}}\right)\right)\right) - c_B^*,
\end{aligned}$$

where $\frac{\bar{c}-c_i^*}{\bar{c}} \in [0, 1]$ is the fraction of stayers and $\frac{c_i^*}{\bar{c}} \in [0, 1]$ is the fraction of movers.

The immobile representative worker in region $A$, anticipating the location decision of mobile workers, chooses the tax rate $t_A$ that maximizes the constrained utility:

$$\max_{t_A} U_A^{im}(C_A, G_A) \qquad \text{s.t.} \qquad G = G(t_A, n_A^*)$$

where $n_A^* = x\left(\frac{\bar{c}-c_A^*}{\bar{c}} + \frac{c_B^*}{\bar{c}}\right) \in [0, 2x]$.

This implicitly defines a tax reaction function $t_A(t_B)$. The same logic leads to a tax reaction function $t_B(t_A)$ for region $B$. The intersection of these two tax reaction functions defines equilibrium tax rates.

We solve the model assuming the following utility functions for mobile and immobile workers born in region $A$:

$$U_A^m = w(1 - t_i),$$

$$U_A^{im} = (1 - t_A)^{1-\rho_A} \left(G(t_A, n_A)\right)^{\rho_A},$$

where $G(t_A, n_A) = t_A \times w \times n_A$ and $\rho_A \in [0, 1]$.

This specification represents the case where mobile workers value only private consumption. Furthermore, we introduce a complementarity between immobile and mobile workers in the production of the publicly provided good. If no mobile worker resides in a region, no publicly provided good can be produced and immobile workers have utility of zero. Without this complementarity condition, an equilibrium may not exist or can be a corner solution where immobile residents in both jurisdictions set their optimal tax rate and all mobile workers reside in the low-tax jurisdiction. We relax these two assumptions in the Web Appendix (see Sections W.2 and W.3).[8]

Solving this model leads to a tax reaction function

$$t_i(t_j) = f(t_j | \frac{\bar{c}}{w}, \rho_i)$$

where one can show that $\frac{\partial t_i}{\partial t_j} \geq 0$, $\frac{\partial t_i}{\partial (\frac{\bar{c}}{w})} \geq 0$, and $\frac{\partial t_i}{\partial \rho_i} \geq 0$ (see Section W.1 of the Web Appendix). Taxes are thus strategic complements. The ratio $\frac{\bar{c}}{w}$ is an inverse measure of the intensity of tax competition: when mobility costs $\bar{c}$ relative to the wage $w$ of mobile workers are lower, equilibrium tax rates will be lower. Finally, tax rates are higher when immobile workers have stronger preferences for the publicly provided good.[9]

Figure 1 illustrates equilibrium tax rates with and without mobile workers for $\rho_A = 0.2$, $\rho_B = 0.8$ and a maximum mobility cost $\bar{c} = 2$. We concentrate on the case where

[8] This case matches standard capital tax competition models where a publicly provided good is financed through a tax on the mobile factor (capital) although the latter does not "benefit" (in terms of productivity) from it (see, e.g., Wilson, 1999, for a review).

[9] If $\rho_A = 1$ and $\rho_B = 1$ (immobile workers maximize tax revenue), it can be shown that equilibrium tax rates are $t_A^* = t_B^* = \frac{\bar{c}}{w}$. For the extreme case where $\rho_A = 0$ and $\rho_B = 1$, $t_A^* = 0$ and $t_B^* = \frac{1}{2}\frac{\bar{c}}{w}$ (see Section W.1 of the Web Appendix).

mobile workers represent a low fraction of the population ($x = 0.25$) but are four times as productive as immobile workers ($w = 4$).[10] Each pair of bars represents two competing jurisdictions that can be located in the same cultural region, in which case immobile workers have the same preferences, or they can lie on either side of the region border such that immobile workers have different preferences for the publicly provided good. Without mobility, tax rates perfectly reflect the differences in preferences ($t_i^* = \rho_i$; white bars in Figure 1) and change discretely at the border between the two cultural regions. If some workers are mobile, jurisdictions in region $B$ still set higher tax rates, but the jurisdiction at the region border has to lower its tax rate more than if it were in competition with a jurisdiction from the same cultural region, because of the pressure imposed by low-preference and hence low-tax jurisdictions on the other side of the border. On the other hand, jurisdictions in $A$ in equilibrium set a higher tax rate when competing with a high-preference jurisdiction than when competing with a jurisdiction of the same region.[11]

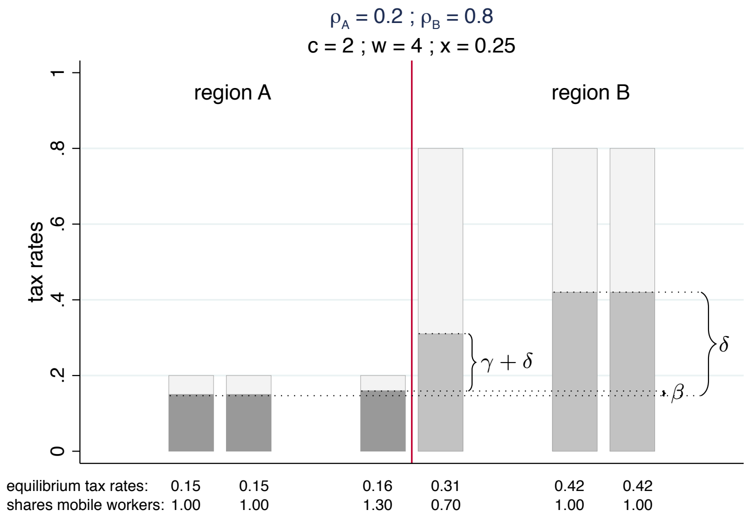
The pattern of tax rates arising here as an equilibrium outcome of strategic tax setting among jurisdictions with different culture-related preferences can be used to identify the existence of tax competition. The observed size of the tax differential among jurisdictions located at the border between two cultural regions reflects the joint effect of differences in preferences and tax competition. To disentangle the two effects, we need jurisdictions in each region that do not compete over the mobile tax base of jurisdictions of the other region to act as a comparison group.[12] Assuming that the mobility cost increases with distance, due, for instance, to longer commuting to an unchanged workplace, one can use as counterfactual jurisdictions located sufficiently far away from the region border.

[10]This matches roughly the income ratio between the first and the fifth income quintile in Switzerland.

[11]This pattern is the same in a more general model where the publicly provided good is financed by all residents, and where mobile taxpayers have a positive valuation of the publicly provided good (see Section W.3 of the Web Appendix). It also holds for models with $N > 2$ jurisdictions (see Section W.4). However, in such more general models, an equilibrium may not exist or can be a corner solution, in which case the pattern of tax rates is not supported by the empirical evidence (see Figure W.2 for an example). Two additional features of the stylized model presented in this Section should be stressed. First, there is no additional psychological cost of living in the other region. Higher mobility costs when changing region would result in a higher tax differential at the region border. Conversely, with a zero mobility cost, all jurisdictions set the lowest possible (non-zero) tax rate, following the standard race-to-the-bottom logic. Second, the median voter is always immobile. Intuitively, if mobile workers can have the majority in one jurisdiction, they will self-select in the same jurisdiction and set a tax rate according to their preferences. Thus, all jurisdictions will set a tax rate equals to zero.

[12]These jurisdictions are henceforth called "counterfactual jurisdictions" or "counterfactual municipalities", even though they are not counterfactual per se. They exist and are used as a comparison group to estimate counterfactual outcomes.

**Figure 1** – Equilibrium tax rates with and without tax competition




Note: Pairs of bars represent two neighboring jurisdictions that can be located in the same cultural region, or one in region $A$ and one in region $B$. The vertical line indicates the region border. White bars represent tax rates without mobility. Dark gray and light gray bars are equilibrium tax rates with mobility. Parameters $\beta$, $\gamma$, and $\delta$ are explained in the text.

This suggests an empirical identification strategy based on a difference-in-differences framework

$$\begin{aligned}\gamma = \{&\overbrace{E(\text{Taxes} \mid \text{Region} = B,\ \text{Border} = 1) - E(\text{Taxes} \mid \text{Region} = A,\ \text{Border} = 1)}^{\gamma+\delta}\} \\ &- \\ \{&\underbrace{E(\text{Taxes} \mid \text{Region} = B,\ \text{Border} = 0) - E(\text{Taxes} \mid \text{Region} = A,\ \text{Border} = 0)}_{\delta}\}\end{aligned} \tag{1}$$

where the first expression is the tax differential of jurisdictions located at the border between the two cultural regions $A$ and $B$ and the second expression is the tax differential of counterfactual jurisdictions located in the interior of two cultural regions. According to the model, the first line captures the joint effect of different preferences ("$\delta$") and tax competition ("$\gamma$"), while the second measures only the effect of different preferences. If the size of the first difference is lower than the size of the second, and hence the difference-in-differences estimate $\gamma$ is negative, this would represent evidence for the existence of tax competition. As suggested by the model, tax competition is the sum of reactions of border jurisdictions in the two cultural regions when competing with each other. For completeness, we denote by "$\beta$" the tax differential that arises when a jurisdiction in $A$ competes with a jurisdiction in $B$ rather than with a jurisdiction of the same cultural region. This effect is identified by the within-region difference $E(\text{Taxes} \mid \text{Region} = A,\ \text{Border} = 1) - E(\text{Taxes} \mid \text{Region} = A,\ \text{Border} = 0)$ and is expected to be positive (see Figure 1).[13]

It is crucial for our identification strategy that median voter preferences for publicly provided goods be significantly different across the two cultural regions and change discretely at the border. If we can measure preferences, this assumption can be tested empirically by comparing fiscal preferences in the two cultural regions and at the region border. In the next Section, we show the existence of large, persistent and discrete differences in voter preferences and local tax rates between the two main language regions in Switzerland.

# 2 Empirical setting and decriptive evidence

## 2.1 Language regions and culture

Switzerland consists of two main language regions, German and French.[14] Eugster et al. (2009) and Eugster et al. (2011) have shown that cultural differences across language regions are deeply rooted and reveal themselves in different attitudes toward work and demand for social insurance.

Table 1 provides illustrative evidence from a 1996 survey on attitudes to government spending and redistribution in the two largest Swiss language regions for individuals with high and low family income. French-speaking respondents expressed consistently stronger support for redistribution and social services, even at the expense of higher taxes. Especially, they favoured more government spending in social policy areas such as health, retirement, and unemployment benefits. The top-25% income respondents are less will-

[13] Each within-region tax differential alone identifies the existence of tax competition, but provides a biased estimate of its intensity. This can be seen by rewriting equation (1) as $\underbrace{\{E(\text{Taxes} \mid \text{Region} = B,\ \text{Border} = 1) - E(\text{Taxes} \mid \text{Region} = B,\ \text{Border} = 0)\}}_{\gamma+\beta} - \underbrace{\{E(\text{Taxes} \mid \text{Region} = A,\ \text{Border} = 1) - E(\text{Taxes} \mid \text{Region} = A,\ \text{Border} = 0)\}}_{\beta}$.

[14] Switzerland has four official languages, German, French, Italian, and Romansh. German is spoken by 63.7% of the population, French by 20.4%, Italian by 6.5%, and Romansh by 0.5%.

**Table 1** – Stated preferences for government spending and redistribution

| % of respondents agreeing | German-speaking Top-25% income | German-speaking Bottom-75% income | French-speaking Top-25% income | French-speaking Bottom-75% income | Difference French-German | Difference Top-25% - Bottom-75% income |
|---|---|---|---|---|---|---|
| Government redistribute wealth | 32.43 | 52.80 | 57.69 | 70.03 | 20.58*** | −20.50*** |
| | | | | | (2.583) | (2.699) |
| More social services vs lower taxes | 32.56 | 42.54 | 44.26 | 50.43 | 7.93*** | −9.86*** |
| | | | | | (3.055) | (3.016) |
| Government should spend more on... | | | | | | |
| health | 21.07 | 31.87 | 30.49 | 52.52 | 18.40*** | −14.40*** |
| | | | | | (2.420) | (2.540) |
| education | 58.99 | 47.93 | 55.56 | 54.05 | 2.21 | 8.92*** |
| | | | | | (2.608) | (2.700) |
| retirement | 19.29 | 30.50 | 34.94 | 52.40 | 21.33*** | −13.86*** |
| | | | | | (2.409) | (2.535) |
| unemployment benefits | 11.20 | 19.74 | 20.73 | 32.84 | 12.36*** | −10.16*** |
| | | | | | (2.076) | (2.176) |
| culture, arts | 19.20 | 14.15 | 28.40 | 22.15 | 8.08*** | 4.69** |
| | | | | | (1.975) | (2.058) |

Note: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.10. Income is net monthly income of the household. The number of observations varies by question. German-speaking respondents: 1236-1600; French-speaking respondents: 325-482. Source: International Social Survey Program (ISSP), Role of Government, 1996. Switzerland.

ing to pay for redistributive public spendings than the bottom-75% income respondents. They express however stronger support for non-redistributive expenditures such as education and culture. Note also that French-speaking top-25% income respondents express similar attitude as German-speaking bottom-75% income respondents.

