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Heterogeneity in Income Tax Capitalization and Its Effects on Segregation within Switzerland

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Abstract**

There is evidence that taxes capitalize into housing prices, but great uncertainty about the magnitude of income tax capitalization. This paper suggests an explanation for the broad range of empirical results: the fact that income tax capitalization depends on income. Results from the analysis of a large Swiss dataset show that capitalization varies with respect to the quality group of the apartment, each of which is demanded by a specific income class. Full capitalization is observed only for tax differentials between relatively nearby regions, and this occurs only for low- and middle-quality apartments (low- and middle-income groups). In-depth analysis of supply-side adjustments in the housing market confirms the existence of taxed-induced segregation tendencies.

JEL Code: H22, H73, R21, R38.

Keywords: Housing Prices, Income Tax Capitalization, Segregation.

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1 Introduction

According to Tiebout's (1956) "voting with one's feet" theory, fully mobile and well-informed consumers tend to settle in municipalities where their preferred mix of tax and public goods is available. Oates (1969) has applied Tiebout's model to an analysis of the links between housing prices and property taxes, focusing on the issue of capitalization. He hypothesizes that the net present value of a future stream of differences between local taxes and local public goods will be reflected in the bid behavior of a fully mobile household interested in buying a house. The results of his empirical investigation suggest a capitalization rate of roughly two-thirds. Following Oates' study (1969), the majority of existing literature suggests that significant but less than full capitalization exists for property taxes if the net user cost of housing is assumed to be 3% (for a review see Yinger et al. 1988; Sirmans et al. 2008). There is little evidence of the capitalization of income taxes, but existing research suggests that capitalization is also less than full (Stull and Stull 1991; Boije 1997).

With respect to income taxes, capitalization will rarely total 100%. As income taxes in most developed countries are progressive, tax burden as a share of household income increases with income level. Furthermore, as housing consumption is a normal good, its share of total expenditures decreases with increasing income; thus, the degree of capitalization depends on household income, tax rate, and housing consumption. Knowing more about this aspect is advantageous, for policy reasons. First, capitalization rates that vary by income level may result in social segregation. Second, it makes the local redistribution of income more difficult. However, there is virtually no empirical evidence on the question of how income heterogeneity influences the capitalization of taxes into housing prices, and if it can lead to social segregation.

This study aims to close this knowledge gap by investigating the capitalization rate of income taxes for different quality groups of apartments (i.e., different income classes) in the Swiss housing market.

The dataset utilized in this study is from the real estate marketplace *homegate.ch*; it includes more than 430,000 apartments for rent and for sale across Switzerland, between 2004 and 2010. The results help to explain why capitalization rates can differ so substantially among studies: capitalization rates vary depending on income level (quality of the apartments) and level of tax competition. Full capitalization can be observed only for tax differentials among nearby municipalities, and only for low- and middle-income groups. Even for the geographically small country of Switzerland, capitalization on the national level was found to

be insignificant. An in-depth analysis finds evidence that regionally different tax rates lead to supply-side adjustments in the housing market, suggesting that capitalization drives segregation tendencies.

This paper is organized as follows. Section 2 briefly reviews existing literature on income tax capitalization. In section 3, the model of income tax capitalization used in this study is defined. In section 4, the empirical model is described. Section 5 provides a short description of the personal income tax system in Switzerland, while section 6 offers a description of the database used in this study. Section 7 discusses the study's results. Section 8 provides the study's conclusion.

2 Literature on capitalization, mobility, and segregation

2.1 Conditions for capitalization

Essentially, two central aspects determine the degree of income tax capitalization: (1) degree of mobility and the related importance of households "voting with their feet" and (2) the ability of municipalities to expand their borders or to substitute agricultural land for urban land.

(1) The mobility of households

If people are immobile, the Tiebout model fails; in such a scenario, people will not move to places where they can obtain their preferred public-tax mix. This implies that taxes and public goods would not capitalize into housing prices. Thus, a necessary condition for capitalization to occur is the tax mobility of households.

A large body of empirical literature has investigated the impact of differences in local taxes and public goods on migration and choice of residential location. Most of these studies are based on data from the United States. Dowding et al. (1994) have carried out an extensive survey on empirical literature and conclude that local fiscal differentials affect migration. Low-income earners are more attracted by higher welfare payments, while wealthier households react to tax differences.

With respect to Switzerland, early studies investigating the impact of income tax competition on migration have been performed by Kirchgässner and Pommerehne (1996) and Feld and Kirchgässner (2001). These authors estimate the impact of local income tax differentials on

regional income distribution, using aggregated cross sectional data. They conclude that income distribution can be partly explained by fiscal factors. By using panel data, Schaltegger et al. (2011) confirm these results for the Zurich metropolitan area.
Schmidheiny (2006b) and Liebig et al. (2007) directly investigate the impact of local income taxes on migration using individual data. They find evidence that rich and highly qualified households are more willing to migrate based on tax incentives than the average household. Morger (2013) finds that income taxes are a significant pull factor for international migration decisions and intra-national migration within Switzerland; however, his results suggest that the relative impact of taxes compared to other locational factors is rather low.

Hence, both international and Swiss studies show some consensus on the existence of the sorting mechanism proposed by Tiebout. Empirical studies indicate, however, that this sorting does not occur independently of income level, and thus results in social segregation. Based on these findings, it is clear that some capitalization should occur, but it is not immediately apparent whether mobility is sufficient in order to ensure full capitalization and whether capitalization differs with respect to income.

(2) The supply elasticity of land and new municipalities

If municipalities with a favorable mix of public services and tax level can expand their supply of land as long as new households arrive, then capitalization will not occur over the long run (see Edel and Sclar 1974; Stadelmann and Billon 2012). Conversely, if the supply of land or the borders of a municipality are fixed, capitalization will occur.

Different theoretical considerations lead one to conclude that the supply of land is not elastic. First of all, as Ross and Yinger (1999) note, referring to Yinger (1982), Rose-Ackerman (1983), and Crampton (1996), land that is far away from metropolitan regions will not often be used for purposes other than agriculture. In rural regions, there are few or no jobs available and transportation costs are high. Secondly, undeveloped land is scarce in urban regions. Thirdly, it is difficult for the municipalities with the best service-tax packages to expand their borders at the cost of less successful municipalities (Yinger 1982). In addition, Epple and Romer (1989) have found that, for the United States, the creation of new municipalities is rare due to institutional rules. All these points suggest that the elastic supply of land and new municipalities is unlikely in real cases.

With regard to Switzerland, Stadelmann and Billon (2010) have investigated whether the capitalization of fiscal variables persists or decreases over time. Their results indicate that,

over a period of observation between 1998 and 2004, no significant decrease of capitalization occurred. Stadelmann and Billon (2012) approach the same issue differently. They analyze whether the supply of undeveloped land in a municipality has an impact on the degree of capitalization. By dividing the municipalities of the canton of Zurich into two groups — one with ample available land and one with little — they find that fiscal variables are not capitalized differently. Both studies suggest that the elasticity of land supply in the Zurich metropolitan region is not sufficiently high to bring capitalization to zero over the long run.

2.2 The consequence of capitalization on regional income distribution

If the supply of new land in a municipality is not elastic, and if not every household is able to live in its preferred place, the aspect of segregation becomes increasingly relevant. By offering a low tax rate and/or providing more public goods, wealthy municipalities can attract more rich people than poorer municipalities can (see Ellickson 1971; Westhoff 1977; Goodspeed 1989). In that case, households will segregate uniformly into different municipalities. Low-income earners will settle down in poor municipalities that impose high taxes and have low housing prices, whereas wealthy households will move to rich municipalities where taxes are low and housing prices are high.

In an economy in which heterogeneity in housing consumption exists, segregation will take on a somewhat different form. By employing a simulation model, Schmidheiny (2006a) shows that with increasing taste variance, a population is increasingly segregated by taste rather than by income. In such cases, municipalities with high taxes and low housing prices can attract wealthy individuals with strong preferences for housing. Conversely, municipalities with low taxes and high housing prices attract poor individuals with weak preferences for housing. This result remains valid if one takes into consideration progressive income taxes (Schmidheiny 2006b). In any of these cases, households are segregated according to their income levels, although differences in taxes among municipalities, and therefore in housing prices, are lower in cases of varying taste than in the case of homogeneous taste.

2.3 Empirical findings on degree of capitalization

An extensive body of empirical literature on property tax capitalization indicates that there is strong evidence of capitalization. Early studies have been reviewed by Yinger et al. (1988), who conclude that the most sophisticated studies of property tax capitalization yield

capitalization rate estimates between 15% and 60%, assuming a discount rate of 3%. A more recent survey by Sirmans et al. (2008) demonstrates that in the 20 years of empirical research on property tax capitalization since Yinger et al.'s (1988) study, the range of credible capitalization rates has not narrowed.

Among newer studies, the work of Palmon and Smith (1998) is particularly worthy of note. The authors provide a solution to the problem of underidentification, which is inherent to all empirical models. This problem results from the fact that both net user costs (discount rates) and capitalization rates are unknown in these models and that only the ratio of the two can thus be estimated. By assuming that notional rental values equal the rental prices of comparable housing, Palmon and Smith (1998) resolve this problem. The authors employ the two-stage least squares method, and estimate capitalization rates between 77.5% and 108%, finding that all values are insignificantly different from full capitalization. Furthermore, their results suggest that net user cost is typically above 3%, falling closer to 9%, and that this number varies depending on the characteristics of a house. Unfortunately, their innovative approach to the problem of underidentification cannot be applied to nonlinear income tax schedules.

Few empirical studies have analyzed the degree of capitalization of income taxes. It appears that the first such study is that of Stull and Stull (1991), who investigate aggregated data from 335 municipal civil divisions in the Philadelphia Metropolitan Area. By assuming that the lifetime of the housing is infinite and the net user cost is 10%, they obtain a capitalization rate of income taxes that is between 73% (ordinary least squares; OLS procedure) and 81% (2SLS). Stull and Stull conclude that property and income taxes capitalize into property values to approximately the same extent. Boije (1997) analyzes income tax capitalization in the "travel to work area" of Stockholm by using micro data and applying ordinary least squares. By assuming a net user cost of 3%, he estimates a capitalization rate between 17% and 59%.

With regard to Switzerland, Feld and Kirchgässner (1997) and Hilber (1998) have investigated the capitalization rate of differences in local income taxes. Unfortunately, both studies used aggregated indices of local tax burden, in which it is questionable whether the derived capitalization estimator is meaningful. Feld and Kirchgässner (1997) find capitalization rates between 18% and 36% for rented apartments. Hilber's (1998) capitalization rates are substantially higher, at 72% for rented apartments and up to 236% for owner-occupied housing and land.