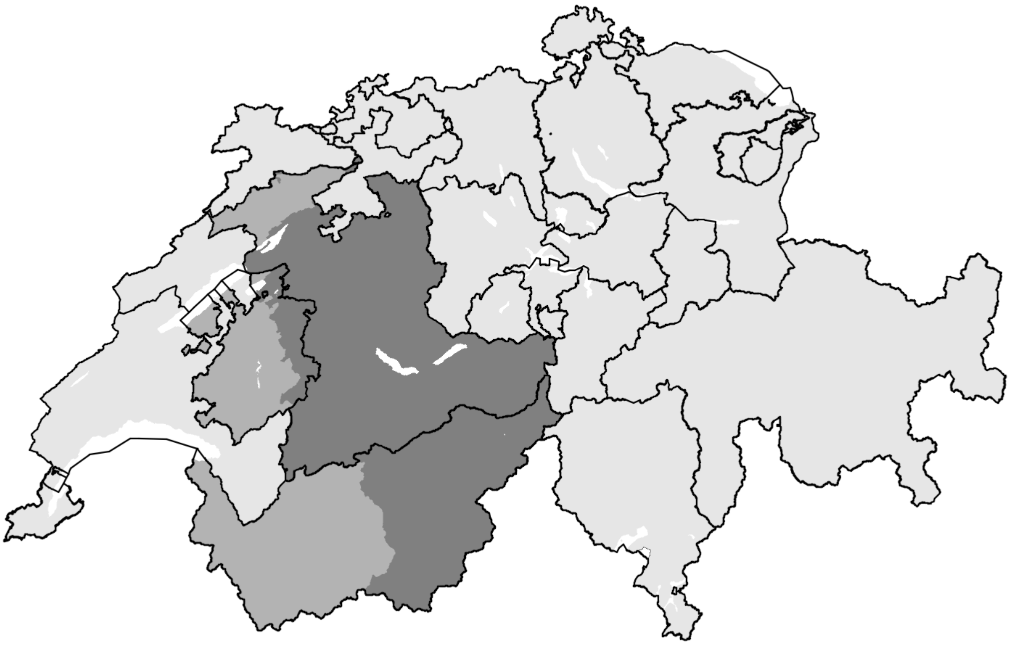
Such survey-based comparisons, while suggestive, do not provide rigorous evidence of an effect of culture on preferences for government spending. In fact, demographic, geographic or institutional characteristics might be correlated with the language divide and should thus be controlled for. To circumvent this problem, we take advantage of the fact that the French-German language border crosses three cantons, Berne, Fribourg, and Valais (see Figure 2). We can therefore compare preferences within the same institutional (cantonal) setting, and even directly at the language border, where demographic and topographic characteristics exhibit no discontinuities.[15]

As a measure of preferences, we use federal referendum outcomes at the municipality level. Switzerland is characterised by a high degree of direct democracy, with citizens voting regularly on a wide range of issues.[16] We select all federal referenda from 1981 to 2011 on subjects that were presented by the federal government as having an influence on

[15]Within the three bilingual cantons, the language border between the French and German regions is sharp. In fact, the percentage French (German) speaking residents jumps from 85% (9%) to 5% (90%) when crossing the language border. This border is historically determined and stable over time.

[16]For example, in the year 2009, there have been 8 federal referenda and a median of 4 cantonal referenda per canton.

**Figure 2** – Language regions and bilingual cantons in Switzerland



Note: Municipalities of the three bilingual cantons (Berne, Fribourg, and Valais) with a majority of German-speaking residents are shown in dark gray. French-speaking municipalities are in light gray. Cantonal borders are in black. We attribute each municipality to a language region according to the majority language spoken, calculated using data of the Swiss census 2000. Source: Swiss Federal Statistical Office.

the level of taxes. This includes all referenda on social insurance and public budget issues such as old age pensions, health insurance, debt-reduction measures, and fiscal transfers among cantons. Of these referenda, we keep those for which left-of-centre and right-of-centre parties published opposite vote recommendations. Table 2 lists the 37 selected referenda and shows the share of "yes" vote in German-speaking and French-speaking municipalities for all cantons as well as for bilingual cantons.[17] We split these referenda into two groups, with the first group containing all referenda for which the left-of-center parties recommended a "yes" vote and the right-of-center parties a "no", and the second group containing referenda with the reverse political constellation. Note first, that only ten out of the 37 referenda were accepted by the Swiss population. The patterns of vote outcomes between German and French-speaking municipalities for all Swiss cantons and for bilingual cantons only are highly comparable with two referenda showing inverse outcomes. In 75% of all analyzed referenda, the French-speaking municipalities show higher support for left-of-center referenda, and lower support for right-of-center referenda,

[17]The 37 selected referenda account for 14% of all federal referenda between 1981 and 2011.

**Table 2** – Federal referenda having influence on taxes

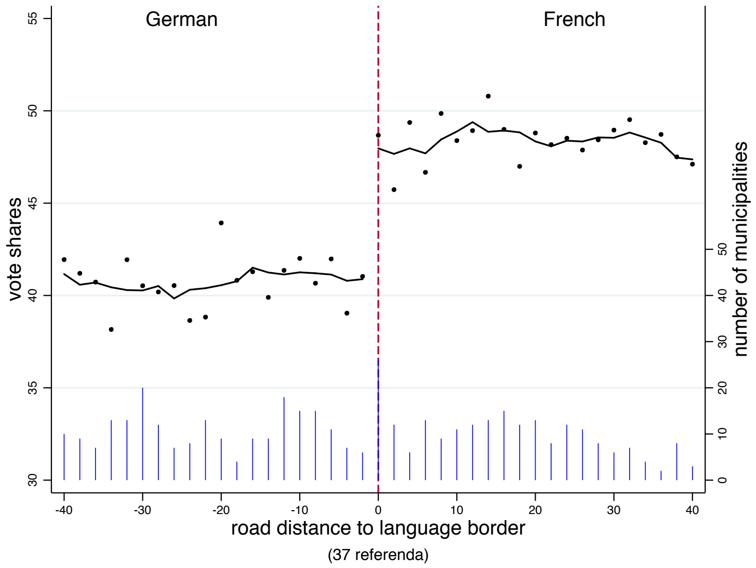
| | | | % "yes" vote | | | | |
|---|---|---|---|---|---|---|---|
| | | | All cantons | | | Bilingual cantons | |
| Referenda ID | Year | Subject | All mun. | German mun. | French mun. | German mun. | French mun. |
| A. Left-of-centre parties recommend "yes" and right-of-centre parties "no" | | | | | | | |
| 323 | 1984 | Maternity insurance | 15.8 | 13.8 | 21.8 | 14.7 | 16.1 |
| 352 | 1988 | Old-age insurance | 35.1 | 31.5 | 43.5 | 27.9 | 38.0 |
| 373 | 1992 | Health insurance | 39.3 | 40.8 | 33.7 | 43.0 | 32.5 |
| 415 | 1994 | Health insurance | 51.8 | 46.7 | 67.7 | 52.5 | 63.3 |
| 416 | 1994 | Health insurance | 23.4 | 20.9 | 31.9 | 24.4 | 26.3 |
| 423 | 1995 | Old-age and disability insurance | 27.6 | 25.6 | 32.3 | 25.2 | 26.9 |
| 444 | 1998 | Old-age insurance | 41.5 | 37.6 | 52.6 | 39.4 | 50.8 |
| 458 | 1999 | Maternity insurance | 39.0 | 31.5 | 65.4 | 34.5 | 59.0 |
| 469 | 2000 | Old-age insurance | 39.5 | 33.5 | 54.9 | 34.9 | 50.8 |
| 470 | 2000 | Old-age insurance | 46.0 | 40.1 | 61.6 | 42.2 | 59.0 |
| 484 | 2001 | Capital gains tax | 34.1 | 33.8 | 36.6 | 40.5 | 35.0 |
| 489.2 | 2002 | Old-age insurance | 46.4 | 46.1 | 47.1 | 49.2 | 42.3 |
| 499 | 2003 | Health insurance | 27.1 | 24.0 | 35.9 | 26.0 | 31.5 |
| 500 | 2003 | Disability rights | 37.7 | 33.8 | 48.7 | 35.9 | 48.0 |
| 503 | 2003 | Education subsidies | 31.6 | 29.2 | 39.2 | 31.1 | 33.1 |
| 508 | 2004 | Old-age and disability insurance | 31.4 | 32.0 | 30.1 | 33.2 | 22.0 |
| 523 | 2006 | Old-age insurance | 41.7 | 39.8 | 45.2 | 41.4 | 39.7 |
| 527 | 2006 | Family subsidies | 68.0 | 65.7 | 73.0 | 72.2 | 71.4 |
| 528 | 2007 | Health insurance | 28.8 | 21.7 | 44.5 | 26.8 | 38.5 |
| 536 | 2008 | Old-age insurance | 41.4 | 37.9 | 49.9 | 38.7 | 48.6 |
| 543 | 2009 | Disability insurance | 54.4 | 51.4 | 62.5 | 53.8 | 62.5 |
| 553 | 2010 | Regulation of tax competition | 41.5 | 40.0 | 46.1 | 46.5 | 40.4 |
| B. Right-of-centre parties recommend "yes" and left-of-centre parties "no" | | | | | | | |
| 328 | 1985 | Education subsidies | 47.6 | 50.3 | 40.1 | 48.0 | 37.8 |
| 398 | 1993 | Unemployment insurance | 70.4 | 70.8 | 69.5 | 70.6 | 70.5 |
| 437 | 1997 | Unemployment insurance | 49.2 | 54.0 | 32.3 | 50.9 | 34.5 |
| 439 | 1998 | State budget balancing | 70.7 | 73.8 | 60.4 | 71.1 | 61.6 |
| 451 | 1999 | Home ownership | 41.3 | 41.7 | 38.9 | 36.7 | 40.0 |
| 457 | 1999 | Disability insurance | 30.3 | 30.0 | 30.9 | 27.9 | 30.0 |
| 480 | 2001 | Debt break | 84.7 | 86.6 | 79.6 | 86.1 | 81.1 |
| 489.1 | 2002 | Old-age insurance | 46.4 | 46.9 | 43.3 | 45.2 | 45.0 |
| 492 | 2002 | Unemployment insurance | 56.1 | 58.4 | 48.3 | 55.6 | 48.0 |
| 507 | 2004 | Old-age insurance | 32.1 | 35.0 | 23.7 | 31.0 | 17.5 |
| 509 | 2004 | Family and property taxation | 34.1 | 35.9 | 28.5 | 27.6 | 19.4 |
| 514 | 2004 | Fiscal transfers | 64.4 | 64.7 | 62.1 | 72.6 | 64.2 |
| 531 | 2008 | Business taxation | 50.5 | 51.4 | 47.2 | 49.5 | 47.9 |
| 534 | 2008 | Health insurance | 30.5 | 37.1 | 12.9 | 33.0 | 18.1 |
| 551 | 2010 | Unemployment insurance | 53.3 | 58.3 | 41.0 | 54.5 | 42.2 |

Note: Federal referenda from 1981 to 2011 having an influence on taxes. Referenda were selected using the official documents by the federal governement, which are distributed to all citizens before the vote. Source: http://www.swissvotes.ch

with a difference in the share of yes votes of 9 percentage points. In the remaining 25%, the outcomes show the inverse pattern, with a lower difference in yes votes of only 4.2 percentage points.