3 Theoretical model

In the following model, the focus is on the demand side of the housing market, assuming that the supply of apartments is fixed. Consider an individual that wants to buy an apartment. The individual is assumed to be fully mobile, with neither work nor family influencing its decision on where to live. This is equivalent to the assumption that no commuting or other transportation costs are involved in its decision. As in the Tiebout model, municipalities compete over the local public services/tax mix that they offer. Local authorities finance their services with a local income tax. Suppose that the utility of a household i is a function of housing consumption, defined in terms of quantity and quality of property (h), consumption of other private goods (x), and consumption of public services (s).[1] In order to determine the appropriate bid for a property in a certain municipality, a household will try to maximize its utility by choosing the preferred municipality m in which to live, as follows:

$$\max u_i(h_i,\ x_i;\ s_m)\ \ s.t.\ \ y_i = p_m h_i + x_i + t_m(y_i)y_i \tag{1}$$

where p_m is the price index of housing in municipality m, and $t_m(y_i)$ is the income tax rate depending on the households' income y_i. The price index of the consumption bundle x is set to unity. The budget constraint implies that all household income is spent on housing, consumption goods, and taxes. Analogously to Yinger et al. (1988), it is assumed that the budget constraint of the municipality in supplying the public goods s_m is exogenous for the bidding household. Neglecting the municipality subscript for the sake of convenience and applying the envelope and implicit function theorems to problem (1) leads to

$$\frac{dp}{dt} = -\frac{t'(y_i)y_i}{h_i} \tag{2}$$

Equation (2) shows the relationship between tax changes and price changes. $t'(y_i)$ is the first derivative of $t(y_i)$ with respect to t and can be interpreted as the change in effective average tax burden in response to a 1% proportional change in the overall rate. In other words, this involves dealing with a progressive tax schedule. The higher $t'(y_i)$ (the more progressive the tax) and the higher the income of the household, the lower the bids per quantity of housing consumed are. This can be made clearer by following Schmidheiny (2006b) and differentiating (2) with respect to y, which yields:

[1] The following deductions are from an application of the property tax model of Yinger et al. (1988) and Yinger (1999) to a progressive income tax.

$$\frac{\partial(dp/dt)}{\partial y_i} = \frac{t'(y_i)}{h_i}\left(\varepsilon_{h_i,y_i} - 1\right) - \frac{(\partial t'/\partial y_i)}{h_i} < 0 \tag{3}$$

The inequality holds if the value of $\varepsilon_{h,y_i} = \frac{y_i}{\partial y_i}\frac{\partial h_i}{h_i}$, the gross income elasticity of housing, is less than one, and the tax progression parameter, with respect to income, is increasing or at least not decreasing (not regressive). In this case, in municipalities with strong progression, price bids per unit of property would be lower for high-income earners than for low-income earners. On the other hand, in low tax areas, price bids per unit of housing would increase with income. This leads to the segregation of households into municipalities according to their incomes. Rich households would then take up residence in municipalities with low taxes and high property prices and poor households would settle down in municipalities with low property prices and high taxes.[2]

By following the procedure of Yinger et al. (1988), integrating the differential equation (2) and rearranging leads to the well-known asset price function for housing:

$$V = \frac{f(p;h) - t(y)y + g(s)}{\rho'} = \frac{R}{\rho'} \tag{4}$$

where V is the value of the housing, and R is the recurring utility of the housing (the rental value), which depends on price, quantity, and quality indicators $(p;h)$, tax burden $t(y)y$, and the utility derived from the public services $\left(g(s)\right)$, all at the location of the housing. ρ' is defined as

$$\rho' = \frac{\rho}{1-(1+\rho)^T} \tag{5}$$

with ρ as the net user cost and T is the life duration of the housing.

Equation (4) only holds if households are mobile. In reality, however, moving is costly, preferences for housing consumption are heterogeneous, and incomes differ among households.

Assume that moving from place *m* to place *n* involves social and monetary costs of $c(y_i)/\rho'$. Let us first look at a household with origin *m* that earns an income of $y_i = y^*$. This household guarantees an equilibrium housing market, given the distribution of the population in different municipalities, the costs of moving, and the demand and supply of housing. We

[2] See Schmidheiny (2006b). Schmidheiny also investigates sorting and segregation mechanisms in cases where both the incomes and preferences of house purchasers differ.

call this household the border household. When costs of migration are accounted for, the border household's bidding function for property *l* located in municipality *m* becomes

$$V_{l,m \mid y_i=y^*} = \frac{f(p_m; h_l) - \beta^* t(y^*)y^* + g(s_m)}{\rho'} \tag{6}$$

where β^* is the personal tax capitalization rate of the border household, with $\beta^* = 1 - c(y^*)/[t(y^*)y^*]$. The personal capitalization rate is strictly less than one if moving is costly $[c(y^*) > 0]$. However, the capitalization rate by definition cannot get smaller than zero, as zero capitalization is the lower bound for a no-mobility case.

Because the border household has a market-clearing function, we assume that its tax burden induces spillover effects $\theta = f(\beta^*, L, \delta)$, with $0 \leq \theta \leq \beta^*$, onto all property prices in a municipality. The higher the scarcity of available land (L) and the higher the elasticity of substitution between classes of apartments (δ) demanded by specific income groups, the more important these spillover effects are. Assume that housing prices in all municipalities are identical, averaging at $\bar{p}$, but differ with respect to spillover effects, which are exogenous for all households with $y_i \neq y^*$. Then, the price function of property *k* located in municipality *m* is

$$f(p_m; h_k) = f(\bar{p}; h_k) - \theta t(y^*)y^* \tag{7}$$

Combining (6) and (7), we get the following bidding function for a household earning an income of $y_i \neq y^*$ for property *k*:[3]

$$V_{k \mid y_i \neq y^*} = \frac{f(\bar{p}; h_k) - \beta_i' t(y_i)y_i + g(s_m)}{\rho'}, \quad \text{with } \beta_i' = \beta_i + (1 - \beta_i)\theta \frac{t(y^*)y^*}{t(y_i)y_i}. \tag{8}$$

where β_i' is the personal capitalization rate of the non-border household. If the household is perfectly mobile, then $\beta_i = 1$, and the personal capitalization rate β_i' equals exactly one; the household will not accept any spillover effects. In that case, households will uniformly segregate into different municipalities according to their income as is compatible with (3). If households are not perfectly mobile, spillover effects become relevant. According to (8), the personal capitalization rate can even exceed one if

[3] Equation (8) contains the plausible assumption that the response β_i of household *i* to any change in own tax burden is identical its response to price changes due to the spillover effects but with the opposite sign (a higher tax burden reduces the price level, which is advantageous but increases own tax burden).

$$\theta > \frac{t(y_i)y_i}{t(y^*)y^*}. \tag{9}$$

According to (9), for any non-regressive tax scheme and for $y_i < y^*$, the probability that capitalization exceeds one increases with decreasing income (with β_i held constant). Instead, for households with $y_i \geq y^*$, the personal capitalization rate will never exceed one (because $\theta \leq 1$).

If β_i depends on income, then the relationship between the personal capitalization rate and income is ambiguous. Empirical literature finds evidence that mobility increases with increasing income. This would suggest that $\partial\beta_i/\partial y_i > 0$. With only low spillover effects, this may even lead to the result that personal capitalization rates are lowest for low-income households and high for affluent households.

These considerations show that there should be no true capitalization rate. Instead, capitalization is something personal, depending on a set of different aspects such as the mobility of different household groups, the income level of the border household, spillover effects, and the progressivity of the tax system. From (8) and (9) we can only conclude that the capitalization rate may exceed 100% for low-income earners, but cannot for high-income earners. Considering these unclear relationships, the following empirical analysis will address the question whether capitalization rates vary with respect to income.

4 Empirical model of income tax capitalization

4.1 Empirical design

Equation (8) serves as the basis for the estimation of the extent of capitalization of income taxes into housing prices. However, by estimating a tax coefficient β_i', one obtains only the ratio of β_i'/ρ'. This information deficit regarding the true value of ρ' is known as an underidentification problem. Instead of directly doing a regression according to equation (8), we logarithmize the left- and right-hand sides of (8). A slight modification of the tax variables leads to the following expressions:[4]

$$lnV_k = ln\,[f(\bar{p}; h_k)] - \tilde{\beta}_{v,i}\, lnt(y_i) - lny_i + ln\rho' + \ln\,[g(s_m)] \tag{10}$$

[4] After the log-linearization of equation (8), the capitalization rates are $ln\beta'_{v,i}$ and $ln\beta'_{r,i}$, respectively. However, in any linear regression, neither $ln\beta'_{v,i}$ nor $ln\beta'_{r,i}$ can be separated from the constant term. Therefore, we redefine $-ln\beta' - \ln\,[t(y_i)] \equiv -\tilde{\beta}\ln\,[\mathrm{t(y_i)}]$.

for owner-occupied housing and

$$lnR_k = ln\,[f(\bar{p}; h_k)] - \tilde{\beta}_{r,i}\, lnt(y_i) - lny_i + \ln\,[g(s_m)] \qquad (11)$$

for rented housing, respectively. In this case, $\tilde{\beta}_{v,i}$ and $\tilde{\beta}_{r,i}$ are elasticities instead of capitalization rates. As can be seen from equation (10), the tax coefficient $\tilde{\beta}_{v,i}$ does not depend any longer on the discount rate ρ'.

If elasticities for owner-occupied and rented apartments are equal, capitalization rates also have to be identical. If they differ, the ratio of the two elasticities ($\tilde{\beta}_{v,i}/\tilde{\beta}_{r,i}$) will indicate to what degree the capitalization rates differ. Because there exists no underidentification problem for apartments for rent, one can easily obtain the capitalization rate of the apartments for sale by multiplying the ratio of the two elasticities and the capitalization rate for apartments for rent.

An additional challenge exists in this case. We want to estimate different dimensions of capitalization, in terms of the capitalization of tax differentials between particular municipalities and the Swiss average, between municipalities and the cantonal average, and within SM- (*mobilité spatial*, meaning spatial mobility) regions. This can be done by defining tax variables as deviations from a specific average, but if logs of a negative value are taken, it leads to missing values and a failure in estimating elasticities. In order to tackle this problem, $lnt(y_i)$ can be replaced by the difference between the tax rate of the respective municipality and the mean Swiss, cantonal, and regional tax rates, as measured in percentage points. Then, $\tilde{\beta}_{v,i}, \tilde{\beta}_{r,i}$ in equations (10) and (11) are no longer elasticities but semi-elasticities.

Specifically, the estimation equations are chosen as follows:

$$lnV_k = \boldsymbol{a_v x_k} + \boldsymbol{f_v x_m} + b_{v,i} t_{m,\tau}(y_i) + g_{vc} + \boldsymbol{d}_\tau + \varepsilon_v \qquad (11)$$

and

$$lnR_k = \boldsymbol{a_r x_k} + \boldsymbol{f_r x_m} + b_{r,i} t_{m,\tau}(y_i) + g_{rc} + \boldsymbol{d}_\tau + \varepsilon_r \qquad (12)$$

where $const + l\,n[f(\bar{p}; h_k)] = \boldsymbol{a_v x_k} + \boldsymbol{f_v x_m} + \boldsymbol{d}_\tau$. The vector $\boldsymbol{x_k}$ includes a constant and price, quality, and quantity variables with coefficients $\boldsymbol{a_v}$; $\boldsymbol{x_m}$ is a vector of location-specific characteristics of municipality m with coefficients $\boldsymbol{f}$. All these variables enter into the estimation equation linearly.[5] $t_{m,\tau}(y_i)$ is the tax rate differential in period τ as defined above,

[5] Several studies suggest that the hedonic price function $f(\bar{p}; h_k)$ is not necessarily linear (see Halvorsen and Pollakowski (1981) or the references in Anglin and Gencay (1995) and Sheppard (1999)). Therefore, the applied log-linear form with respect to $f(\bar{p}; h_k)$ seems appropriate.

and $b_{v,i}$ and $b_{r,i}$ are estimates of semi-elasticity. $\boldsymbol{d}_\tau$ is a dummy variable that captures year fixed effects for periods $\tau=1,\ldots T$. ε is the stochastic error term. $g_{.c}$ is a cluster-specific fixed effect that accounts for all unobservable, time-invariant, and region-specific effects. Especially, it includes the influence of the local public goods provision on the housing prices and rents. As a clustering variable, the spatial mobility region—as defined by the Swiss Federal Statistical Office (SFSO)—is chosen. Spatial mobility regions, defined as small job market regions, unite relatively homogenous neighboring municipalities. The subscript k stands for different classes of apartments demanded by specific groups of households i who earn the same household income y_i. As discussed in section 6.2, the empirical analysis examines six classes of apartments, each of which is demanded by a household group earning a specific income ($i=k=1,2,\ldots,6$).