To investigate the pattern of referenda outcomes at the language border in the three bilingual cantons, we construct a preference measure as the average of the share of "yes" votes at the municipal level for referenda in the first group and the share of "no" votes for referenda in the second group. Figure 3 shows this municipality-level preference measure as a function of road distance to the language border. The language border (with distance

**Figure 3** – Support for left-of-center referenda




Note: Vote shares in support for left-of-center referenda in the three bilingual cantons (Berne, Fribourg, and Valais). Support for left-of-center referenda is the average of the share of "yes" for left-of-center votes and the share of "no" for right-of-center votes at municipal level for federal referenda from 1981 to 2011 presented by the Federal Council as involving tax issues (see list in Table 2). Points show average vote shares for distance bandwidths of 2 km. Lines are 10 km moving averages weighted by the number of municipalities. Road distance is negatively coded for German-speaking municipalities and positively for French-speaking municipalities. Road distances from the on-line route planner search.ch.

0) is defined as those French-speaking municipalities that share a common border with a German-speaking municipality. Distance for the remaining municipalities is then defined as road distance to the closest language border municipality. Distance is negatively coded for Swiss-German municipalities. Preferences show strong differences in average levels and a discrete jump of about eight percentage points at the language border. Voters in French-speaking municipalities show significantly stronger support for policies recommended by left-of-center parties.[18] This evidence is stable over time (see Appendix Figure A.1) and in line with the stated preferences summarized in Table 1. Note that a discrete jump in referenda outcomes at the language border is consistent with the mobility of the tax base, provided that the median voter is always immobile. In Section 3, we shall elaborate on this descriptive evidence and provide quantitative estimates of the implied differences in

[18] Note that the mean vote share in favour of left-of-center referenda in German-speaking municipalities in the three bilingual cantons is 42.5%. Therefore, a difference of eight percentage points is sufficient to have different political outcomes if each language region could decide independently.

preferences across the linguistic divide.

An interesting particularity of Switzerland is that inhabitants of municipalities can vote on municipal tax levels, either directly by attending the communal assembly (80% of municipalities) or indirectly through the election of representatives to municipal parliaments (see, e.g., Brülhart and Jametti, 2007, for more details).[19] Because of this possibility to express their preferences through voting, we expect French-speaking municipalities to set higher tax rates than German-speaking ones.

## 2.2 Tax competition: preliminary evidence

The Swiss fiscal system is highly decentralized. The smallest political units are the 2,591 municipalities, with a median population of some 1,000 inhabitants and a maximum of 422,640 (city of Zurich). Municipalities independently manage and finance a number of public services, including schools, social services, energy supplies, and roads. On average, 50% of total municipal revenue come from own tax revenue, while 15% come from fiscal transfers. The remaining revenue is divided between user fees and other income. Among tax revenue, 69% are raised through resident-based income taxation, 9% from wealth taxation, 16% from corporate taxation, and the remaining 6% are composed of property and other taxes.[20]

Municipalities cannot determine their own tax schedules. Rather, cantons decide on the progressivity of the cantonal tax schedule, as well as on exemptions and deductions. Municipalities can then only set a tax multiplier as a scalar shifter on the cantonal tax schedule. This tax multiplier applies to income and wealth taxation. Moreover, corporate taxation in the three bilingual cantons is closely linked to income tax schedules.[21] This implies that municipal tax policy is basically constrained to a single instrument, which in turn allows for perfect comparability within cantons.

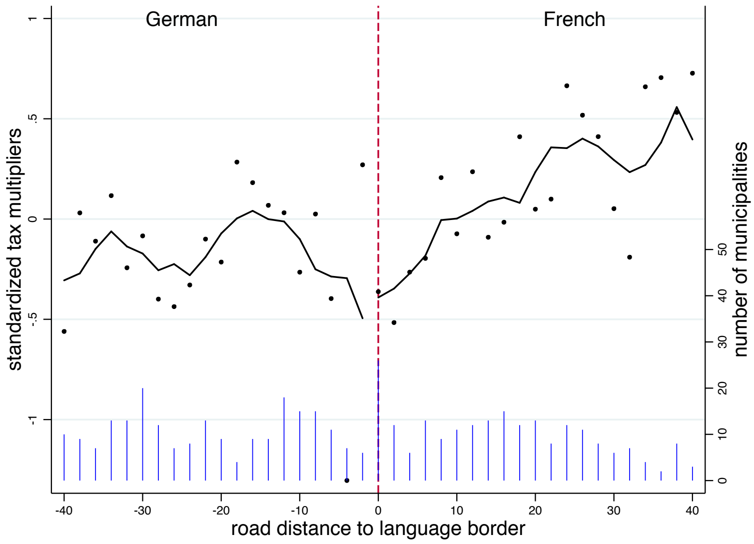
To ensure comparability across the three bilingual cantons, we standardize tax multipli-

[19] In practice, the municipal council suggests its preferred municipal tax level, which is then approved by the inhabitants of the municipality.

[20] Municipalities levy 31% of all income and wealth taxes in Switzerland. This is more than the Confederation (26%) and less than the cantons (43%).

[21] In the canton of Berne, both the income and the corporate tax share the same tax multiplier. In the canton of Fribourg, tax multipliers are not exactly the same but have more than 90% correlation, while in the canton of Valais, the corporate tax multiplier is constant across municipalities.

**Figure 4** – Municipal tax multipliers




Note: Standardized municipal tax multipliers in the three bilingual cantons (Berne, Fribourg and Valais). Tax multipliers are standardized within each canton and year by dividing by their standard deviation and by deducting the mean tax multipliers of German-speaking municipalities. Points show average standardized municipal tax multipliers for distance bandwidths of 2 km. Lines are 10 km moving averages weighted by the number of municipalities. Distance is negatively coded for German-speaking municipalities and positively for French-speaking municipalities. Source: Income tax multipliers from cantonal statistics (1970-2011). Road distances from the on-line route planner search.ch.

ers within each canton and year by dividing by their standard deviation and by deducting the mean tax multipliers of German-speaking municipalities.[22] Figure 4 plots average standardized municipal tax multipliers for the years 1970 to 2011 in the three bilingual cantons over the distance to the language border. Contrary to referendum outcomes, tax multipliers do not jump at the language border.[23] However, French-speaking municipalities located further away from the language border set higher tax rates than their German-speaking counterparts. It is this penomenon that we interpret as a manifestation of tax competition: French-speaking municipalities located at the language border would like to set higher tax rates according to their preferences. However, they are constrained by the threat of mobile residents relocating to low-tax municipalities on the German-speaking

[22]Different standardization procedures are possible. Deducting the overall mean, or including canton fixed effects, would lead to spurious within-region distance trends, as the maximum distance and the number of observations in each language region vary by canton. We avoid this problem by taking German-speaking municipalities as a reference group.

[23]As for preferences, the spatial pattern of tax multipliers is relatively stable over time (see Appendix Figure A.1).

side.

This constellation of measurable differences in preferences and perfectly comparable tax rates at the language border offers a unique setting for the identification of the existence of tax competition and its spatial reach. We shall compare tax differentials among municipalities directly at the language border, where preferences change discontinuously, and among counterfactual municipalities with the same differences in preferences but located further away from the border.

# 3 Econometric analysis

## 3.1 Estimation strategy and descriptive statistics

In line with the difference-in-differences representation suggested in equation (1), we estimate the following model

$$y_{it} = \alpha + \beta \text{ Border}_i + \delta \text{ French}_i + \gamma \text{ Border}_i \times \text{French}_i + \vartheta' \mathbf{X}_{it} + \lambda_t + \varepsilon_{it} \tag{2}$$

where $y_{it}$ represents either standardized tax multipliers or vote shares in support for left-of-center referenda at the municipality level. $Border_i$ is a dummy variable equal to 1 if the municipality $i$ is located at the language border and 0 otherwise, and $French_i$ is a dummy variable equal to 1 if the municipality is located in the French-speaking region and 0 if it is located in the German-speaking region. $\mathbf{X}_{it}$ is a vector of municipality characteristics and $\lambda_t$ is a year fixed effect. The notation for parameters is chosen such as to correspond with Figure 1.

The parameter $\beta$ measures the tax (vote share) differential between border and counterfactual German-speaking municipalities. $\delta$ measures the tax (vote share) differential between French-speaking and German-speaking counterfactual municipalities. A positive and statistically significant coefficient in both regressions, for standardized tax multipliers and for vote shares, identifies the effect of different preferences on tax levels. The coefficient on the interaction term, $\gamma$, represents the difference-in-differences estimate. Under the condition that the difference-in-differences estimate for vote shares is equal to 0, a negative and statistically significant coefficient for municipal tax multipliers shows the existence of tax competition. It represents the reduction in the tax differential $\delta$ due to different preferences when French-speaking and German-speaking municipalities are in tax competition with each other.

This identification strategy requires that municipalities differ only with respect to preferences and distance to the language border. That is, border municipalities would have behaved the same as municipalities in the same region but located further away from the border in a hypothetical situation without mobility across the border. This is the standard "common trend" assumption in difference-in-differences models. The key concern is not that French-speaking and German-speaking municipalities differ in background characteristics, but that these differences vary between border and counterfactual municipalities. To test for this assumption, we present in Table 3 difference-in-differences estimates for a wealth of municipality characteristics, including population size and population characteristics (percentage of foreigners, age structure, education structure, income distribution), economic activity (employment shares by sectors, unemployment rate, economic center, urban area, tourism), and geographic attributes (altitude, area, distance to center, lake shore). To proxy for unobserved attractiveness and strategic importance of municipalities, we use a binary variable for whether a municipality has a castle on its territory and the per-taxpayer wealth tax revenue per municipality in 1940.[24]

Table 3 presents descriptive statistics for taxes, vote shares in Panel A, background characteristics of municipalities in Panel B, and migration-related characteristics in Panel C. Column (1) shows means for all municipalities located within 40 kilometers from the language border. Columns (2)-(3) show differences in means between the French-speaking and the German-speaking regions for municipalities located at the language border and for counterfactual municipalities, respectively. We define municipalities at the language border to be in a bandwidth from 0 to 20 kilometers and counterfactual municipalities from 20 to 40 kilometers. Columns (4)-(5) present differences between border and counterfactual municipalities in the French-speaking and German-speaking region, respectively. Column (6) presents the difference-in-differences estimates for each variable.

Columns (2) and (3) suggest statistically significant differences in vote shares between

[24]The wealth tax was raised by the Federal government in 1940 to finance defense expenditures. As this tax was highly progressive, the per-taxpayer tax revenue indicates the location of very wealthy individuals.