The specification of g assumes that public goods consumption is independent of any housing or individual characteristics, and thus that public goods provision is fixed within regions but heterogeneous across regions. This assumption allows for public goods provision to be approximated by regional dummies, or more specifically, through the use of a cluster-specific model. By applying a fixed effects specification, the problems inherent in the nonobservability of the quality of public goods and the correlation between local public goods and local income taxes can be handled; consistent estimation of the capitalization parameter is made possible.[6]

4.2 Problems inherent to empirical studies

Palmon and Smith (1998) and Ross and Yinger (1999) describe different problems with estimating capitalization rates for property taxes. These issues can easily also be examined with regard to income tax studies, as the methodological problems involved are very similar.

First, in estimating capitalization rates for property taxes, there is the problem of simultaneity between property taxes and property prices. Concerning income taxes, however, any simultaneity would be, at most, indirect. Simultaneity could occur if lower taxes led to higher housing prices, inducing social segregation and subsequent changes in tax rates.

Second, every data set is constrained in terms of available variables. If few variables are used, there is a danger of an omitted variable bias, which would distort capitalization estimators.

[6] See, for example, Wooldridge (2002, p. 266) for a discussion of the properties of the fixed-effects estimators.

Third, all capitalization studies are confronted with the problem of underidentification (one exception is Palmon and Smith's (1998) study of the property tax[7]). All studies work with assumptions about net user costs and lifetimes of properties. By fixing the value of the net user cost, the coefficient in demand is set arbitrarily, and the "true" capitalization rate remains unknown. Stull and Stull (1991), for example, assume an infinite lifetime and a net user cost of 10% in order to obtain a capitalization rate for income taxes that is between 73% and 81%. The application of a net user cost of 3% reduces their capitalization rates to 21.8% and 24.2%.

Finally, there are different problems concerning the inclusion of local public services into a capitalization estimation equation. First of all, public expenditure data do not take into account the differences in quality of public services or the efficiency of the provision of local public goods (see Rosen and Fullerton 1977). Further, as discussed in Palmon and Smith (1998), due to the budget constraints facing municipalities, supplies of local public goods and local taxes are positively correlated. Based on this multicollinearity, the estimation of capitalization coefficients is biased downward. Lastly, depending on the heterogeneity of the household utility functions, the provision of local public goods may enter nonlinearly into housing prices.

This study attempts to consider these problems. In order to cope with the problems of omitted variable bias and the multicollinearity of taxes and public goods, a cluster-specific regression model has been applied. This cluster-specific model has the additional advantage of controlling for a simple form of spatial correlation between nearby municipalities. In addition, with the specific log-linear functional form of the statistical model, and based on knowledge about the elasticity of housing consumption with respect to income, the capitalization rate for both rented and owner-occupied apartments can be obtained without knowledge of discount rates. Finally, we run two-stage least squares (2SLS) in order to examine the potential endogeneity bias of the tax variable. However, the results suggest that the income tax rate is exogenous.

[7] As Ross and Yinger (1999, 2032) point out, "Do and Sirmans (1994) claim to estimate ρ' but in fact, they simply reverse the usual procedure by assuming $\beta_v = 1$ and calculating the implied ρ'."

5 The taxation of personal income in Switzerland

In terms of revenue, the personal income tax is the most important tax in Switzerland, generating 51.4 billion Swiss francs (CHF) (equivalent to 9.0% of GDP) in 2010. All three levels of governments have the authority to tax personal income; 47.9% of personal income tax revenue goes to the cantons, 32.7% to the municipalities, and only 19.4% to the federal government. Cantons are fully sovereign in fixing their own tax schedules.[8] Municipalities can generally apply a multiplier to the cantonal income tax, or participate in other ways (e.g. share tax earnings or apply extraordinary schedule). As only a small share of total income tax earnings goes to the federal government, overall income tax rates differ substantially among and within cantons. A one-earner household with two childen that earns CHF 100,000 must pay 2.6% income taxes in Walchwil (Canton of Zug), but 11.5% in Montalchez (Canton of Neuenburg).[9] For a household with a gross income of CHF 250,000, the lowest statutory tax rate is levied in Wollerau (Canton of Schwyz), at 10.5%; the highest tax rate, 26.8%, is levied in Montalchez.[10] However, even within cantons, tax rates differ significantly: on average, the differential between the maximum and minimum tax rate within cantons is 1.8 (4.0) percentage points, among households with gross incomes of CHF 100,000 (CHF 250,000).

6 Data

6.1 Advertisement data

Homegate.ch is one of the biggest and best-known marketplaces for advertising apartments for rent and sale in Switzerland. After excluding duplicates, the raw data for apartments (houses were excluded because they are only seldom for rent), taken for the period from 2004 to 2010, contains 943,856 advertisements. Of these, 760,366 involved apartments for rent and 183,493 involved apartments for sale. Advertisements that did not contain price information, indications of the number of rooms in the apartment, information on year built, or information on surface area were omitted (473,370 observations). Advertisements with non-plausible price information were also not used (2,025 observations). The resulting advertisement data were then paired with tax burden statistics. For the years under investigation, only tax burdens for the 800 biggest municipalities were available (as of 2010, a total of 2,551 municipalities

[8] However, the Federal Supreme Court of Switzerland restricted the autonomy of the cantons by declaring that regressive tax schedules violate the constitution. Furthermore, the tax base is widely harmonized by federal law.

[9] Including federal taxes (0.7%); rates are applicable to taxable income from the year 2010.

[10] Including federal taxes of 5.3%.

existed). Therefore, only advertisements involving apartments located in one of these 800 municipalities could be reconsidered. After having matched the advertisement data with other municipality-level variables, the final database contained 430,054 objects, namely, 336,121 apartments for rent and 93,933 apartments for sale.[11]

The revised dataset includes information on the following characteristics: code of the municipality where the apartment is located, year built, number of rooms, surface in square meters, average surface per room, and dummies for if the apartment has a view, a garage, or an elevator. Furthermore, some apartments are classified as being a duplex apartment, attic, penthouse, terrace house, loft, or a furnished apartment. In addition, the number of advertised days is of interest as an opportunity to control for non-observable differences between the advertised prices of the apartment and the final sales price. Finally, the dataset includes dummies for the year of advertisement, in order to consider price developments during 2004–2010.

Table 1 gives further information (summary statistics) on the dataset. About two-thirds of all apartments for rent were built after 1961, but two-thirds of all advertised apartments for sale were built after 1991. Apartments for sale are on average not only much newer, but also bigger: the average number of rooms is 4.3, and the average surface 121.9 square meters, compared to 3.4 rooms and 82.0 square meters for apartments for rent.

The matched statistics at the municipality level include: the median taxable income in the respective year[12] (source: Federal Tax Administration, FTA); the share of full-time employees in the first, second, and third sector (average of 2005 and 2008, SFSO); the share of secondary residences (year 2000 values from the SFSO); the share of residential and mixed-use zones that are undeveloped (year 2007 values, Federal Office for Spatial Development); and the proportion of newly constructed apartments with respect to the stock of all apartments (yearly values from the SFSO). Further, urban indicators are included (municipalities are classified as city, suburb, peri-urban, industrial or tertiary orientated, touristic, or rural)[13], and some dummy variables indicate if the apartments are located in the Alps or in the French-speaking part of the country. Last, the advertisement dataset needs to be matched with income tax statistics. This procedure will be discussed below.

[11] The data comparison between the advertisement and the Swiss Household Budget Survey, shown in figure 2, does not suggest any significant sample bias due to the exclusion of a substantial part of the raw data.

[12] Data for 2010 were not available at the moment of the study. Therefore, the statistics of 2009 are used for the period 2009-2010.

[13] According to the geographical classifications of the Swiss Federal Statistical Office. Rural and agrarian municipalities are classed together as "rural."

Table 1: Summary statistics

		apartments for rent				apartments for sale			
	variable	N	median	mean	s.d.	N	median	mean	s.d.
	Total	**336,121**				**93,933**			
apartment specific variables	*built <1901(reference)*	41,694				3,979			
	built 1901-1910	4,676				,372			
	built 1911-1920	3,122				,307			
	built 1921-1930	5,067				,348			
	built 1931-1940	6,938				,313			
	built 1941-1950	7,625				,281			
	built 1951-1960	30,707				1,010			
	built 1961-1970	49,167				4,233			
	built 1971-1980	39,892				10,694			
	built 1981-1990	46,406				10,584			
	built 1991-2000	42,385				16,622			
	built 2001-2005	30,243				13,034			
	built > 2005	28,199				32,156			
	number of rooms		3.5	3.4	1.2		4.5	4.3	1.1
	surface		82.0	85.5	35.1		119.0	121.9	42.7
	surface per room		24.0	25.3	7.4		27.1	28.2	7.7
	with view	94,068				42,699			
	with elevator	141,270				61,181			
	with garage	142,719				60,054			
	advertisement duration in days		23	50	79		57	113	157
	duplex apartment	16,190				8,026			
	attic	9,716				7,221			
	penthouse	12,420				5,354			
	furnished	4,961				233			
	terrace house	1,400				2,897			
	loft	1,266				541			
	other apartments (reference)	290,168				69,661			
	year of advertisement: 2004 (reference)	30,010				6,103			
	year of advertisement: 2005	44,033				8,379			
	year of advertisement: 2006	53,546				11,267			
	year of advertisement: 2007	56,946				15,695			
	year of advertisement: 2008	48,264				17,246			
	year of advertisement: 2009	50,226				16,863			
	year of advertisement: 2010	53,096				18,380			
location specific variables (at municipality level)	*median taxable income*		45,400	46,817	6,300		45,600	45,989	8,743
	share of employees in primary sector		0.005	0.015	0.027		0.015	0.032	0.044
	share of empl. in secondary sector		0.252	0.266	0.134		0.289	0.300	0.143
	share of empl. in tertiary sector (reference)		0.746	0.719	0.144		0.683	0.668	0.155
	share secondary residence		0.085	0.095	0.038		0.095	0.144	0.137
	share unbuilt area		0.149	0.148	0.067		0.172	0.183	0.081
	share new construction		0.005	0.012	0.021		0.009	0.019	0.030
	population number		17,086	79,573	117,387		8,432	29,836	68,864
	share population 65+		0.159	0.162	0.027		0.158	0.160	0.033
	location: center	153,196				23,828			
	location: suburb	130,342				34,121			
	location: peri-urban	18,153				10,463			
	location: industrial/tertiary	9,766				6,714			
	location: rural	3,971				3,282			
	location: touristic	1,388				8,096			
	location: wealthy municipalities (reference)	19,305				7,429			
	Alps	36,518				29,687			
	French speaking	29,925				14,804			
	German, Italian, Rhaeto-Romanic (reference)	306,196				79,129			