**Table 3** – Descriptive statistics

| | Mean | Difference French-German | | Difference Border - Non-border | | DiD |
|---|---|---|---|---|---|---|
| | | Border | Non-border | French | German | |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| A. Taxes and preferences | | | | | | |
| Standardized tax multipliers | -0.05 | 0.02 | 0.52*** | -0.42*** | 0.08 | -0.50*** |
| Vote shares | 44.53 | 7.20*** | 8.13*** | -0.04 | 0.90 | -0.93 |
| B. Background characteristics | | | | | | |
| Population (in 1,000) | 1.63 | -0.25 | -0.16 | 0.47 | 0.56 | -0.09 |
| % Foreigners | 6.16 | 2.68*** | 2.06*** | 1.73** | 1.10* | 0.63 |
| % Young ($\leq$ 20) | 29.18 | 0.71* | 0.18 | 0.07 | -0.47 | 0.54 |
| % Old ($\geq$ 65) | 13.43 | -0.12 | 0.03 | -0.84** | -0.69* | -0.15 |
| % Primary sector | 17.49 | -0.54 | 1.70 | -5.36*** | -3.12* | -2.24 |
| % Secondary sector | 36.24 | -1.23 | -0.26 | 0.82 | 1.79 | -0.97 |
| % Tertiary sector | 46.27 | 1.77 | -1.44 | 4.55*** | 1.33 | 3.22* |
| Urban area | 0.22 | 0.02 | -0.08* | 0.17*** | 0.07 | 0.10 |
| Center of urban area | 0.02 | 0.01 | -0.00 | 0.02 | 0.00 | 0.02 |
| Distance to center | 11.15 | -1.26* | 0.43 | -2.56*** | -0.87 | -1.69 |
| Tourist destination | 0.02 | 0.03** | 0.01 | 0.00 | -0.02* | 0.03 |
| Lake | 0.16 | -0.05 | 0.04 | 0.10* | 0.19*** | -0.09 |
| Altitude (min) | 0.57 | 0.11*** | 0.05** | 0.00 | -0.05** | 0.06** |
| Altitude (km.a.s.l.) | 0.66 | 0.16*** | 0.08** | -0.00 | -0.08*** | 0.08** |
| Altitude (max) | 1.12 | 0.34*** | 0.28** | -0.23** | -0.30*** | 0.07 |
| Area (km$^2$) | 12.25 | 4.30* | 6.82* | -4.88 | -2.37 | -2.52 |
| Castle | 0.21 | 0.11* | 0.00 | 0.15*** | 0.05 | 0.10 |
| Per-taxpayer wealth tax revenue in 1940 (in 1,000 CHF) | 0.54 | 0.06 | -0.25*** | 0.20*** | -0.10** | 0.31*** |
| C. Migration-related characteristics | | | | | | |
| % Top-1% income | 0.42 | -0.00 | -0.02 | 0.30*** | 0.29** | 0.02 |
| % Bottom-25% income | 27.16 | 1.50 | 0.59 | -2.93** | -3.84*** | 0.90 |
| Gini index | 0.42 | 0.02* | 0.00 | 0.01 | -0.01 | 0.01 |
| % High education (tertiary) | 13.57 | -0.16 | -2.67*** | 3.38*** | 0.87 | 2.51*** |
| % Intermediate education | 85.38 | 0.23 | 2.71*** | -3.28*** | -0.80 | -2.48*** |
| % No education | 1.04 | -0.07 | -0.04 | -0.10 | -0.07 | -0.03 |
| Unemployment rate | 1.37 | 0.28*** | 0.27*** | 0.11 | 0.10 | 0.01 |
| No. French-speaking municipalities | 208 | 129 | 79 | | | 208 |
| No. German-speaking municipalities | 212 | 97 | 115 | | | 212 |
| No. border municipalities | 226 | | | 129 | 97 | 226 |
| No. non-border municipalities | 194 | | | 79 | 115 | 194 |

Note: *** p<0.01, ** p<0.05, * p<0.10. Standard errors are clustered two-ways, by municipality and by year. The top percentile includes all taxpayers with a gross annual income over CHF 320,000 in 2008 and CHF 237,000 in 1995. The bottom quartile includes all taxpayers with a gross annual income below CHF 25,000. Income shares and Gini index computed at municipality level using the Federal Income Tax statistics for 1995 to 2008. Data available for fiscal years 1995/1996, 1997/1998, 1999/2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008. No data for Valais in 2001, 2002. Source: Swiss Federal Tax Administration, Bern. Urban area, center of urban area, tourist destination, lake are binary variables. Source: Swiss Federal Statistical Office. Castle is a binary variable. Source: www.swisscastles.ch. War wealth tax data in 1940 from *Eidgenössisches Wehropfer 1940*, Swiss Federal Statistical Office. Other data from Swiss Federal Census (1970, 1980, 1990, 2000). Source: Swiss Federal Statistical Office.

the language regions with a similar coefficient for border and counterfactual municipalities. In contrast, the tax differential is statistically significant only for counterfactual municipalities. Columns (4) and (5) show no within-region differentials in vote shares and tax multipliers in the German-speaking region, but statistically significantly lower taxes of French-speaking border municipalities. Accordingly, difference-in-differences estimates in column (6) are negative and statistically significant for tax multipliers but not statistically different from zero for vote shares. This corresponds with our priors and is consistent with tax competition. However, there could be confounding differences in background characteristics. Yet, difference-in-differences estimates for background characteristics from Panel B are rarely statistically significant, and are economically relevant only for the initial location of wealthy individuals. These differences can nevertheless be controlled for in the regressions. Difference-in-differences estimates of education variables in Panel C are also statistically significant, but this can reflect an equilibrium outcome of tax-induced mobility of the tax base. Controlling for these potentially endogenous migration-related characteristics implies a trade-off between controlling for endogenous covariates and possible omitted variable bias.

## 3.2 Regression results

### 3.2.1 The existence of tax competition: difference-in-differences

Table 4 presents our main results for the identification of the existence of tax competition. The first line shows difference-in-differences estimates for standardized tax multipliers and vote shares, sequentially introducing exogenous and migration-related background characteristics. Difference-in-differences estimates are very robust. Hence, we concentrate on the specifications including only exogenous background characteristics, with columns (2) and (5) as our preferred specifications.

Estimates of $\delta$ presented in the third line show that French-speaking counterfactual municipalities set 0.4 standard deviation higher tax rates than their German-speaking counterparts. This has to be compared with a 8 percentage points difference in vote shares and reflects the effect of different preferences on tax levels.[25] The difference-in-

[25]This difference in taxes is also economically relevant. To illustrate this, we can compute the tax liability

**Table 4** – The existence of tax competition: differences-in-differences

| | Tax rates | | | Vote shares | | | Tax rates | | |
|---|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| Border*French ($\hat{\gamma}$) | -0.503*** | -0.417*** | -0.404*** | -0.931 | -1.104 | -1.150 | -0.480*** | -0.380*** | -0.383*** |
| | (0.163) | (0.143) | (0.128) | (0.866) | (0.714) | (0.731) | (0.162) | (0.143) | (0.127) |
| Border mun. ($\hat{\beta}$) | 0.082 | 0.241** | 0.325*** | 0.896 | 0.797* | 0.918** | 0.060 | 0.214** | 0.309*** |
| | (0.123) | (0.103) | (0.096) | (0.612) | (0.420) | (0.416) | (0.122) | (0.101) | (0.094) |
| French-speaking mun. ($\hat{\delta}$) | 0.519*** | 0.420*** | 0.407*** | 8.134*** | 7.999*** | 7.934*** | 0.315** | 0.155 | 0.265** |
| | (0.125) | (0.109) | (0.105) | (0.685) | (0.577) | (0.578) | (0.149) | (0.142) | (0.131) |
| Vote shares for left-of-center ref. | | | | | | | 0.025** | 0.033*** | 0.018* |
| | | | | | | | (0.013) | (0.013) | (0.011) |
| Population | | 0.015 | 0.004 | | 0.252*** | 0.210*** | | 0.006 | 0.000 |
| | | (0.010) | (0.009) | | (0.055) | (0.058) | | (0.010) | (0.010) |
| % Foreigners | | -0.029*** | -0.027*** | | -0.088** | -0.106** | | -0.026*** | -0.025*** |
| | | (0.007) | (0.007) | | (0.044) | (0.048) | | (0.008) | (0.008) |
| % Young ($\leq$ 20) | | 0.046*** | 0.043*** | | -0.016 | -0.026 | | 0.046*** | 0.043*** |
| | | (0.009) | (0.008) | | (0.058) | (0.055) | | (0.009) | (0.008) |
| % Old ($\geq$ 65) | | 0.043*** | 0.033*** | | -0.023 | -0.042 | | 0.044*** | 0.033*** |
| | | (0.011) | (0.008) | | (0.056) | (0.048) | | (0.010) | (0.008) |
| % Secondary sector | | -0.005 | -0.009*** | | 0.185*** | 0.169*** | | -0.011*** | -0.012*** |
| | | (0.004) | (0.003) | | (0.022) | (0.022) | | (0.004) | (0.003) |
| % Tertiary sector | | -0.008* | -0.002 | | 0.064*** | 0.075*** | | -0.010** | -0.004 |
| | | (0.005) | (0.004) | | (0.023) | (0.024) | | (0.005) | (0.004) |
| Urban area | | -0.203** | -0.050 | | 0.303 | 0.561 | | -0.213*** | -0.060 |
| | | (0.080) | (0.079) | | (0.403) | (0.395) | | (0.079) | (0.078) |
| Center of urban area | | -0.052 | -0.067 | | -0.186 | -0.004 | | -0.046 | -0.067 |
| | | (0.292) | (0.258) | | (1.927) | (1.969) | | (0.294) | (0.258) |
| Distance to center | | 0.006 | 0.007 | | 0.027 | 0.030 | | 0.005 | 0.006 |
| | | (0.007) | (0.007) | | (0.041) | (0.041) | | (0.007) | (0.007) |
| Tourist destination | | 0.016 | 0.028 | | -1.271 | -0.545 | | 0.058 | 0.037 |
| | | (0.208) | (0.188) | | (1.426) | (1.419) | | (0.202) | (0.185) |
| Lake | | -0.232** | -0.090 | | -0.522 | -0.164 | | -0.215** | -0.087 |
| | | (0.102) | (0.082) | | (0.454) | (0.423) | | (0.096) | (0.082) |
| Altitude (min) | | 0.146 | -0.009 | | 5.589** | 4.193 | | -0.040 | -0.084 |
| | | (0.473) | (0.466) | | (2.700) | (2.912) | | (0.474) | (0.462) |
| Altitude | | 0.721*** | 0.722** | | 2.586 | 4.135* | | 0.636** | 0.648** |
| | | (0.274) | (0.295) | | (2.031) | (2.406) | | (0.266) | (0.287) |
| Altitude (max) | | -0.134** | -0.174*** | | 0.068 | 0.191 | | -0.136** | -0.177*** |
| | | (0.054) | (0.065) | | (0.304) | (0.389) | | (0.053) | (0.064) |
| Area (km$^2$) | | 0.003* | 0.002* | | -0.039*** | -0.040*** | | 0.004*** | 0.003** |
| | | (0.002) | (0.001) | | (0.009) | (0.009) | | (0.002) | (0.001) |
| Castle | | -0.024 | 0.042 | | -0.069 | -0.043 | | -0.022 | 0.042 |
| | | (0.085) | (0.061) | | (0.398) | (0.380) | | (0.081) | (0.060) |
| Per-taxpayer wealth tax revenue in 1940 | | -0.338*** | -0.105** | | -1.286*** | -0.719* | | -0.296*** | -0.092* |
| | | (0.059) | (0.048) | | (0.386) | (0.392) | | (0.055) | (0.049) |
| % Top-1% income | | | -0.191** | | | -0.745 | | | -0.178** |
| | | | (0.075) | | | (0.514) | | | (0.074) |
| % Bottom-25% income | | | 0.019** | | | -0.061 | | | 0.020** |
| | | | (0.009) | | | (0.066) | | | (0.010) |
| Gini index | | | -3.140** | | | -2.664 | | | -3.093** |
| | | | (1.273) | | | (9.465) | | | (1.279) |
| % High education (tertiary) | | | 0.006 | | | -0.347*** | | | 0.012 |
| | | | (0.023) | | | (0.120) | | | (0.023) |
| % Intermediate education | | | 0.037 | | | -0.295** | | | 0.042* |
| | | | (0.023) | | | (0.117) | | | (0.023) |
| Unemployment rate | | | 0.020 | | | 0.268** | | | 0.015 |
| | | | (0.022) | | | (0.113) | | | (0.022) |

Note: Standard errors in parentheses. $^{***}$ p<0.01, $^{**}$p<0.05, $^{*}$p<0.10. Dependent variables are standardized tax multipliers and vote shares in support for left-of-center referenda. 42 years of observations (1970-2011) in 208 French-speaking municipalities and 212 German-speaking municipalities for a total of 17,640 observations. Standard errors are clustered two-ways, by municipality and by year.

differences estimates in the first line show that this tax differential is reduced to zero at the language border, without a corresponding reduction in vote share differentials.[26] This identifies the existence of tax competition. It represents the sum of reactions by French-speaking and German-speaking municipalities when in tax competition with each other. Estimates of $\beta$ in the second line indicate that half of the effect is driven by German-speaking municipalities setting higher taxes at the language border. Note that their increase in tax rates coincides with a slight increase in vote shares. Therefore, in Columns (7)-(9), we present results for tax rates controlling for vote shares. Estimates for $\beta$ and $\gamma$ are only slightly lower and the general pattern persists.

Coefficients on controls behave as expected. In particular, a higher share of young and elderly individuals, and a higher altitude are associated with higher tax rates. Conversely, urban areas, municipalities with a high share of foreigners, as well as municipalities with a lake shore and favorable initial wealth conditions set lower tax rates. Finally, in column (3), we can observe that top-1% income taxpayers locate in low-tax municipalities, which is consistent with a tax competition equilibrium.