6.2 Matching advertisement data with income tax statistics

The aim of this work is to focus on the question of whether capitalization rates vary with respect to income—or, in other words, whether capitalization differs between luxury housing and frugal housing. To investigate this research question, one needs to know the hypothetical income tax burden for a given apartment. With respect to (11) and (12), this means that for each V_k a specific y_i must be assigned. In order to obtain this information, the following three-step procedure needs to be undertaken:

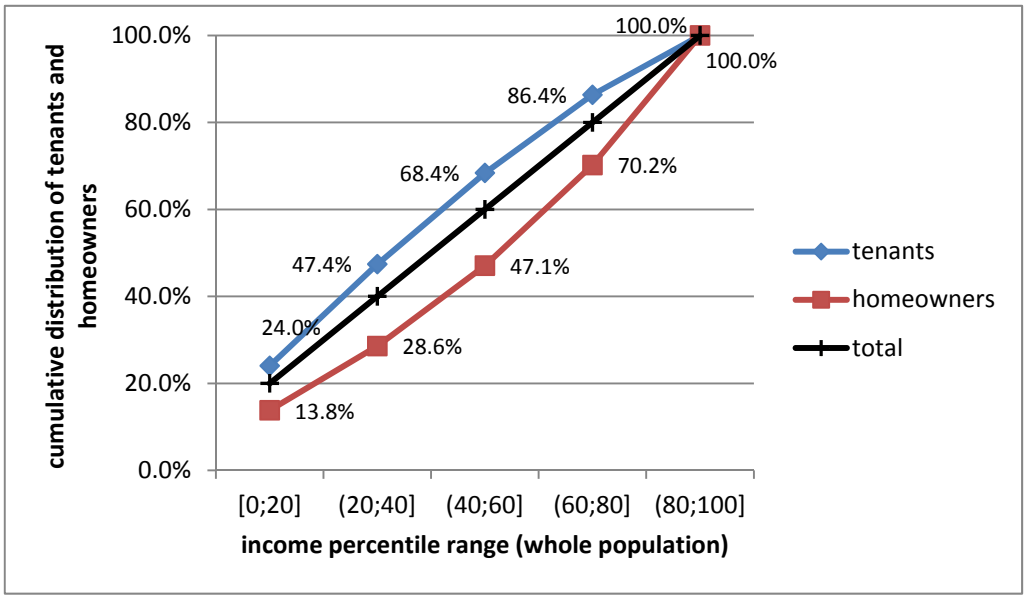
1. categorize apartments into relatively homogeneous groups k ($k=1,2,...,6$) assuming that every apartment within a group is demanded by the same interested party;
2. define household groups i ($i=1,2,...,6$) that are representative as housing demanders for a specific category of apartments; and
3. assign each apartment of a specific category k a representative household group i, where $k=i$, to determine the related income which is taxed at the location of the housing.

1. Categorizing apartments into relatively homogeneous groups of quality

For each spatial area, year, and number of rooms, apartments are ranked according to the advertised price and rental fee. The full dataset is then grouped in terms of the apartment ranking. This two-step procedure is comparable to an approach that ranks all apartments according to their price/rental fee after controlling for the spatial area, year, and number of rooms. This procedure assumes that every income percentile has the same household composition (the same distribution of demand for housing with respect to number of rooms), but that preferences with respect to quality of housing differ among income groups. Three different rankings are done: one where the spatial area is the spatial mobility region, a second where it is the canton, and a third where the spatial area is the whole of Switzerland; the last of these is identical to an approach that does not control for regional price differences.

The ranked apartments are grouped into one of the following six percentile ranges: [0; 20], (20; 40], (40; 60], (60; 80], (80; 90], and (90; 100]. Each specific income group demands one of these categories of apartments. However, one must take into account that the income distributions of homeowners and tenants differ. Figure 1 shows the different slopes of the cumulative distribution of tenants and homeowners, indicating that lower-income groups are overrepresented by tenants, and higher-income groups by homeowners.

Figure 1: Cumulative distribution of tenants and homeowners with respect to income groups



Source: Swiss household budget survey; authors own calculations.

According to figure 1, the lowest percentile range [0; 20] includes the 13.8% poorest homeowners and the 24% poorest tenants. We apply this distribution to the housing market, concluding that the 20% lowest-ranked apartments include the 13.8% lowest-ranked apartments for sale and the 24% lowest-ranked apartments for rent. The second percentile range (20; 40] includes the subsequent 14.8% (= 28.6% – 13.8%) of apartments for sale and the 23.4% of apartments for rent, and so on. Table 2 shows the number, mean prices/rents, median prices/rents, and standard deviation for every percentile range, all derived from this categorization. The mean of the advertised prices ranges between CHF 344,199 for the [0; 20] percentile and CHF 1,528,258 for the (90; 100] percentile, and the mean annual rents range from CHF 14,655 to CHF 43,137.

Table 2: Advertised prices and rents with respect to classes of apartments

a) Apartments ranked with respect to price differences within regions

k=	percentile class of apartment	apartments for rent (annual rent in CHF)				apartments for sale (advertised price in CHF)			
		N	mean	p50	sd	N	mean	p50	sd
1	[0;20]	85,984	16,182	15,696	6,777	17,979	472,985	390,000	476,529
2	(20;40]	78,701	18,937	18,408	7,033	13,999	522,505	470,000	256,739
3	(40;60]	70,367	21,452	20,400	8,785	16,633	605,659	530,000	314,377
4	(60;80]	59,343	24,777	23,160	11,176	21,345	732,648	615,000	471,937
5	(80;90]	22,120	29,014	26,640	14,145	13,018	909,331	750,000	564,474
6	(90;100]	19,606	37,064	32,400	20,388	10,959	1,299,247	995,000	1,050,659
	Total	336,121	21,511	19,500	11,290	93,933	719,734	570,000	598,568

b) Apartments ranked with respect to price differences within cantons

k=	percentile class of apartment	apartments for rent (annual rent in CHF)				apartments for sale (advertised price in CHF)			
		N	mean	p50	sd	N	mean	p50	sd
1	[0;20]	83,005	15,643	15,360	6,049	14,947	416,344	370,000	355,462
2	(20;40]	78,853	18,523	18,192	6,309	13,986	482,865	460,000	210,569
3	(40;60]	70,385	21,069	20,400	7,777	17,155	566,099	525,000	302,064
4	(60;80]	59,735	24,521	23,520	9,983	21,578	692,968	620,000	385,394
5	(80;90]	22,658	29,377	27,600	13,174	13,580	890,955	785,000	526,880
6	(90;100]	21,485	39,929	34,920	21,268	12,687	1,408,282	1190,000	1,035,865
	Total	336,121	21,511	19,500	11,290	93,933	719,734	570,000	598,568

c) Apartments ranked with respect to price differences within Switzerland

k=	percentile class of apartment	apartments for rent (annual rent in CHF)				apartments for sale (advertised price in CHF)			
		N	mean	p50	sd	N	mean	p50	sd
1	[0;20]	81,747	14,655	14,640	5,008	13,418	344,199	345,000	151,235
2	(20;40]	78,588	18,112	18,132	5,519	13,917	439,093	435,000	133,007
3	(40;60]	70,309	20,935	20,820	6,874	17,459	526,576	500,000	186,381
4	(60;80]	60,182	24,696	24,240	8,713	21,400	667,472	621,650	278,379
5	(80;90]	22,720	29,785	29,220	11,317	13,989	885,447	800,000	387,704
6	(90;100]	22,575	43,137	38,700	21,154	13,750	1,528,258	1293,000	1,067,337
	Total	336,121	21,511	19,500	11,290	93,933	719,734	570,000	598,568

Source: Authors own calculations.

2. Define household groups

Six subpopulation groups represent the Swiss income distribution. These types of households only differ with respect to gross household income (and not, for example, with respect to the number of household members). Group 1 earns a gross income that equals the 20th percentile of the Swiss income distribution. The gross income of group 2 corresponds to the 40th percentile, that of group 3 to the 60th percentile, that of group 4 to the 80th percentile, that of group 5 to the 90th percentile, and that of group 6 to the 95th percentile of the income distribution.

Information on the effective distribution of income in Switzerland is obtained from federal tax data and from the Swiss Household Budget Survey (SHBS). The advantage of the tax data is that they contain all taxpayers in Switzerland, whereas the SHBS is a relatively small sample (with an underrepresentation of high incomes). The drawback of the tax data is that only taxable income is available, along with some deductions that are applicable to the gross income. A comparison of the tax data[14] with the survey data shows that nonobservable tax deductions amount to approximately 20% of gross income (see table 3). Therefore, it seems more adequate to rely on SHBS data when calculating the percentile values of gross income. Because the 90th and 95th percentiles are not available from published SHBS data, one must rely on tax data for them. These values are calculated by multiplying gross taxable income by a factor of 1.2. Overall, the gross incomes of the six groups vary between CHF 55,320 (20th percentile) and CHF 235,881 (95th percentile).

Table 3: Gross income of different types of households

i =	**Income percentile**	taxable income 1)	estimated gross taxable income 2)	gross income 3)	diff. between 2) and 3)
1	**20**	15,900	44,800	55'320	23%
2	**40**	36,400	69,800	80'088	15%
3	**60**	52,900	90,000	107'436	19%
4	**80**	77,500	121,100	147'840	22%
5	**90**	105,400	154,100	184'795*	20%*
6	**95**	141,400	196,700	235'881*	20%*

1) Source: Income tax statistics 2009

2) Own calculations based on 1)

*3) Swiss Household Budget Survey 2006-2008; * mean difference of the 20th, 40th, 60th, and 80th percentiles.*

3. Assigning each apartment a specific household

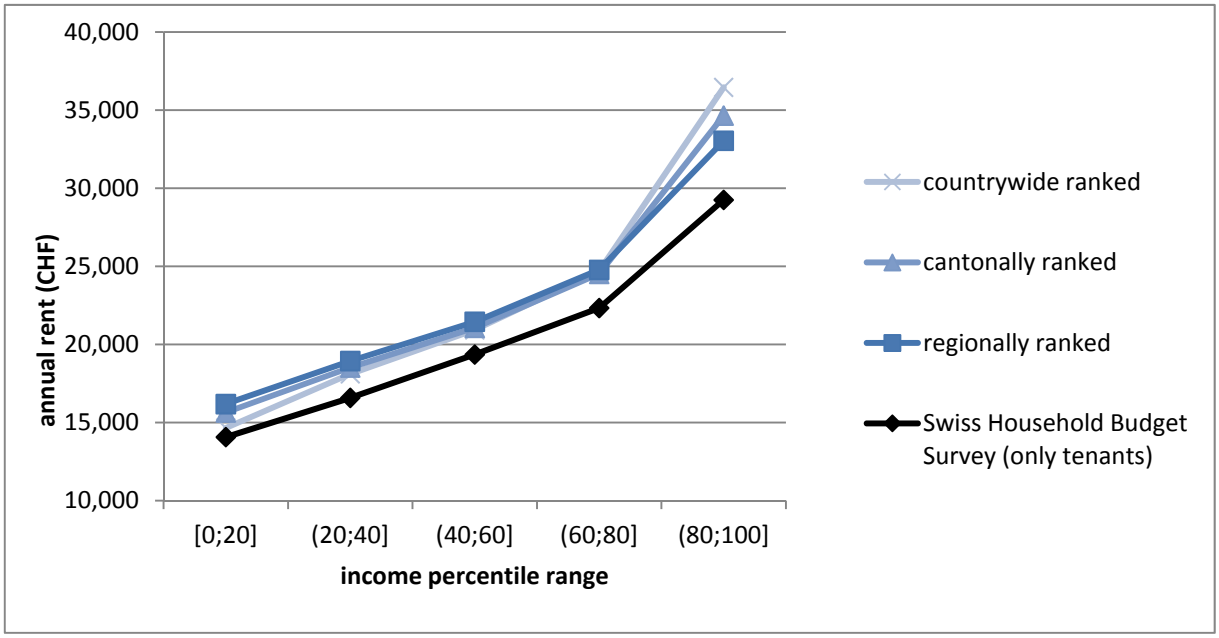
Having defined the household groups that represent specific types of housing demanders (see table 3) and having categorized the apartments into groups of different qualities (see table 2), the two tables are matched. Specifically, we assume that the [0; 20] percentile-range apartments are demanded by households earning a gross income that equals the 20th percentile of the overall income distribution, the (20; 40] percentile-range apartments are demanded by households with a gross income that equals the 40th percentile of the overall income distribution, and so on.[15]

[14] In order to estimate the gross income with tax data, all deductions which are available in the tax database as well as non-observable, hypothetical payroll taxes are added to the taxable income.

[15] The upper level of the range is chosen as income reference because of the fundamental assumption of the bidding model: The household with the highest willingness to pay gets the award. Only for the most luxury apartments – the ones that are in the (90; 100] percentile class – we assume that the typical interested person has

Until now, several assumptions were needed to assign each apartment a specific household. Therefore, it is ambiguous whether the matching procedure aligns with reality. Once more, the SHBS data can serve as a reference, to check for reliability. Expenditure data are publicly available for each income quintile. Figure 2 shows the housing expenditures for these different quintiles (including additional costs), derived from comparing the SHBS data and the advertisement dataset[16] that is grouped as per table 2.

Figure 2: Annual rent according to SBHS and advertisement data



Source: SHBS; authors own calculations.

In each income group and for each type of spatial ranking, advertised rents are higher than average housing expenditures, according to SHBS. However, the discrepancy between the two sources remains stable with respect to the various income classes. Up to the 80th percentile, the difference lies between 11% and 15%; only for the high-class apartments does the discrepancy increase up to 25% (if the spatial area is the whole of Switzerland—otherwise, the discrepancy is lower). Most likely, the difference between the advertisement data and the SHBS data exists because new-tenancy rents are, on average, higher than rented apartments that have already been let for an extended period. (Swiss tenancy law prevents tenants from high rent increases during the rental period.) SFSO statistics show that in 2003,

an income which equals the 95th income percentile (due to the fact that high incomes are distributed very unequally and therefore price bids in this whole group should, on average, not be based on the bid of the richest person in Switzerland).

[16] In figure 2, the (80; 90] and the (90; 100] percentiles are grouped together because these intervals are not separately available in SHBS data.

apartments that had been let for only one or two years were, on average, 13% more expensive than all rented apartments.

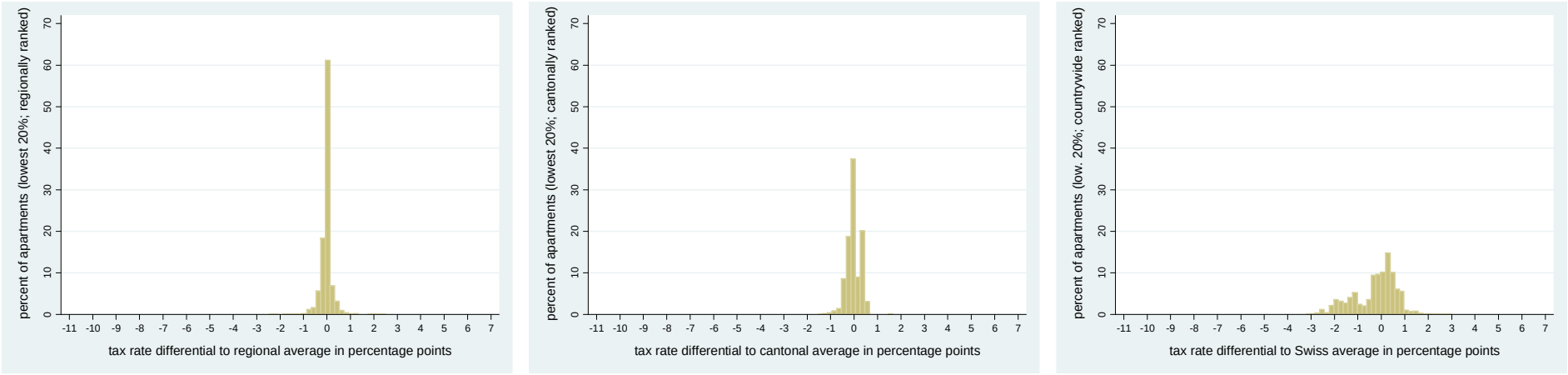
Overall, a comparison of these two sources suggests that the matching procedure is adequate; no systematical bias can be detected. Furthermore, the results of this check generally suggest that the advertisement dataset is not biased with respect to a specific class of apartment.

Having for every advertised apartment now a representative housing demander, one knows the potential income tax base for each apartment (see column 5 of table 3). Because published tax data are available only for specific income levels,[17] the tax burden of every specific income group is linearly interpolated by considering the values of its two nearest neighbors. Because capitalization shall be measured for different levels of tax competition, the tax variable is defined as its deviance to a spatial mean in percentage points of gross income. We choose three types of spatial means: the spatial mobility region, the canton, and the whole of Switzerland. Figure 3 shows the distribution of these tax differences for two classes of apartments: low-quality apartments (the bottom 20% ranked) and high-quality apartments (the 10% highest ranked). As can be seen, for low-quality apartments, the tax differentials are mostly negligible at the regional and cantonal level, and merely low on the Swiss level. With respect to high-quality apartments, the tax differential to the spatial average is in most cases within 3 percentage points. Tax differentials to the Swiss average, however, can amount up to 10 percentage points of gross household income, equaling CHF 2,359 annually.

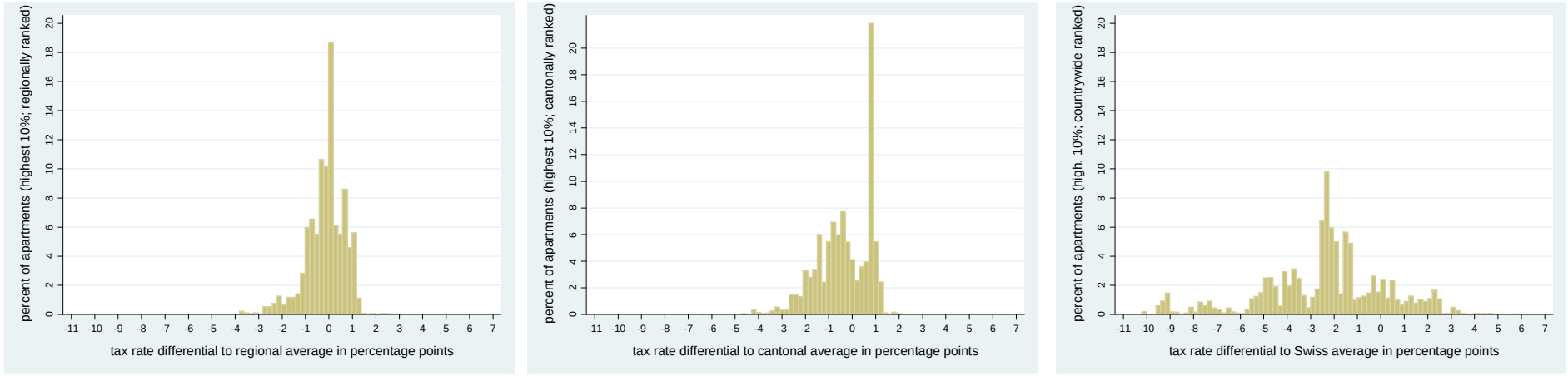
[17] The tax burden is available for 18 income levels and different types of households. As household type, we choose a married one-earner household with two children.

Figure 3: Distribution of the apartments with respect to their income tax differential to a spatial average

a. Low quality apartments (bottom 20%; tax rate of a household earning a gross income of CHF 55,320)



b. High quality apartments (top 10%; tax rate of a household earning a gross income of CHF 235,881)



Width of bins: 0.2 percentage points.

7 Results

7.1 Fixed vs. random effects model

Two main empirical models are potentially appropriate for equations (11) and (12): the cluster-specific (within) fixed effect (CSFE) model and the cluster-specific random effects (CSRE) model. As cluster variable, we choose the so-called spatial mobility (SM-) regions. SM-regions are relatively homogenous spatial groups of municipalities with a common regional center and can be regarded as small job market regions. Based on this definition, the municipalities have been divided into one of 106 Swiss regions.

Both the CSFE and the CSRE models can be applied in order to cluster the apartments into regions. If the cluster-specific effects are not correlated with the error term, the CSRE model is the more efficient estimator, but if this restriction does not apply, the CSRE model is inconsistent and the CSFE is the preferred estimator, with regard to consistency. As the clusters should control for any unobservable heterogeneity, especially in public service supply, which is most likely correlated with tax burden, it is likely that the CSFE model is the appropriate estimator.

To begin with a simple regression model, the control variables and a unique tax rate are applied to the entire dataset (instead of using the simulated, apartment-specific tax rate). We apply the tax rate of the municipality where the apartment is located to a gross income of CHF 147,840 (the 80^{th} percentile value), measured as the deviance from its spatial mobility average. This tax base is chosen, because the literature suggests that mainly the wealthy people are tax-sensitive. Table 4 shows the results for the CSRE and the CSFE models. Standard errors are robust to both arbitrary heteroskedasticity and intra-cluster correlation. As the results show, the coefficients are virtually identical if one compares the fixed and random-effects models. However, if one tests for overidentification restrictions (Arellano 1993; Wooldridge 2002)[18], the CSFE model is found to be clearly superior to the CSRE model; this finding is consistent with the assumption described above.

[18] The test was implemented in STATA with Schaffer and Stillman's (2010) *xtoverid* command.