So far, we have somewhat arbitrarily assumed border municipalities to be within 20 kilometers from the language border. We now relax this assumption. Table 5 presents the tax differential between French-speaking and German-speaking municipalities for different distance bandwidths. Panel A of Table 5 adopts the same distance bandwidth of 20 kilometers as Table 4 and results are perfectly comparable, where the first difference estimates $\gamma + \delta$ and the second estimates $\delta$. Panel B shows the results for bandwidths of 15 kilometers. Differences in vote shares are very stable, while differences in taxes indicate a smooth spatial gradient. Reducing bandwidths further to 10 kilometers, the general pattern is confirmed, that is, the tax differential is smaller for municipalities located closer to the language border.

Table 5 provides a first approximation of the spatial reach of tax competition. All

for a representative taxpayer, who is married and has a gross annual income of CHF 80,000 ($ 73,000), in the three bilingual cantons for the year 2009. Our estimates suggest that French-speaking taxpayers are willing to accept a 2.5% higher total annual tax liability (or about CHF 200).

[26]Note that if mobility costs were higher when moving to the other language region (because of cultural and language differences) than within the same region, we would expect a higher tax differential at the language border than with equal mobility costs everywhere. Finding no differential at the language border reinforce our result on the existence of tax competition.

**Table 5** − French-German differentials for alternative distance bandwidths

| | Taxe rates | | Vote shares | |
|---|---|---|---|---|
| | No controls (1) | With controls (2) | No controls | With controls |
| | Panel A : Bandwidth of 20 km | | | |
| 0-20 km | 0.016 | -0.005 | 7.203*** | 7.733*** |
| | (0.109) | (0.100) | (0.531) | (0.461) |
| No. of observations | 9,492 | 9,492 | 9,492 | 9,492 |
| No. of French municipalities | 129 | 129 | 129 | 129 |
| No. of German municipalities | 97 | 97 | 97 | 97 |
| 21-40 km | 0.519*** | 0.417*** | 8.134*** | 7.686*** |
| | (0.126) | (0.113) | (0.687) | (0.655) |
| No. of observations | 8,148 | 8,148 | 8,148 | 8,148 |
| No. of French municipalities | 79 | 79 | 79 | 79 |
| No. of German municipalities | 115 | 115 | 115 | 115 |
| | Panel B : Bandwidth of 15 km | | | |
| 0-15 km | 0.008 | 0.011 | 7.226*** | 7.901*** |
| | (0.125) | (0.109) | (0.600) | (0.505) |
| No. of observations | 7,392 | 7,392 | 7,392 | 7,392 |
| No. of French municipalities | 95 | 95 | 95 | 95 |
| No. of German municipalities | 81 | 81 | 81 | 81 |
| 16-30 km | 0.449*** | 0.391*** | 8.029*** | 7.295*** |
| | (0.128) | (0.114) | (0.790) | (0.696) |
| No. of observations | 6,720 | 6,720 | 6,720 | 6,720 |
| No. of French municipalities | 86 | 86 | 86 | 86 |
| No. of German municipalities | 74 | 74 | 74 | 74 |
| 31-45 km | 0.485*** | 0.346*** | 7.497*** | 8.295*** |
| | (0.179) | (0.133) | (0.791) | (0.670) |
| No. of observations | 4,746 | 4,746 | 4,746 | 4,746 |
| No. of French municipalities | 33 | 33 | 33 | 33 |
| No. of German municipalities | 80 | 80 | 80 | 80 |
| | Panel C : Bandwidth of 10 km | | | |
| 0-10 km | 0.042 | 0.062 | 7.204*** | 7.369*** |
| | (0.171) | (0.137) | (0.809) | (0.587) |
| No. of observations | 4,830 | 4,830 | 4,830 | 4,830 |
| No. of French municipalities | 66 | 66 | 66 | 66 |
| No. of German municipalities | 49 | 49 | 49 | 49 |
| 11-20 km | -0.006 | -0.140 | 7.213*** | 7.896*** |
| | (0.127) | (0.128) | (0.680) | (0.652) |
| No. of observations | 4,662 | 4,662 | 4,662 | 4,662 |
| No. of French municipalities | 63 | 63 | 63 | 63 |
| No. of German municipalities | 48 | 48 | 48 | 48 |
| 21-30 km | 0.660*** | 0.620*** | 8.283*** | 7.696*** |
| | (0.155) | (0.134) | (1.009) | (1.024) |
| No. of observations | 4,620 | 4,620 | 4,620 | 4,620 |
| No. of French municipalities | 52 | 52 | 52 | 52 |
| No. of German municipalities | 58 | 58 | 58 | 58 |
| 31-40 km | 0.350* | 0.101 | 8.034*** | 9.395*** |
| | (0.198) | (0.147) | (0.893) | (0.837) |
| No. of observations | 3,528 | 3,528 | 3,528 | 3,528 |
| No. of French municipalities | 27 | 27 | 27 | 27 |
| No. of German municipalities | 57 | 57 | 57 | 57 |

Note: Standard errors in parentheses. *** p<0.01, **p<0.05, *p<0.10. Dependent variables are standardized tax multipliers and vote shares in support for left-of-center referenda. Controls in Columns (2) and (4) include all background characteristics from panel B in Table 3. 42 years of observations (1970-2011). Standard errors are clustered two-ways, by municipality and by year.

panels suggest a stronger constraint from tax competition for municipalities located closer to the language border. If we define the spatial reach of tax competition as the distance up to which tax differentials between the French-speaking and the German-speaking region are not statistically significantly different from zero, our results indicate a spatial reach of tax competition between 15 and 20 kilometers. This measure indicates the maximum distance where tax competition offsets tax differentials due to different preferences ($\gamma + \delta = 0$).

**Table 6** – Tax gradients and the spatial reach of tax competition

| | Tax rates | | | |
|---|---|---|---|---|
| | No controls | | With controls | |
| | (1) | (2) | (3) | (4) |
| French-speaking municipalities | -0.141 | -0.071 | -0.050 | 0.016 |
| | (0.162) | (0.291) | (0.140) | (0.241) |
| Distance to border: French-speaking municipalities | 0.024*** | 0.039*** | 0.009** | 0.005 |
| | (0.005) | (0.013) | (0.004) | (0.012) |
| Distance to border$^2$: French-speaking municipalities | | -0.000 | | 0.000 |
| | | (0.000) | | (0.000) |
| Distance to border: German-speaking municipalities | 0.002 | 0.021 | -0.005 | 0.002 |
| | (0.006) | (0.028) | (0.005) | (0.023) |
| Distance to border$^2$: German-speaking municipalities | | -0.000 | | -0.000 |
| | | (0.001) | | (0.001) |
| Joint significance test of coefficients on distance (p-value): | | | | |
| French | | 0.000 | | 0.093 |
| German | | 0.747 | | 0.510 |
| Implied maximum distance at which marginal effect of distance $\neq 0$: | | | | |
| French | | 25 | | n/a |
| German | | 0 | | 0 |

Note: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.10. Dependent variables are standardized tax multipliers. Controls in Columns (2) and (4) include all background characteristics from panel B in Table 3. Distance to border is road distance in kilometer. It is positively coded for German-speaking and French-speaking municipalities. Implied distances computed for a 99% confidence interval. 42 years of observations (1970-2011) in 208 French-speaking municipalities and 212 German-speaking municipalities for a total of 17,640 observations. Standard errors are clustered two-ways, by municipality and by year.

Interestingly, Panel B and C also suggest that tax differentials increase with distance up to a certain distance. This suggests another measure for the spatial reach of tax competition that we investigate further in the next subsection.

### 3.2.2 Tax gradients and the spatial reach of tax competition

Table 6 explores distance trends in tax rates in both language regions. Columns (1) and (3) include distance from the language border linearly. Results are robust to the inclusion of background characteristics. Estimates show no jump in tax rates at the language border, and, as opposed to estimates in Table 4, no statistically significant distance trend in the German-speaking region. As expected, however, the distance trend in the French-speaking region is positive and statistically significant.

Columns (2) and (4) include quadratic distance trends. The joint significance tests of coefficients on distance again indicate a statistically significant distance trend for the French-speaking region only. Quadratic distance trends provide another measure for the spatial reach of tax competition. That is to search, for each language region, the distance up to which municipalities take into account tax rates of the other language region by setting a different tax rate than if they were in competition only with municipalities of their own language region. It can be estimated by the maximum distance up to which the marginal effect of distance is statistically significantly different from zero. In Column (2), this measure indicates a spatial reach of 25 kilometers in the French-speaking region, while in Column (3) this measure is not applicable because of non-concavity of the distance trend. The marginal effect in the German-speaking region is on the contrary nowhere statistically significant.

# 4 Discussion

## 4.1 Moving and commuting

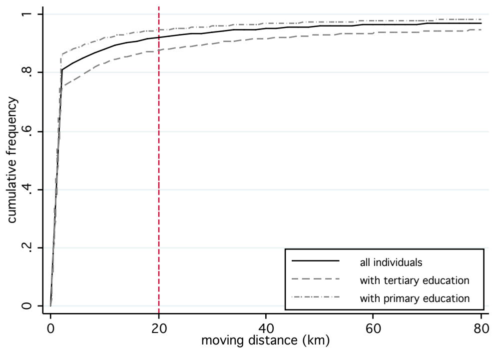
Mobility of taxpayers is a prerequisite for the existence of resource-flow income tax competition. Using individual data of the 2000 Federal Population Census covering all Swiss residents, we first investigate moving behavior in our three bilingual sample cantons. For each individual older than 15, we compute the road distance between their municipality of residence in 2000 and that of 1995. Figure 5(a) plots the cumulative frequency of moving distances for all individuals and for individuals with tertiary and primary education. Some 80% of all individuals have either not moved, or moved only within their municipality of residence. Figure 5(b) presents the cumulative frequency of moving distances conditional on moving. About half of the movers stay within a radius of 20 kilometers of their former municipality of residence.

The willingness to commute is another important determinant of the existence of tax competition and its spatial reach. Recall that municipalities in Switzerland, when setting their tax multipliers, cannot target a specific income group but compete mostly for a heterogeneous pool of individuals choosing where to reside around a central labor market. Figure 5(c) plots the cumulative frequency of commuting distances for all employed individuals and for individuals with tertiary and primary education. More than 80% of all individuals reside within a radius of 20 kilometers from their workplace. This prevalence of mostly local mobility is consistent with our interpretation of the results in terms of resource-flow tax competition and with our measure of its spatial reach of some 20 kilometers.

It is worth to note that individuals with higher education levels have a higher propensity

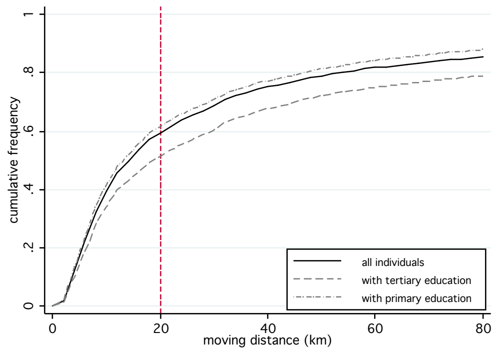
**Figure 5** – Cumulative frequencies of distance of commuting and moving

Distance of moving
(across municipalities, all individuals)



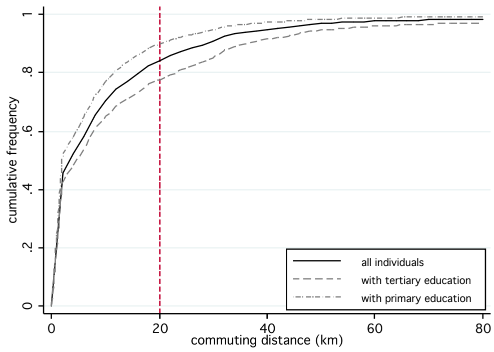

(a)

Distance of moving
(across municipalities, conditional on moving)




(b)

Distance of commuting
(within and across municipalities)




(c)

Note: Figure 5(a) and (b): Road distance between the residence municipality in 1995 and 2000 for all individuals older than 15 residing in one of the three bilingual cantons in 2000. Figure 5(c): Road distance of commuting for all individuals residing in one of the three bilingual cantons and working in Switzerland. Source: Federal Population Census 2000. Swiss Federal Statistical Office. Road distances from the on-line route planner search.ch.

to move, move on average over larger distances, and do also commute over larger distances. This is in line with the theoretical model that assumed higher mobility of more productive individuals.