Table 4: Cluster-specific random and fixed effects estimates

	apartments for sale				apartments for rent			
	CSFE		*CSRE*		*CSFE*		*CSRE*	
	Coef.	Robust S.E.	Coef.	Robust S.E.	Coef.	Robust S.E.	Coef.	Robust S.E.
tax differential	-0.0808***	0.0146	-0.0790***	0.0146	-0.0305***	0.0059	-0.0295***	0.0059
built 1901-1910	-0.0063	0.0733	-0.0064	0.0733	0.0525***	0.0179	0.0524***	0.0180
built 1911-1920	-0.0840	0.0790	-0.0837	0.0789	0.0224	0.0184	0.0224	0.0184
built 1921-1930	-0.0193	0.0526	-0.0202	0.0526	0.0077	0.0098	0.0077	0.0098
built 1931-1940	-0.0726**	0.0291	-0.0727**	0.0292	-0.0028	0.0121	-0.0027	0.0121
built 1941-1950	-0.1191***	0.0352	-0.1193***	0.0352	-0.0563***	0.0073	-0.0564***	0.0073
built 1951-1960	-0.1981***	0.0263	-0.1979***	0.0263	-0.0749***	0.0070	-0.0748***	0.0070
built 1961-1970	-0.1860***	0.0161	-0.1863***	0.0161	-0.0769***	0.0104	-0.0769***	0.0104
built 1971-1980	-0.1649***	0.0161	-0.1646***	0.0161	-0.0686***	0.0121	-0.0685***	0.0121
built 1981-1990	-0.0629***	0.0147	-0.0628***	0.0147	-0.0123	0.0147	-0.0124	0.0147
built 1991-2000	0.0100	0.0144	0.0099	0.0144	0.0411***	0.0150	0.0411***	0.0150
built 2001-2005	0.0718***	0.0133	0.0720***	0.0133	0.0699**	0.0282	0.0699**	0.0282
built > 2005	0.1071***	0.0188	0.1070***	0.0188	0.1197***	0.0260	0.1196***	0.0260
number of rooms	0.0974***	0.0081	0.0970***	0.0081	0.1131***	0.0110	0.1131***	0.0110
surface	0.0058***	0.0002	0.0058***	0.0002	0.0058***	0.0005	0.0058***	0.0005
surface per room	0.0045***	0.0010	0.0045***	0.0010	0.0014**	0.0007	0.0014**	0.0007
with view	0.0312***	0.0067	0.0314***	0.0067	0.0292***	0.0058	0.0292***	0.0058
with elevator	-0.0003	0.0060	-0.0001	0.0060	0.0156***	0.0047	0.0157***	0.0047
with garage	0.0219***	0.0052	0.0218***	0.0052	0.0018	0.0057	0.0019	0.0057
adv. duration	-7.7E-05***	1.2E-05	-7.7E-05***	1.2E-05	2.0E-04***	2.8E-05	2.0E-04***	2.8E-05
duplex apartment	-0.0288***	0.0072	-0.0290***	0.0072	-0.0053	0.0069	-0.0053	0.0069
attic	0.1833***	0.0129	0.1832***	0.0129	0.1448***	0.0077	0.1449***	0.0077
penthouse	0.0165*	0.0087	0.0163*	0.0087	0.0526***	0.0079	0.0526***	0.0079
furnished	-0.0598	0.0396	-0.0602	0.0396	0.2176***	0.0245	0.2179***	0.0244
terrace house	0.1479***	0.0145	0.1478***	0.0144	0.1423***	0.0149	0.1425***	0.0149
loft	-0.0906***	0.0315	-0.0908***	0.0315	0.1162***	0.0269	0.1163***	0.0269
year 2005	0.0097	0.0078	0.0096	0.0078	0.0038	0.0028	0.0037	0.0028
year 2006	0.0192**	0.0083	0.0192**	0.0082	0.0040	0.0035	0.0040	0.0035
year 2007	0.0352***	0.0106	0.0348***	0.0105	0.0147***	0.0049	0.0144***	0.0050
year 2008	0.0699***	0.0131	0.0694***	0.0130	0.0529***	0.0045	0.0525***	0.0045
year 2009	0.1085***	0.0137	0.1080***	0.0137	0.0697***	0.0052	0.0692***	0.0051
year 2010	0.1627***	0.0177	0.1619***	0.0177	0.0847***	0.0062	0.0842***	0.0062
median income	5.7E-06***	2.0E-06	6.0E-06***	2.0E-06	7.1E-06***	7.9E-07	7.3E-06***	7.8E-07
primary sector	-0.6314***	0.1831	-0.6387***	0.1813	-0.5621***	0.0991	-0.5733***	0.0984
secondary sector	-0.1997***	0.0504	-0.2038***	0.0501	-0.1056***	0.0280	-0.1091***	0.0280
sec. residence	0.8987***	0.2441	0.9001***	0.2406	0.3323***	0.0984	0.3320***	0.0932
unbuilt area	-0.1602	0.1343	-0.1652	0.1329	-0.0375	0.0370	-0.0425	0.0372
new construction	-0.1235*	0.0687	-0.1207*	0.0690	-3.3E-01***	9.65E-02	-3.3E-01***	9.65E-02
population	1.6E-06***	3.3E-07	1.6E-06***	3.2E-07	7.8E-07***	1.1E-07	8.0E-07***	1.05E-07
population 65+	0.8986***	0.3091	0.8893***	0.3053	0.3634***	0.1069	0.3450***	0.1072
center	-0.1233***	0.0339	-0.1254***	0.0338	-0.0439	0.0266	-0.0453*	0.0265
suburb	-0.1041***	0.0292	-0.1039***	0.0291	-0.0413*	0.0225	-0.0411*	0.0224
peri-urban	-0.0952***	0.0297	-0.0958***	0.0296	-0.0595***	0.0206	-0.0594***	0.0206
industrial/tertiary	-0.1528***	0.0318	-0.1551***	0.0317	-0.0777***	0.0244	-0.0790***	0.0244
rural	-0.1256***	0.0333	-0.1265***	0.0332	-0.0338	0.0233	-0.0340	0.0234
touristic	-0.0544	0.0607	-0.0537	0.0607	-0.0286	0.0390	-0.0211	0.0404
Alps	0.0288	0.0282	0.0277	0.0273	2.4E-02	1.89E-02	2.3E-02	1.83E-02
French	-0.2857***	0.0266	-0.0888	0.0818	-1.9E-01***	1.09E-02	-8.2E-02**	3.63E-02
constant	11.5877***	0.1243	11.4686***	0.1170	8.5052***	0.0608	8.4235***	0.0639
within R^2		0.7238		0.7238		0.7947		0.7947
Number of obs.		93,933		93,933		336,121		336,121

legend: * p<.1; ** p<.05; *** p<.01

The results show that for both rented and owner-occupied apartments, semi-elasticity is significantly negative. They also show that an increase in the tax rate by one percentage point, relative to the regional average, will lead to a reduction in apartment prices of about 8% for owner-occupied apartments and 3% for rented apartments, suggesting that capitalization for apartments for sale is about 2.5 times higher than that for apartments for rent. Most apartment-specific factors are statistically highly significant. For example, apartments built between 1931 and 1990 are significantly cheaper than old buildings built before 1901. Instead, new apartments for rent and for sale (built after 2001) are on average 7–12% more expensive. For any given apartment, the provision of one additional room would lead to an increase in price (rent) of about 10% (11%). If an apartment has a view, its price will be approximately 2–3% higher than if it had no view.

Furthermore, the estimation results show that the structural features of municipalities can explain differences in rents and prices. In municipalities with a large first or secondary sector, rents and prices are significantly lower than the national average. Prices and rents are higher than average in municipalities with high median incomes, with a high number of inhabitants, or with a high share of older citizens. Urban dummy variables were also found to explain some differences. Time dummy variables show that apartment prices/rents increased steadily after 2004. In 2010, prices were about 16% higher and rents increased about 8%, compared to 2004. Overall, the models for apartments for sale were able to explain up to 72% of within-region price heterogeneity; for apartments for rent, the goodness of fit was even higher.

7.2 Test of endogeneity

In order to control for endogeneity, estimations should be repeated with two-stage least squares (2SLS). As income tax instruments, the wealth tax rates are used. This is motivated by two considerations. First, the correlation between these variables is considerable.[19] Second, the wealth tax rate is likely to have been less endogenous in recent years, as tax competition between municipalities has been much more pronounced for income taxes than for wealth taxes.[20]

[19] For example, the correlation between the tax rate for gross family incomes of CHF 147,840 and assets of CHF 500,000 is between 0.67 and 0.74 within the time period 2004–2010 in the 800 largest municipalities.

[20] This stylized fact can be seen if one analyzes tax changes between 2004 and 2010 in terms of interquartile range (difference between the 75th and the 25th percentile). Whereas the interquartile range of property tax (assets of CHF 1 million) increased by 47.6%, it decreased for income taxes (income of CHF 150,000) by 17.4%. According to the race-to-the-bottom hypothesis, with increasing tax competition, tax differences should decline over time (as tax burdens converge toward a lower limit).

If 2SLS CSFE is applied to the wealth tax rate (difference to the mean of the spatial mobility) for assets of CHF 500,000, the semi-elasticities are virtually identical to those found for OLS estimates. For apartments for sale, semi-elasticity becomes -0.090 (compared to -0.081 for OLS), and for apartments for rent it becomes -0.031 (compared to -0.031 for OLS).[21] In order to test the quality of the instruments, it is necessary to implement an additional instrument. Otherwise, the model is just identified and the testing of instruments will not be possible. With this in mind, the 2SLS procedure can be repeated, additionally including the property tax rate differential for assets of CHF 100,000. In this case, the tax coefficient remains virtually unchanged (-0.085 for apartments for sale and -0.032 for apartments for rent). Furthermore, the overidentification test suggests that the instruments are exogenous. The Hansen-J-statistics give p-values of 0.22 (for apartments for sale) and 0.15 (for apartments for rent), which is highly insignificant. Underidentification test statistics (LM-test) show that the instruments are valid, with p-values below the 0.01% level. Finally, the hypothesis of exogeneity cannot be rejected by the Hausman test, for both apartments for rent and for sale. Due to the clear indication that OLS estimates should not be substantially biased, the following estimates have been based on the OLS method.

7.3 Capitalization and heterogeneity in income and housing demand

As this paper aims to investigate whether capitalization rates differ in terms of income (i.e., quality of housing), we now investigate separately each group of housing and apply the simulated tax rates, as discussed in section 6.2. As the primary interest is to obtain capitalization rates, rather than semi-elasticities, it is necessary to retransform the estimated tax coefficients which will be obtained below. Table 5 shows an equivalence scale that allows for the direct retransformation of semi-elasticity measures into capitalization rates for apartments for rent. As equal semi-elasticity estimates for apartments for rent and for sale demonstrate equal capitalization rates, the equivalence scale is also directly applicable to the apartments for sale. A semi-elasticity value of -0.0342 for the lowest 20% of regionally ranked apartments is equal to a capitalization rate of 100%. With respect to the top 10% ranked apartments, capitalization is full if the semi-elasticity amounts to -0.0636. A lower (higher) absolute semi-elasticity value means that taxes are only partially (more than fully) capitalized into housing prices.

[21] The estimation of the 2SLS cluster effects model and the subsequent tests were performed with Schaffer's (2010) *xtivreg2* module (STATA).

Table 5: Conversion of the semi-elasticity measures into capitalization rates

Income brackets / classes of apartments	gross income	Average yearly rental fee in CHF			full capitalization equals semi-elasticity of…1)		
		regionally ranked	cantonally ranked	country-wide ranked	regionally ranked	cantonally ranked	country-wide ranked
[0;20]	55,320	16,182	15,643	14,655	-0.0342	-0.0354	-0.0377
(20;40]	80,088	18,937	18,523	18,112	-0.0423	-0.0432	-0.0442
(40;60]	107,436	21,452	21,069	20,935	-0.0501	-0.0510	-0.0513
(60;80]	147,840	24,777	24,521	24,696	-0.0597	-0.0603	-0.0599
(80;90]	184,795	29,014	29,377	29,785	-0.0637	-0.0629	-0.0620
(90;100]	235,881	37,064	39,929	43,137	-0.0636	-0.0591	-0.0547

*1) This factor multiplied by the annual rent for the respective household yields a 100% capitalization rate: Example for the lowest income percentile (regionally ranked apartments): -0.0342*16,182 = -553.2= -1% * 55,320.*

Now, for each of the six classes of apartments, three sets of regressions are run: the first set includes the respective regionally ranked apartments; the logarithmized prices are regressed on the control variables and a tax variable. The tax variable is defined as the deviation in percentage points from the mean of the spatial mobility region. The second set includes the cantonally ranked apartments; their prices are regressed on the control variables and a tax rate that is defined as the deviation from the cantonal mean. The third set of regressions is the countrywide ranked apartments; their prices are regressed on the deviation from the average Swiss tax rate. Table 6 shows the semi-elasticity measures and the capitalization rates for these different regressions. With a few exceptions, the results suggest that capitalization is rarely full or greater than 100%. Overall, the table indicates three tendencies:

(1) *Capitalization decreases with increasing gross household income.* This result signifies that tax-induced migration is most profitable for households with middle and high incomes. For households with incomes of CHF 107,436 or more, tax-induced migration is profitable on average, as higher housing prices are more than offset by lower taxes.

(2) *Capitalization rates for apartments for sale are substantially higher than those for apartments for rent.* For all levels of tax competition and all classes of apartments, the capitalization rate for apartments for rent is significantly lower than 100%. An application of the Welch test shows that the higher elasticity of apartments for sale compared to apartments for rent is statistically significant at the 0.001 level, in most cases (except those at the Swiss national level, where capitalization for apartments for sale are insignificant or have the wrong sign). This signifies that property owners are

more tax-sensitive than renters at the moment of the search for a new apartment. This is rational, because property owners cannot escape future tax burdens.

(3) *Capitalization is substantial at the regional and cantonal levels, but low or insignificant at the national level*. The capitalization at the Swiss level is insignificant, statistically significant but with the wrong sign, or low, while capitalization on the regional and cantonal levels can even exceed 100% with respect to low-quality apartments for sale. At regional level, full capitalization cannot be rejected at the 5% level for the five lower classes of apartments for sale. However, full capitalization can be rejected in most cases at cantonal level and in all cases with regard to tax competition at national level. This signifies that tax competition is most intensive between nearby municipalities. This result is interesting, because as figure 3 shows, differences in tax rates are only modest within small regions, suggesting that migration owing to tax differences are more important at the national level.

Table 6: Capitalization for different qualities of apartments and different tax competition levels

			apartments for rent				apartments for sale			
	housing class percentile	**applied tax base**	**Coeff. (robust Std.Err.)**	**R^2 (within)**	**N**	**degree of capi-talization**	**Coeff. (robust Std.Err.)**	**R^2 (within)**	**N**	**degree of capitali-zation**
Capitalization at regional level	[0;20]	CHF 55,320	-0.0084* (0.0043)	0.818	85,984	**24.6%**	-0.0415 (0.0281)	0.797	17,979	-
	(20;40]	CHF 80,088	-0.0170*** (0.0047)	0.928	78,701	**40.2%**	-0.0647*** (0.0191)	0.811	13,999	153.0%
	(40;60]	CHF 107,436	-0.0162*** (0.0046)	0.923	70,367	**32.3%**	-0.0334*** (0.0105)	0.804	16,633	66.7%
	(60;80]	CHF 147,840	-0.0088** (0.0037)	0.903	59,343	**14.7%**	-0.0412*** (0.0144)	0.784	21,345	69.0%
	(80;90]	CHF 184,795	-0.0089** (0.0039)	0.889	22,120	**14.0%**	-0.0389** (0.0152)	0.764	13,018	61.1%
	(90;100]	CHF 235,881	0.0039 (0.0056)	0.792	19,606	-	-0.0371** (0.0148)	0.581	10,959	**58.3%**
Capitalization at cantonal level	[0;20]	CHF 55,320	-0.0099 (0.0092)	0.810	83,005	-	-0.0633** (.0309)	0.808	14,947	179.1%
	(20;40]	CHF 80,088	-0.0194*** (0.0052)	0.934	78,853	**44.8%**	-0.0430*** (0.0117)	0.867	13,986	99.5%
	(40;60]	CHF 107,436	-0.0202*** (0.0039)	0.933	70,385	**39.6%**	-0.0267** (.0116)	0.853	17,155	**52.4%**
	(60;80]	CHF 147,840	-0.0133*** (0.0034)	0.915	59,735	**22.0%**	-0.0231* (0.0117)	0.825	21,578	**38.3%**
	(80;90]	CHF 184,795	-0.0048 (0.0059)	0.910	22,658	-	-0.0183 (0.014)	0.809	13,580	-
	(90;100]	CHF 235,881	-0.0033 (0.0088)	0.786	21,485	-	-0.0141 (0.015)	0.605	12,687	-
Capitalization at national level	[0;20]	CHF 55,320	-0.0033** (0.0015)	0.808	81,747	**8.7%**	-0.0071 (.0045)	0.786	13,418	-
	(20;40]	CHF 80,088	-0.003*** (7.3e-04)	0.952	78,588	**6.3%**	0.004* (0.0021)	0.911	13,917	**-8.3%**
	(40;60]	CHF 107,436	-0.001 (8.9e-04)	0.957	70,309	-	-0.001 (0.0028)	0.907	17,459	-
	(60;80]	CHF 147,840	-0.0004 (.0014)	0.948	60,182	-	-0.0016 (0.0026)	0.894	21,400	-
	(80;90]	CHF 184,795	0.001 (0.0014)	0.953	22,720	-	-0.003 (0.003)	0.891	13,989	-
	(90;100]	CHF 235,881	-0.018** (0.0078)	0.784	22,575	**32.8%**	-0.013 (.0085)	0.651	13,750	-

* p<0.10, **, p<0.05, *** p<0.01, - insignificant; the boldface rates indicate significant difference from full capitalization at the 10% level.

7.4 Robustness check

In the following, the robustness of the results with respect to a potential multicollinearity problem will be checked. Semi-elasticity measures may be biased, because of a negative correlation between the tax rate variable and the median taxable income in the corresponding municipality. The correlation coefficients between the income variable and the different tax variables is nonnegligible, ranging from -0.13 (tax rate differential to Swiss average for gross incomes of CHF 55,320) to -0.55 (tax rate differential to Swiss average for incomes of CHF 235,881). To test whether the semi-elasticity is robust to this multicollinearity, the income variable is substituted with the unemployment rate of the municipality (year 2010 values) and the share of the population aged between 25 and 64 that has a tertiary education (year 2000 values). The correlation coefficient between these two variables and the tax variables is reduced substantially, in most cases. Nevertheless, replication of the results from table 6 shows that capitalization remains very close to previous results, with only minor deviations (see table 7).

7.5 Heterogeneity in capitalization and segregation tendencies at spatial mobility level

In the previous analysis, we did not take into account that the tax rate of other household groups, too, can determine the price of an apartment (as shown in equation (8)). In order to test for these aspects, the previous regression analysis is repeated for each apartment group, with one of the six tax rate differentials used in each case. Therefore, 72 regressions have been run (six classes of apartments, times six classes of households, for each of two owner types). The tax coefficients can now no longer be transformed to capitalization rates, because the chosen tax base and that of the potential resident no longer coincide. However, the statistical significance of the coefficients and the overall goodness of fit measure (within R^2) demonstrate which of the tax bases influences a specific group of apartments the most.

Table 7: Robustness check

			apartments for rent				apartments for sale			
	housing class percentile	**applied tax base**	**Coeff. (robust Std.Err.)**	**R^2 (within)**	**N**	**degree of capi-talization**	**Coeff. (robust Std.Err.)**	**R^2 (within)**	**N**	**degree of capitali-zation**
Capitalization at regional/spatial mobility level	[0;20]	CHF 55,320	-0.0124** (0.005)	0.818	85,984	**36.4%**	-0.0413* (0.0247)	0.797	17,979	**120.8%**
	(20;40]	CHF 80,088	-0.0190*** (0.0048)	0.928	78,701	**44.9%**	-0.0562*** (0.0167)	0.813	13,999	**132.8%**
	(40;60]	CHF 107,436	-0.0211*** (0.0046)	0.923	70,367	**42.2%**	-0.0299*** (0.0084)	0.805	16,633	**59.7%**
	(60;80]	CHF 147,840	-0.0155*** (0.0033)	0.903	59,343	**26.0%**	-0.0348*** (0.01)	0.785	21,345	**58.4%**
	(80;90]	CHF 184,795	-0.0138*** (0.0037)	0.889	22,120	**21.7%**	-0.0339*** (0.0107)	0.765	13,018	**53.2%**
	(90;100]	CHF 235,881	-0.0021 (0.004)	0.792	19,606	-	-0.0381*** (0.0112)	0.581	10,959	**59.8%**
Capitalization at cantonal level	[0;20]	CHF 55,320	-0.0077 (0.0101)	0.810	83,005	-	-0.0594* (.0332)	0.809	14,947	**168.0%**
	(20;40]	CHF 80,088	-0.0196*** (0.0051)	0.934	78,853	**45.4%**	-0.0365*** (0.0099)	0.867	13,986	**84.5%**
	(40;60]	CHF 107,436	-0.0215*** (0.0037)	0.933	70,385	**42.1%**	-0.0196** (.0086)	0.853	17,155	**38.4%**
	(60;80]	CHF 147,840	-0.0178*** (0.0034)	0.915	59,735	**29.5%**	-0.0148* (.0076)	0.825	21,578	**24.6%**
	(80;90]	CHF 184,795	-0.0082 (0.0058)	0.910	22,658	-	-0.0116 (0.0103)	0.810	13,580	-
	(90;100]	CHF 235,881	-0.0067 (0.0075)	0.785	21,485	-	-0.0167 (0.0143)	0.605	12,687	-
Capitalization at national level	[0;20]	CHF 55,320	-0.0035** (0.0016)	0.808	81,747	**9.2%**	-0.0076 (.0046)	0.786	13,418	-
	(20;40]	CHF 80,088	-0.0029*** (7.5e-04)	0.952	78,588	**6.6%**	0.0026 (0.002)	0.910	13,917	-
	(40;60]	CHF 107,436	-0.0013 (.001)	0.957	70,309	-	-0.0018 (.0027)	0.907	17,459	-
	(60;80]	CHF 147,840	-0.0015 (.0016)	0.948	60,182	-	-0.0026 (0.0023)	0.895	21,400	-
	(80;90]	CHF 184,795	0.0008 (0.0014)	0.953	22,720	-	-0.0030 (0.0027)	0.892	13,989	-
	(90;100]	CHF 235,881	-0.0191** (0.0085)	0.784	22,575	**34.9%**	-0.0144 (.0089)	0.652	13,750	-

* p<0.10, **, p<0.05, *** p<0.01

Table 8 shows the regression results for the regionally ranked apartments. The regression equations with the best goodness of fit for a specific class of apartment are marked in bold. Gray-shaded cells include the results from table 6. Concerning apartments for rent, the results suggest that spillover effects are negligible. For every group of apartment, the tax rate that fits the best the model is very close to the matched ceiled group (the gray-shaded cells and the cells with figures in bold do overlap in most cases, or are close together); the suggested tax base increases with increasing apartment quality. Concerning apartments for sale, however, the results are different: it seems that even for low and middle-quality apartments, the highest tax bases can explain better variations in advertised prices than can lower tax bases. This is the first indication that certain spillover effects may induce some type of segregation.