## 4.2 Location of top-income taxpayers in equilibrium

Our setting identifies the equilibrium outcome of tax competition. In this equilibrium, French-speaking municipalities, in line with their culture-specific preferences, set higher tax rates than German-speaking municipalities. However, French-speaking municipalities

**Table 7** – Top 1% income taxpayers: difference-in-differences

| | **Share of top-1% income** | |
|---|---|---|
| | No controls | With controls |
| | (1) | (2) |
| Border*French | 0.021 | -0.170 |
| | (0.131) | (0.139) |
| Border municipalities | 0.286** | 0.249*** |
| | (0.112) | (0.090) |
| French-speaking municipalities | -0.025 | 0.114** |
| | (0.043) | (0.054) |

Note: Standard errors in parentheses. *** p<0.01, **p<0.05, *p<0.10. Dependent variables are shares of top-1% income taxpayers. The top-1% income is calculated using individual tax data covering all taxpayers in Switzerland from 1995 to 2008. Data available for fiscal years 1995/1996, 1997/1998, 1999/2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008. No data for Valais in 2001, 2002. Controls in Column (2) include all background characteristics from panel B in Table 3. There are 208 French-speaking municipalities and 212 German-speaking municipalities for a total of 4,476 observations. Standard errors are clustered two-ways, by municipality and by year.

at the language border are constrained by the presence of low-preference low-tax German-speaking municipalities to lower their tax rate. If top-income individuals are mobile and tend to locate in low-tax municipalities, we expect, in equilibrium, to observe a higher share of top-income individuals in French-speaking border municipalities compared to counterfactual French-speaking municipalities.

To investigate the location of top-income individuals, we repeat in Table 7 the difference-in-differences analysis for the share of top-1% income taxpayers. The top-1% income is calculated yearly using individual tax data covering the full population of taxpayers in Switzerland from 1995 to 2008. It corresponds to a gross annual income of CHF 237,000 in 1995 and CHF 320,000 in 2008.[27]

Results indicate that both German-speaking and French-speaking municipalities have a higher share of top-income taxpayers than counterfactual municipalities in their respective regions.[28] As suggested by the third line, there is no differential in the share of top-income taxpayers between French-speaking and German-speaking counterfactual municipalities as long as no controls are included. With controls, it appears that French-speaking counterfactual municipalities have a higher share of top-income taxpayers than their German-speaking counterpart. This difference appears as soon as we control for the

[27]In our sample, the maximum share of top-1% income taxpayers at the municipal level is 12%.

[28]The second line in Table 7 shows that German-speaking municipalities at the language border have a statistically significantly higher share of top-income taxpayers than German-speaking counterfactual municipalities. The difference-in-differences estimates presented in the first line indicate that this difference is the same in the French-speaking region.

location of wealthy individuals in 1940.[29] Note that the higher share of top-income taxpayers at border municipalities is not explained by previous location of wealthy individuals. Results of Table 7 are consistent with top-income taxpayers moving from high-tax to low-tax municipalities along with increasing mobility costs by distance and French-speaking counterfactual municipalities attracting top-income taxpayers from further away.

### 4.3 Yardstick competition

In a yardstick competition setting, voters evaluate the efficiency of their government by comparing the supply of publicly provided goods relative to the taxes paid in their jurisdiction against that ratio in neighboring jurisdictions (for recent applications, see, e.g., Geys, 2006; Revelli and Tovmo, 2007). Rent-seeking politicians are then disciplined by the threat of non re-election if they manage their jurisdiction less efficient than do their neighbors. Because of these information spillovers across jurisdictions in a model of yardstick competition, the ratio between the supply of publicly provided goods relative to the taxes paid, and thus potentially also local tax rates, are spatially correlated in equilibrium, even if there is no mobility of the tax base. This could offer an alternative explanation for our findings to that based on resource-flow tax competition.

To test the yardstick competition argument, we have collected data on financial ratings of municipalities in the three bilingual cantons, where municipalities are ranked on a scale from C to Aaa.[30] These ratings, when purged from municipality background characteristics, can be used as a proxy for the efficiency of municipal governments. Since debt levels of Swiss municipalities as well as financial equalization payments are relatively low, financial ratings yield important information on the relative level of expenditures to public goods provided and on the efficiency of the management of the municipality.[31]

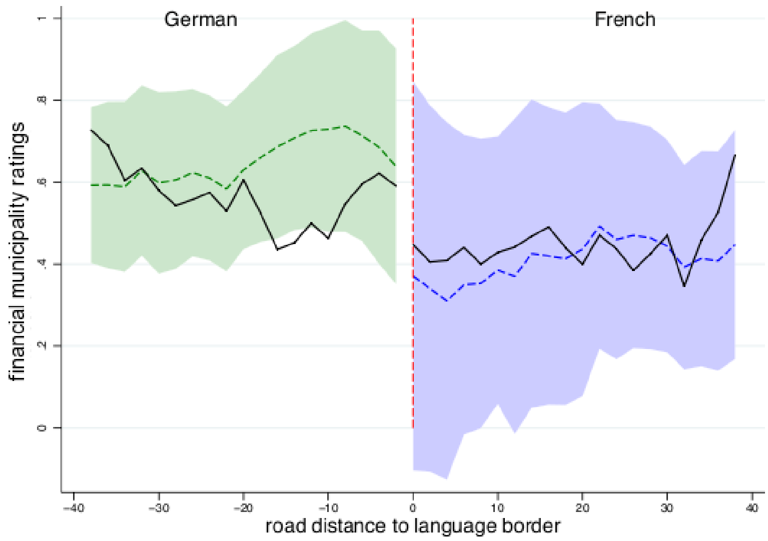
In Figure 6, we use counterfactual municipalities of one language region to predict

[29]Per capita war wealth tax revenue in 1940 is a strong predictor of the current share of top-income taxpayers (point estimate equals 0.45 with a $p$-value of 0.00). When per capita war wealth tax revenue in 1940 is not included in controls, the coefficient on French-speaking municipalities is no longer statistically significant (point estimate equals to 0.00 with a $p$-value of 0.99). Results available upon request.

[30]Financial ratings are elaborated by fedafin AG, a private Swiss firm specialized in financial ratings of public entities.

[31]The ratings provide information on a composite of factors that influence the probability of bankruptcy of a municipality. Different risk and support factors - evaluated ex post - as well as the institutional framework and systematic support factors - evaluated ex ante - enter the ratings.

**Figure 6** – Predicted and actual financial ratings




Note: Lines are 10 km moving averages of financial ratings weighted by the number of observations. The financial rating variable is a dummy for a rating better than the median. The dashed line in the French-speaking region represents predicted financial ratings on the base of the common support regression including only French-speaking municipalities located between 20 and 40 kilometers. The dashed line in the German-speaking region represents predicted financial ratings estimated using German-speaking municipalities located between -40 and -20 kilometers. Shaded areas are 90% confidence intervals. Distance is negatively coded for German-speaking municipalities and positively for French-speaking municipalities. Source: Financial ratings of municipalities of the cantons of Berne, Fribourg, and Valais for the year 2009 from fedafin AG. Road distances from the on-line route planner search.ch.

financial ratings that would have been predicted for border municipalities within the same language region if there were no difference in preferences and only intraregional strategic interaction. Financial ratings have been transformed into a dummy variable and 1 denotes financial ratings better than the median (Aa+, the second of 16 ranks). This figure suggests that German-speaking municipalities are more efficiently run than the French-speaking ones. Furthermore, there is no clear spatial trend within the language regions. With yardstick competition, we would expect the French-speaking municipalities at the language border to have better ratings than those further away from the language border. Thus, yardstick competition seems not to be the cause of the convergence of tax rates at the language border.

# 5 Conclusions

We propose a difference-in-differences approach to identify the existence of tax competition by exploiting systematic and measurable differences in preferences among spatially proximate local jurisdictions within the same institutional setting.

We develop a stylized tax competition model allowing for different preferences for a public good in neighboring jurisdictions and deduce from it our identification of tax competition. Applying this identification strategy to the Swiss language border, we first show that preferences approximated by referenda outcomes differ persistently, discretely and statistically significantly between the French and the German-speaking regions of the three bilingual cantons. Second, we investigate the effect of preference differentials on local tax rates. We find an economically and statistically significant effect of culture-related preferences on taxes: an 8 percentage points higher support for left-of-center referenda is associated with about 0.4 standard deviation higher tax rates. Third, we identify tax competition with a difference-in-differences approach by comparing the tax differential of municipalities located directly at the language border with the tax differential of counterfactual municipalities located further away from the language border. Border municipalities are found to have the same differences in preferences as non-border municipalities, but the tax differential at the language border is zero. This identifies the existence of tax competition.

Repeating the analysis across different distance bandwidths and estimating tax gradients, we propose two measures for the spatial reach of tax competition. We find that tax competition exerts its pressure between 15 and a maximum of 25 kilometers. This is consistent with general moving and commuting patterns in Switzerland.

Note that municipalities in Switzerland are restricted to one single tax instrument that affects all elements of the tax base equally. Our results may thus be interpreted as a lower bound on the spatial reach of tax competition as municipalities are not allowed to target high-income taxpayers specifically. The link between the range of available tax instruments and the spatial reach of tax competition would appear to be a fruitful object of future empirical examination.

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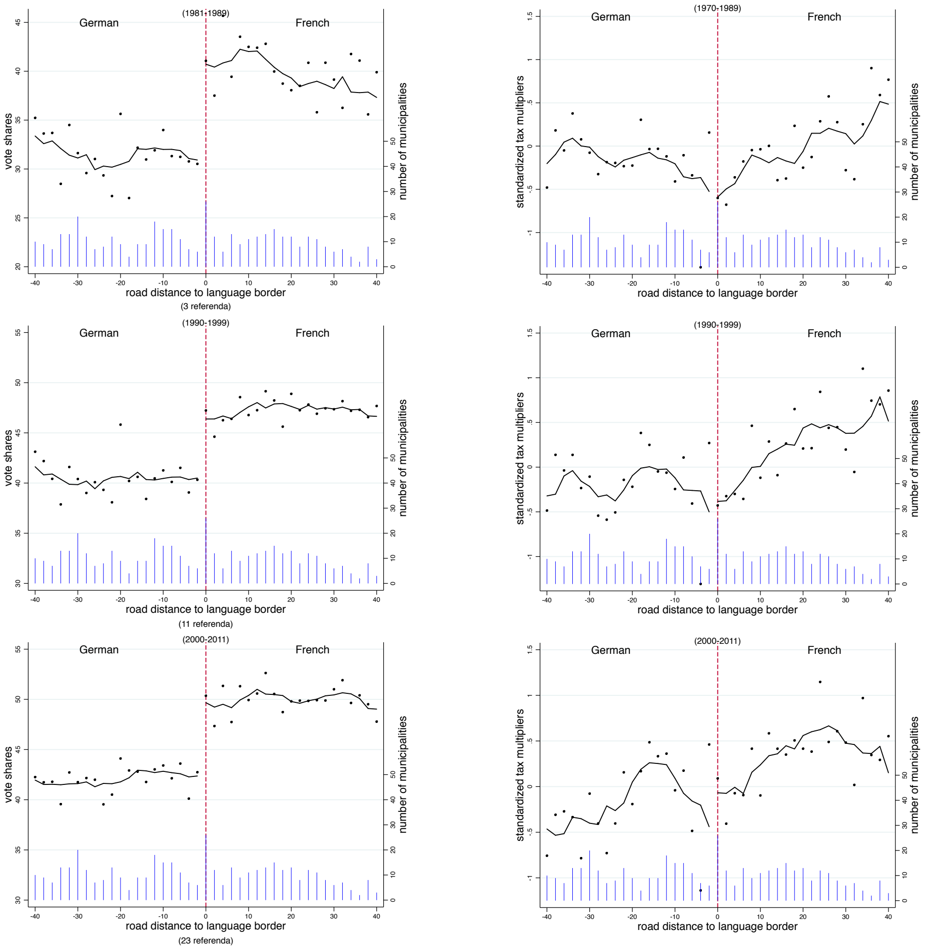
# Appendix

## A Supplementary Figures

**Figure A.1** – Support for left-of-center referenda and tax multipliers for different time spans

Support for left-of-center referenda | Tax multipliers




Note: Vote shares in support for left-of-center referenda in the three bilingual cantons (Berne, Fribourg, and Valais). Support for left-of-center referenda is the average of the share of "yes" for left-of-center votes and the share of "no" for right-of-center votes at municipal level for federal referenda from 1981 to 2011 presented by the Federal Council as involving tax issues (see list in Table 2). Points show average vote shares for distance bandwidths of 2 km. Lines are 10 km moving averages weighted by the number of municipalities. Road distance is negatively coded for German-speaking municipalities and positively for French-speaking municipalities. Road distances from the on-line route planner search.ch.

Note: tandardized municipal tax multipliers in the three bilingual cantons (Berne, Fribourg and Valais). Tax multipliers are standardized within each canton and year by dividing by their standard deviation and by deducting the mean tax multipliers of German-speaking municipalities. Points show average standardized municipal tax multipliers for distance bandwidths of 2 km. Lines are 10 km moving averages weighted by the number of municipalities. Distance is negatively coded for German-speaking municipalities and positively for French-speaking municipalities. Source: Income tax multipliers from cantonal statistics (1970-2011). Road distances from the on-line route planner search.ch.

# Web Appendix (not for publication)

# W Model

## W.1 Baseline model

We solve the baseline model presented in Section 1. Mobile and immobile workers born in region $A$ have the following utility functions, respectively:

$$U_A^m = w(1-t_i) \quad ,$$

$$U_A^{im} = (1-t_A)^{1-\rho_A}\,(G(t_A,n_A))^{\rho_A} \quad ,$$

with $G(t_A,n_A) = t_A \times w \times n_A$ and $\rho_A \in [0,1]$.

Mobile workers take tax rates as given and choose where to live depending on their specific mobility cost. In equilibrium, the fraction of movers in each region is given by

$$\frac{c_A^*}{\bar{c}} = \frac{w(t_A-t_B)}{\bar{c}} \in [0,1] \quad ,$$
$$\frac{c_B^*}{\bar{c}} = \frac{w(t_B-t_A)}{\bar{c}} \in [0,1] \quad ,$$

such that the number of mobile workers in region $A$ is

$$n_A^* = x\left(1+\frac{w(t_B-t_A)}{\bar{c}}\right) \in [0,2x] \quad .$$

The maximization problem of the representative immobile worker in region $A$ is

$$\max_{t_A} \quad (1-t_A)^{1-\rho_A}\left(t_A \times w \times x\left(1+\frac{w(t_B-t_A)}{\bar{c}}\right)\right)^{\rho_A} \quad .$$

The first order condition is:

$$\begin{aligned}
(1-\rho_A)(1-t_A)^{-\rho_A}\left(t_A \times w \times x\left(1+\frac{w}{\bar{c}}(t_B-t_A)\right)\right)^{\rho_A} &= (1-t_A)^{(1-\rho_A)}\rho_A\left(t_A \times w \times x\left(1+\frac{w}{\bar{c}}(t_B-t_A)\right)\right)^{\rho_A-1} \\
&\quad w \times x\left(1+\frac{w}{\bar{c}}(t_B-2t_A)\right) \\
(1-\rho_A)t_A \times w \times x\left(1+\frac{w}{\bar{c}}(t_B-t_A)\right) &= (1-t_A)\rho_A \times w \times x\left(1+\frac{w}{\bar{c}}(t_B-2t_A)\right) \\
\left(1+\frac{w}{\bar{c}}t_B\right)((1-\rho_A)t_A-(1-t_A)\rho_A) &= \frac{w}{\bar{c}}\left((1-\rho_A)t_A^2-(1-t_A)\rho_A 2t_A\right)
\end{aligned}$$

$$\left(\frac{\bar{c}}{w}+t_B\right)(t_A-\rho_A) = t_A^2(1+\rho_A)-2\rho_A t_A$$
$$t_A^2(1-\rho_A)-t_A\left(2\rho_A+\frac{\bar{c}}{w}+t_B\right)+\rho_A\left(\frac{\bar{c}}{w}+t_B\right) = 0$$

which leads to the following tax reaction function:[32]

$$t_A(t_B)=\frac{2\rho_A+\lambda-\sqrt{\lambda^2+4\rho_A^2\left(1-\lambda\right)}}{2(1+\rho_A)} \quad ,$$

where $\lambda \equiv \frac{\bar{c}}{w}+t_B \geq 0$.

Note that $\lambda^2+4\rho_A^2\left(1-\lambda\right)$ is always positive as it is a convex function of $\lambda$ with a minimum in $\lambda_{min}=2\rho_A^2$. At $\lambda_{min}$, the function has a value of $4\rho_A^2(1-\rho_A^2)$ which is always positive as $\rho_A \in [0,1]$.

**Remarks**

If $\rho_A=0$ - both immobile and mobile workers value only the private good - $t_A(t_B)=0$. Then, the equilibrium tax rate $t_A^*=0$, which is also the first-best solution (optimal tax rate without mobility).

If $\rho_A=1$ - immobile workers maximize tax revenue - $t_A(t_B)=\begin{cases}\frac{1}{2}\lambda & \text{if } 0\leq\lambda<2\\ 1 & \text{if } \lambda\geq 2\end{cases}$.

Then, $t_A^*=\frac{\bar{c}}{w}$ if $\rho_B=1$ and $t_A^*=\frac{1}{2}\frac{\bar{c}}{w}$ if $\rho_B=0$ ($t_B^*=0$).[33]

**Comparative statics**

We first show that $\frac{\partial t_A}{\partial t_B}\geq 0$.

$$\frac{\partial t_A}{\partial t_B} = \underbrace{\frac{1}{2(1+\rho_A)}}_{>0}\left(1-\underbrace{\frac{\overbrace{\lambda-2\rho_A^2}^{A}}{\sqrt{\lambda^2+4\rho_A^2\left(1-\lambda\right)}}}_{B>0}\right)$$

- if $A<0$:

$$\frac{\partial t_A}{\partial t_B} > 0$$

- if $A>0$:

$$\frac{\partial t_A}{\partial t_B} \geq 0 \quad \text{if} \quad (\lambda-2\rho_A^2)^2\leq\lambda^2+4\rho_A^2\left(1-\lambda\right)$$

[32] This model leads to a second possible tax reaction function of the form $t_A(t_B)=\frac{2\rho_A+\lambda+\sqrt{\lambda^2+4\rho_A^2(1-\lambda)}}{2(1+\rho_A)}$, which does not lead to an equilibrium.

[33] $t_A^*\in[0,1]$. The first-best tax rate would be to set $t_A$ to unity.

$$
\begin{aligned}
&\geq 0 \quad \text{if} \quad \lambda^2 + 4\rho_A^4 - 4\rho_A^2\lambda \leq \lambda^2 + 4\rho_A^2 - 4\rho_A^2\lambda \\
&\geq 0 \quad \text{if} \quad \rho_A^2 \leq 1, \text{ which is always the case as } \rho_A \in [0,1].
\end{aligned}
$$

It is also straightforward to show that $\frac{\partial t_A}{\partial \frac{c}{w}} = \frac{\partial t_A}{\partial t_B} \geq 0$ .
Last, we show that $\frac{\partial t_A}{\partial \rho_A} \geq 0$

$$
\frac{\partial t_A}{\partial \rho_A} = \underbrace{\frac{1}{2(1+\rho_A)^2}}_{>0}\left((1+\rho_A)\left(2 - \frac{4\rho_A(1-\lambda)}{\sqrt{\lambda^2 + 4\rho_A^2(1-\lambda)}}\right) - 2\rho_A - \lambda + \sqrt{\lambda^2 + 4\rho_A^2(1-\lambda)}\right)
$$

$$
\begin{aligned}
\frac{\partial t_A}{\partial \rho_A} &\geq 0 \quad \text{if} \quad 2 - \lambda - \frac{4\rho_A(1-\lambda)(1+\rho_A)}{\sqrt{\lambda^2 + 4\rho_A^2(1-\lambda)}} + \sqrt{\lambda^2 + 4\rho_A^2(1-\lambda)} \geq 0 \\
&\geq 0 \quad \text{if} \quad (2-\lambda)\sqrt{\lambda^2 + 4\rho_A^2(1-\lambda)} - 4\rho_A(1-\lambda)(1+\rho_A) + \lambda^2 + 4\rho_A^2(1-\lambda) \geq 0 \\
&\geq 0 \quad \text{if} \quad \underbrace{(2-\lambda)\sqrt{\lambda^2 + 4\rho_A^2(1-\lambda)}}_{A} \geq \underbrace{4\rho_A(1-\lambda) - \lambda^2}_{B}
\end{aligned}
$$

- for $\lambda > 2$: $A < 0$, $B < 0$, and

$$
\begin{aligned}
\frac{\partial t_A}{\partial \rho_A} &\geq 0 \quad \text{if} \quad \left((2-\lambda)\sqrt{\lambda^2 + 4\rho_A^2(1-\lambda)}\right)^2 \leq \left(4\rho_A(1-\lambda) - \lambda^2\right)^2 \\
&\geq 0 \quad \text{if} \quad (4 + \lambda^2 - 4\lambda)(\lambda^2 + 4\rho^2 - 4\rho_A^2\lambda) < \left(4\rho_A(1-\lambda) - \lambda^2\right)^2 \\
&\geq 0 \quad \text{if} \quad 4\lambda^2(1 + \rho_A^2 + 2\rho_A) \leq 4\lambda^3(1 + rho_A^2 + 2\rho_A) \\
&\geq 0 \quad \text{if} \quad \lambda^2 \leq \lambda^3, \text{ which is satisfied for } \lambda > 2.
\end{aligned}
$$

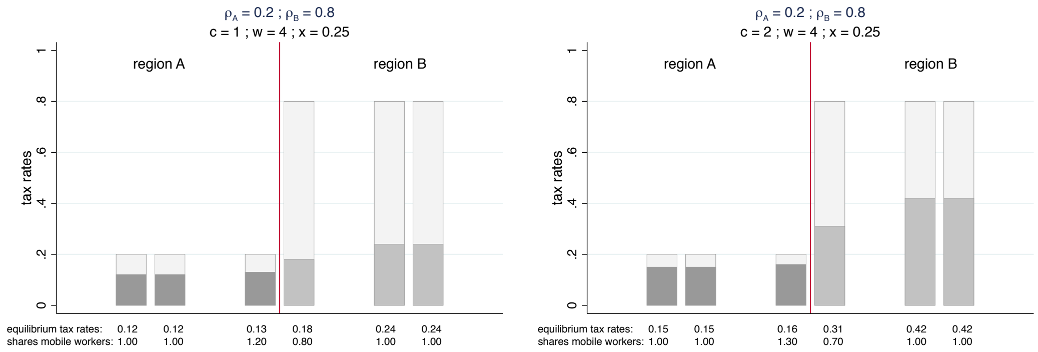
- for $1 \leq \lambda \leq 2$: $A \geq 0$, $B \leq 0$, and

$$
\frac{\partial t_A}{\partial \rho_A} \geq 0
$$

- for $0 \leq \lambda < 1$:
  - either $A > 0$ and $B < 0$: $\frac{\partial t_A}{\partial \rho_A} > 0$
  - or $A > 0$ and $B > 0$: $\frac{\partial t_A}{\partial \rho_A} > 0$ if $\lambda^2 > \lambda^3$, which is satisfied for $0 \leq \lambda < 1$.

Figure W.1 presents equilibrium tax rates for $\rho_A = 0.2$, $\rho_B = 0.2$, $w = 4$ and $x = 0.25$. Figures W.1(a) and W.1(b) display results for $\bar{c} = 1$ and $\bar{c} = 2$, respectively. Figure W.1(b) reproduces Figure 1 presented in Section 1.

**Figure W.1** – Equilibrium tax rates in the stylized model




Note: Pairs of bars represent two neighboring jurisdictions that can be located in the same cultural region, or one in region $A$ and one in region $B$. The line indicates the region border. White bars represent tax rates without mobility. Dark gray and light gray bars are equilibrium tax rates with mobility.

## W.2 Production of the public good

We now relax the assumption of complementarity between immobile and mobile workers in the production of the publicly provided good. Consider the more general production function

$$G(t_i, n_i) = t_i(1 + w \times n_i) \quad ,$$

such that the public good is produced using taxes payed by all workers.