For a more explicit analysis of segregation tendencies, a regression analysis is run with municipality-level data. Specifically, as dependent variables, the change between 2004 and 2010 in the share of low-quality (high-quality) apartments to all apartments in a specific municipality is chosen. If there are some segregation tendencies, the share of low-quality apartments in a municipality should decrease over time, if the tax burden compared to a spatial average is low or if the tax burden decreases over time. Conversely, the share of high-quality apartments should increase over time in low-tax municipalities. One must remember that low-quality apartments are defined as the 20% cheapest ranked apartments within Switzerland and the high-quality apartments, as the top 10% most expensive apartments.

Table 8: Capitalization for different qualities of apartments and different income tax bases (tax rate differentials to regional average)

a) apartments for rent

		tax rate for gross household income of…					
apartment class		**55,320**	**88,088**	**107,436**	**147,840**	**184,795**	**235,881**
[0;20]	Coeff.	-0.0084*	**-0.0113****	-0.0081	-0.0059	-0.0045	-0.0035
	S.E.	(.0043)	**(.0047)**	(.0050)	(.0043)	(.0038)	(.0034)
	R^2	0.8179	**0.8179**	0.8179	0.8179	0.8179	0.8179
(20;40]	Coeff.	-0.0132***	**-0.0170*****	-0.0142***	-0.0103**	-0.0081**	-0.0065**
	S.E.	(.0044)	**(.0047)**	(.0048)	(.0040)	(.0035)	(.0030)
	R^2	0.9279	**0.9280**	0.9280	0.9280	0.9280	0.9279
(40;60]	Coeff.	-0.0092	-0.0169***	**-0.0162*****	-0.0123***	-0.0098***	-0.0080***
	S.E.	(.0058)	(.0053)	**(.0047)**	-0.0039	(.0034)	-0.0029
	R^2	0.9230	0.9231	**0.9231**	0.9231	0.9231	0.9231
(60;80]	Coeff.	-0.0048	-0.0105*	**-0.0112****	-0.0088**	-0.0073**	-0.0060**
	S.E.	(.0050)	(.0054)	**(.0047)**	(.0037)	(.0032)	(.0028)
	R^2	0.9034	0.9034	**0.9034**	0.9034	0.9034	0.9034
(80;90]	Coeff.	0.0009	-0.0105	-0.0134**	**-0.0109****	-0.0089**	-0.0076**
	S.E.	(.0079)	(.0070)	(.0058)	**(.0045)**	(.0039)	(.0034)
	R^2	0.8889	0.8890	0.8890	**0.8890**	0.8890	0.8890
(90;100]	Coeff.	0.0024	0.0035	0.0041	0.0035	0.0037	**0.0039**
	S.E.	(.0148)	(.0112)	(.0097)	(.0077)	(.0065)	**(.0056)**
	R^2	0.7924	0.7924	0.7924	0.7924	0.7924	**0.7924**

b) apartments for sale

		tax rate for gross household income of…					
apartment class		**55,320**	**88,088**	**107,436**	**147,840**	**184,795**	**235,881**
[0;20]	Coeff.	-0.0415	-0.0554**	-0.0603***	-0.0505***	**-0.0448*****	-0.0387***
	S.E.	(.0281)	(.0237)	(.0162)	(.0126)	**(.0116)**	(.01)
	R^2	0.7967	0.7972	0.7978	0.7979	**0.7980**	0.7980
(20;40]	Coeff.	-0.0578**	-0.0647***	-0.0596***	-0.0516***	-0.0451***	**-0.0388*****
	S.E.	(.0279)	(.0191)	(.0132)	(.013)	(.0125)	**(.0112)**
	R^2	0.8104	0.8113	0.8117	0.8122	0.8124	**0.8124**
(40;60]	Coeff.	-0.0284	-0.0333*	-0.0334***	-0.0307***	-0.0278**	**-0.0246****
	S.E.	(.0239)	(.0178)	(.0105)	(.0106)	(.011)	**(.0105)**
	R^2	0.8036	0.8039	0.8041	0.8044	0.8046	**0.8047**
(60;80]	Coeff.	-0.0441	-0.0546***	-0.0486***	-0.0412***	-0.0358**	**-0.0309****
	S.E.	(.0293)	(.02)	(.0146)	(.0144)	(.0137)	**(.0123)**
	R^2	0.7826	0.7833	0.7835	0.7838	0.7838	**0.7839**
(80;90]	Coeff.	-0.0678*	-0.0691***	-0.0568***	-0.0455***	**-0.0389****	-0.0328**
	S.E.	(.0368)	(.0246)	(.0176)	(.0162)	**(.0152)**	(.0134)
	R^2	0.7630	0.7636	0.7636	0.7637	**0.7637**	0.7637
(90;100]	Coeff.	-0.0469	-0.0640**	-0.0570***	-0.0505***	-0.0431**	**-0.0371****
	S.E.	(.0423)	(.0272)	(.0186)	(.0173)	(.0165)	**(.0148)**
	R^2	0.5797	0.5805	0.5808	0.5812	0.5813	**0.5813**

* p<0.10, **, p<0.05, *** p<0.01

Note: Regression models with best within-R^2 for a given class of apartments are marked in bold; regression results from table 6 are gray-shaded.

The endogenous variables are regressed on each of the following: the share of apartments in the respective class as of 2004, the tax rate differentials to the regional average in 2004 (the 90th income percentile is chosen as the tax base), the change in the tax rate differential during 2004–2010, population growth, income growth, and on other, aforementioned municipality control variables. As above, regressions estimates are clustered at the spatial mobility level. The results (table 9) show that for both low-quality apartments for rent and for sale there were significant positive tax coefficients. A tax rate that was, in 2004, one percentage point below the regional average led to a decrease in the share of low-quality apartments in the amount of 3.0 (apartments for rent) and 4.0 (apartments for sale) percentage points during 2004–2010. Additionally, a one-percentage-point decrease in the tax rate during 2004–2010 led to a statistically significant decrease in the share of low-quality apartments, both for rent and for sale; the magnitude is even larger. With respect to high-quality apartments, tax coefficients do have the expected negative signs. The coefficients are significant, however, only for apartments for sale.

Table 9: Testing for segregation tendencies

	apartments for rent				**apartments for sale**			
	low quality [0;20]		*high quality (90;100]*		*low quality [0;20]*		*high quality (90;100]*	
	Coef.	Robust S.E.	Coef.	Robust S.E.	Coef.	Robust S.E.	Coef.	Robust S.E.
share, 2004	-0.8698***	0.0386	-0.9345***	0.0912	-0.9855***	0.0447	-0.7783***	0.0770
tax differential, 2004 (t_04)	2.9639*	1.5272	-0.8120	0.7640	4.0319***	1.4896	-2.3718**	0.9601
t_10 - t_04	5.2438**	2.4538	-0.3393	1.1982	6.8804**	2.8398	-2.6141*	1.3242
median income, 2004 (inc_04)	-1.1E-03***	3.3E-04	1.6E-04*	8.0E-05	-6.5E-04*	3.4E-04	1.1E-04	2.4E-04
inc_10 - inc_04	-6.5E-04	5.8E-04	4.1E-04	2.7E-04	-9.9E-04	9.0E-04	9.9E-04*	5.2E-04
population, 2004 (pop_04)	-1.9E-04***	5.6E-05	4.7E-05***	1.6E-05	-2.4E-05	4.5E-05	1.2E-04**	5.0E-05
pop_10 - pop_04	-0.8361***	0.1683	0.0206	0.0662	-0.2630	0.1809	-0.1314	0.1318
empl. primary sector	16.7192	30.9019	-11.8532*	6.2680	13.0796	26.4923	-34.6004**	14.0884
empl. secondary sector	11.4261	8.5988	-0.7890	2.7566	13.5633*	8.0301	-6.9560*	3.8163
secondary residence	-45.5089	32.0960	30.0050***	9.5778	-39.9675**	16.8827	47.4542**	18.9549
share unbuilt area	10.5011	17.6264	-3.4019	4.5034	3.4745	16.3920	-18.6345***	6.9262
center	-2.3606	5.2344	-9.1648**	3.7160	-5.6126	4.8423	-13.9811***	3.8546
suburb	-3.0823	4.3629	-9.4103***	3.5940	-8.2729**	3.6550	-12.7776***	3.9367
peri-urban	-3.8951	4.6562	-9.7067***	3.6818	-3.5030	4.0766	-12.4752***	3.8070
industrial/tertiary	-5.3771	6.8602	-8.5257**	3.5599	-8.4510	5.2196	-12.2084***	3.9715
rural	-5.4975	6.9645	-7.6818**	3.6592	3.4778	7.5545	-10.7924**	4.3558
touristic	-12.2052	9.5157	-12.8536***	4.4269	-13.5947**	5.2148	-13.8298**	5.6561
Alps	2.8256	4.3285	2.5511*	1.5318	6.5142	6.2916	8.4722***	3.1166
constant	94.5309***	19.2863	0.5373	5.1265	55.4172***	16.7171	10.6544	13.8864
within R^2		0.5819		0.6099		0.6681		0.5467
Number of obs.		588		588		546		546

legend: * p<.1; ** p<.05; *** p<.01

Overall, the results suggest that income taxes do influence the advertised prices and/or the quality of the supplied housing. This indicates segregation-oriented tendencies.

8 Conclusion

To what extent do interregional tax differences capitalize into housing prices? The answer to this question is of interest for social policy reasons. If tax and public service differentials are fully capitalized, then every property owner will implicitly pay the same price for public services, because public goods prices and housing prices will counterbalance each other. In this case, redistribution will not be possible. However, with regard to income taxes, capitalization will rarely be exactly 100%. The degree of capitalization is something personal, depending on household income, tax rate, and housing consumption, which means that there is no single "true rate." Households that are confronted with a personal capitalization rate that is higher than 100% are better off when they reside in high tax regions, all other things being equal. For households with a personal capitalization rate of less than 100%, it is more profitable to reside in low tax municipalities. This results in social segregation and makes redistribution more difficult.

This study differs from previous studies on income tax capitalization in the way that it estimates capitalization rates for different types (i.e., levels of quality) of apartments and household groups. Estimations were performed by using a large dataset containing advertised prices for more than 430,000 apartments from across Switzerland, between 2004 and 2010. The results support the hypothesis that there is no "one true capitalization rate," meaning that capitalization varies substantially, depending on the quality of the apartment, which coincides with household income. In most cases, capitalization is only moderate. These results indicate that full capitalization does not occur at the national level, even within the geographically small country of Switzerland. However, full capitalization is observed for tax differentials between nearby municipalities, with respect to low-quality apartments. Finally, this study finds clear indications that regional tax rate differentials lead to supply-side adaptations in the housing market. Low income taxes and tax cuts in a municipality resulted in a decline in the supply of low-price apartments and an increase in high-quality apartments during 2004–2010.

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