The maximization problem of the representative immobile worker in region $A$ becomes (with the same utility functions as in Section W.1):

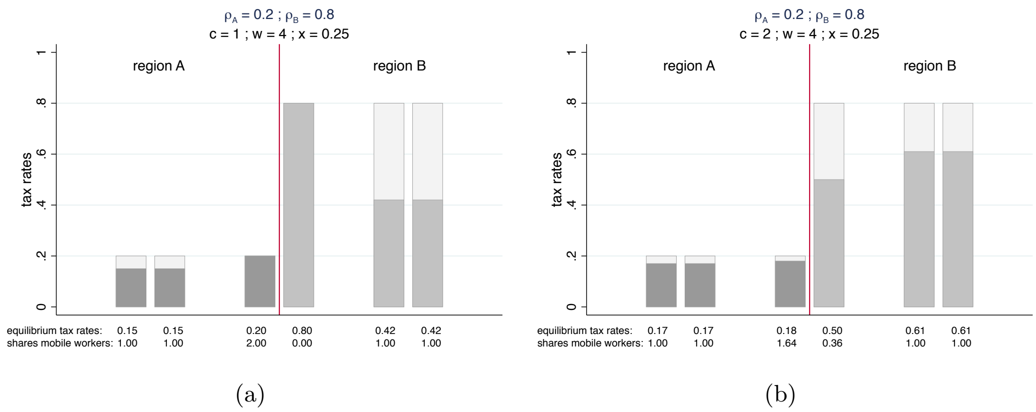
$$\max_{t_A} \quad (1 - t_A)^{1-\rho_A} \left( t_A \left( 1 + w \times x \left( 1 + \frac{w(t_B - t_A)}{\bar{c}} \right) \right) \right)^{\rho_A} \quad ,$$

which leads to the following tax reaction function:

$$t_A(t_B) = \begin{cases} \dfrac{2\rho_A + \frac{\bar{c}(1+w\times x)}{w^2 x} + t_B - \sqrt{\left(\frac{\bar{c}(1+w\times x)}{w^2 x} + t_B\right)^2 + 4\rho_A^2\left(1 - \frac{\bar{c}(1+w\times x)}{w^2 x} - t_B\right)}}{2(1+\rho_A)} & \\ \qquad \text{if} \quad (1-\rho_A)^{1-\rho_A}(\rho_A)^{\rho_A} \leq U_A^{im}\left(t_A(t_B)\right) & \\ \rho_A \qquad \text{otherwise} \quad . & \end{cases}$$

Without complementarity between immobile and mobile workers in the production of the public good, tax reaction functions are not continuous. Therefore, an equilibrium may

**Figure W.2** – Equilibrium tax rates when the publicly provided good is financed by all workers




Note: Pairs of bars represent two neighboring jurisdictions that can be located in the same cultural region, or one in region $A$ and one in region $B$. The line indicates the region border. White bars represent tax rates without mobility. Dark gray and light gray bars are equilibrium tax rates with mobility.

not exist or can be at a corner solution where immobile workers set their optimal tax rate, $t_i = \rho_i$, and all mobile workers reside in the low-tax jurisdiction.[34]

Figure W.2 presents equilibrium tax rates for the same parameter values as in Figure W.1. Corner solutions are exemplified in Figure W.2(a) for the case of two jurisdictions located in a different cultural region.

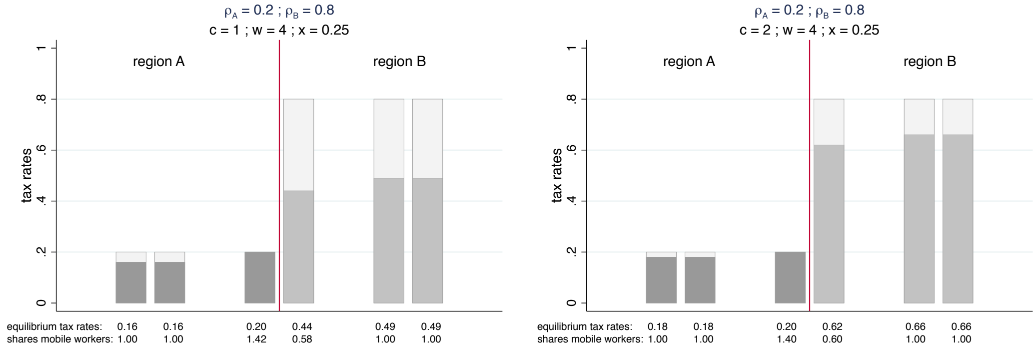
## W.3 Utility of mobile workers

Consider now the case where mobile workers value the publicly provided good positively, but less than immobile workers, such that they have an incentive to move to a low-tax region. A general utility function can be written such that the relative valuation of the private and publicly provided good depends on the region where a worker is born and his income (keeping the same general production function of the publicly provided good as in Section W.2):

$$U_i = (1-t_i)^{1-\frac{\rho_i}{w}} \left(t_i \left(1 + w \times n_i\right)\right)^{\frac{\rho_i}{w}} \quad ,$$

[34]Recall that $n_A^* = x\left(1 + \frac{w(t_B - t_A)}{\bar{c}}\right) \in [0, 2x]$. Hence, if the tax differential between the two jurisdictions is large enough, the high-tax jurisdiction will loose all mobile workers. However, immobile workers will still have a strictly positive utility by producing themselves the publicly provided good. In that case, they will set the optimal tax rate without mobility.

**Figure W.3** – Equilibrium tax rates when the publicly provided good is financed by all workers and when mobile workers have a positive valuation of the publicly provided good




(a) (b)

Note: Pairs of bars represent two neighboring jurisdictions that can be located in the same cultural region, or one in region $A$ and one in region $B$. The line indicates the region border. White bars represent tax rates without mobility. Dark gray and light gray bars are equilibrium tax rates with mobility.

where $n_i = x\left(\frac{\bar{c}-c_i}{\bar{c}} + \frac{c_{-i}}{\bar{c}}\right)$. The fractions of mobile workers leaving their home region, $\frac{c_A^*}{\bar{c}} \in [0,1]$ and $\frac{c_B^*}{\bar{c}} \in [0,1]$, are given implicitly by:

$$(1-t_A)^{1-\frac{\rho_A}{w}}\left(t_A\left(1+w\times x\left(\frac{\bar{c}-c_A^*}{\bar{c}}+\frac{c_B^*}{\bar{c}}\right)\right)\right)^{\frac{\rho_A}{w}} = (1-t_B)^{1-\frac{\rho_A}{w}}\left(t_B\left(1+w\times x\left(\frac{\bar{c}-c_B^*}{\bar{c}}+\frac{c_A^*}{\bar{c}}\right)\right)\right)^{\frac{\rho_A}{w}} - c_A^* \quad ,$$

$$(1-t_B)^{1-\frac{\rho_B}{w}}\left(t_B\left(1+w\times x\left(\frac{\bar{c}-c_B^*}{\bar{c}}+\frac{c_A^*}{\bar{c}}\right)\right)\right)^{\frac{\rho_B}{w}} = (1-t_A)^{1-\frac{\rho_B}{w}}\left(t_A\left(1+w\times x\left(\frac{\bar{c}-c_A^*}{\bar{c}}+\frac{c_B^*}{\bar{c}}\right)\right)\right)^{\frac{\rho_B}{w}} - c_B^* \quad ,$$

and the maximization problem of the representative immobile worker in region $A$ is:[35]

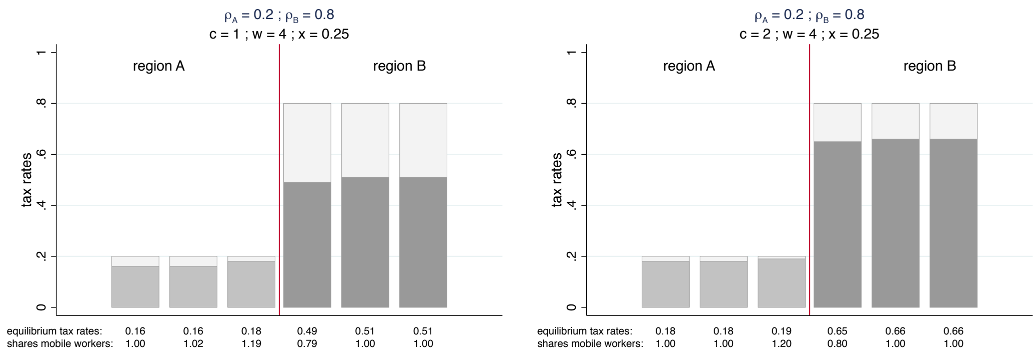
$$\max_{t_A} \quad (1-t_A)^{1-\rho_A}\left(t_A\left(1+w\times x\times n_A^*\right)\right)^{\rho_A} \quad ,$$

where $n_A^* = x\left(\frac{\bar{c}-c_A^*}{\bar{c}}+\frac{c_B^*}{\bar{c}}\right) \in [0, 2x]$.

Figure W.3 presents equilibrium tax rates for the same parameter values as in Figure W.1.[36] Note that, for $w = 4$, mobile workers of region $B$ have the same valuation of the publicly provided public good as immobile workers of region $A$. This matches the illustrative evidence on different preferences for government spending and redistribution among German-speaking and French-speaking respondents with high and low family income (see Table 1).

[35]Recall that $w = 1$ for immobile workers and $w > 1$ for mobile workers.
[36]As before, equilibrium tax rates are not guaranteed to exist, nor to be an interior solution.

**Figure W.4** – Equilibrium tax rates for a model with 12 jurisdictions




(a) (b)

Note: A bar represent a jurisdiction. The model is solved for twelve jurisdictions on a circle (symmetric problem). The line indicates the region border. White bars represent tax rates without mobility. Dark gray and light gray bars are equilibrium tax rates with mobility.

## W.4 A model with $N > 2$ jurisdictions

In this Section, we expand the model of Section W.3 for the case of $N > 2$ jurisdictions. This allows us to consider the case where jurisdictions are in competition with more than one jurisdiction. To keep the model tractable, we restrict jurisdictions to compete with two other jurisdictions. More specifically, consider that jurisdictions are located on a circle such that each one has two neighbors.[37] Mobile workers are now divided into two equal groups ($\frac{x}{2}$), each one located close to one of the jurisdiction's border. Each group of mobile workers can migrate only to the jurisdiction that is right one the other side of the border. This restrictions ensures a symmetric problem for immobile workers between raising and lowering their tax rate (same effect on the tax base), such that an equilibrium is possible.[38]

Equations of Section W.3 can be easily expanded for $N$ jurisdictions. The major difference is the number of mobile workers which becomes, for jurisdiction $i$ with neighbors $h$ and $j$:

$$n_i = \frac{x}{2}\left(\frac{\bar{c} - c_{ij}}{\bar{c}} + \frac{c_{ji}}{\bar{c}}\right) + \frac{x}{2}\left(\frac{\bar{c} - c_{ih}}{\bar{c}} + \frac{c_{ih}}{\bar{c}}\right) \quad ,$$

[37] This setting of a circle is inspired from Agrawal (2012). The advantage is that it avoids the boundary problem of considering jurisdictions on a line.

[38] As before, the existence of an equilibrium is not guaranteed. However, without this restriction, an equilibrium never exists. To see this point, consider that mobile workers may choose to migrate to either the jurisdiction on the right or on the left. If immobile workers increase the tax rate, they will loose an amount $\varepsilon$ of mobile workers but they will attract $2\varepsilon$ if they lower their tax rate by the same amount. Tax reaction functions are thus discontinuous near the equilibrium such that the latter never exists.

where $\frac{c_{ij}}{\bar{c}} \in [0,1]$ is the fraction of mobile workers leaving jurisdiction $i$ for jurisdiction $j$.[39]

We present here a solution of this model for 12 jurisdictions with the cultural border dividing them into two equal groups. Utility functions and parameter values are the same as in Section W.3.

Figure W.4 presents equilibrium tax rates for six of the twelve jurisdictions (the problem is symmetric).[40]

[39]Note that $\frac{c_{ij}}{\bar{c}}$ are found by solving a system of $2 \times N$ equations.

[40]For the ease of presentation, these jurisdictions are represented on a line.