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Capitalization of Fiscal Variables and Land Scarcity

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Capitalization of Fiscal Variables and Land Scarcity

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Abstract

Fiscal packages usually capitalize into house prices. But if enough land for construction is available, housing developers can supply new houses and capitalization may disappear. We provide a theoretical model in which income taxes and public services capitalize at lower rates when housing supply elasticity increases. Using an empirical linear interaction model, we estimate the impact of available land for construction on capitalization rates with a panel of Swiss communities. Results indicate that fiscal variables do not capitalize differently in communities where housing supply is constrained by land availability. Thus, land availability is not sufficient for capitalization to disappear.

Key words: Capitalization, Land Scarcity, Taxes, Local public goods.

JEL Classification: R21, R31, H40.

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1 Introduction

Households usually bid higher prices for houses in communities with lower taxes and higher public service levels to obtain their preferred fiscal package. This leads to capitalization of fiscal differences into house prices. In his seminal paper, Oates (1969) confirms empirically that taxes and public expenditures are capitalized into property prices. Many papers confirm Oates's result in the subsequent empirical capitalization literature: Oates (1973), Johnson and Lea (1982), Reinhard (1981), Richardson and Thalheimer (1981), Yinger et. Al. (1988), Palmon and Smith (1998) and others report significant and negative tax capitalization. Yinger (1981, 1982) shows that capitalization is a feature of long-run equilibrium in a theoretical urban model with several local jurisdictions which decide on their own levels of taxes and public expenditures. As housing suppliers build new houses in fiscally attractive communities, land becomes scarcer and prices rise. Hence, changes in housing demand due to attractive tax-public spending combinations raise the price of housing.

However, authors such as Edel and Sclar (1974), Henderson (1985) or Henderson and Thisse (2001) state that capitalization should not occur in equilibrium if land and housing developers react to fiscal differences between communities. They argue that if land for new construction is available, housing developers supply new houses in fiscally attractive communities until prices are equalized. As a result, fiscal variables do not capitalize. There is some empirical evidence supporting the no capitalization hypothesis: Wales and Wiens (1974), Chinloy (1978), and Gronberg (1979) do not find capitalization of taxes into property values while Edel and Sclar (1974) show that the degree of capitalization decreases over time. Thus, there is an old conflict in the theoretical and empirical literature whether capitalization of fiscal variables really occurs or not.

This paper contributes to the debate by comparing differences in capitalization of fiscal variables between communities with available land resources to communities where land is scarce. We analyze the impact of land availability on the extent of capitalization. Land availability serves as a proxy for housing supply elasticity. In a theoretical model which combines the basic ideas of the two competing literature branches, we show that capitalization of fiscal variables depends on the elasticity of housing supply. If housing supply is perfectly elastic due to ample construction possibilities, the reasoning of Edel and Sclar (1974) as well as Henderson (1980, 1985) can be applied. In equilibrium fiscal variables do not capitalize into property values. On the other hand, if housing supply is inelastic because of land scarcity, capitalization persists as price differences are then driven by the demand side and suppliers cannot compensate demand shocks. A testable prediction from these theoretical contributions is that if housing supply reacts then capitalization of fiscal variables should be lower in communities with large land resources for construction. In contrast, communities with small construction areas should see higher capitalization. If no construction areas are available, supply cannot react even if enterprises would like to build new houses. Thus, the availability of land for construction is a necessary condition for housing supply to react.

We then bring our model to the data and analyze empirically whether there is higher capitalization of fiscal variables when construction areas are scarce. We use a panel dataset of 169 local jurisdictions from 1998 to 2004 in the Swiss Canton of Zurich which includes a comprehensive list of controls for public spending, mobility issues concerning individuals and location specific characteristics. Moreover, our dataset allows us to study capitalization effects of different public expenditure categories as opposed to most of the literature. Two approaches allow us to identify differences in capitalization rates over communities depending on construction space availability. The first approach is to divide the dataset into two samples, a "No space available" and a "Space available" set. Capitalization coefficients of fiscal variables should be smaller for the "Space available" set if housing suppliers react to differences in capitalization. In a second step, we directly use the amount of available land for construction and interact it with all fiscal variables. If housing supply reacts to capitalization, the interaction effects together with the base effects in the estimations should tend to zero for communities with ample construction possibilities.

The general finding of this paper is that capitalization does not significantly diminish when more land for construction is available. Even though capitalization of fiscal variables is usually lower for communities in the "Space available" set, differences are not statistically significant. Thus the hypothesis that housing supply reacts more when land for construction is available can be rejected and empirical evidence seems to support the pro-capitalization fraction. Instrumental variable estimates with geographic instruments show that the results are not driven by politically induced changes in the amount of available construction area within different communities. By analyzing differences in capitalization of fiscal variables between communities with and without available land resources, this paper offers a more comprehensive insight of how fiscal variables influence house prices.

The results indicate that housing supply reactions do not only depend on the relative scarcity of land. Thereby, we complement the existing literature on capitalization and land availability. Recently, Brasington (2002) argued that the two views of the capitalization debate would be consistent if housing supply reactions were accounted for. Housing developers have few opportunities to realize new housing projects near to the center due to high population density and land scarcity. Conversely, at the urban edge more land for construction is available and suppliers can react. Thus, fiscal variables should capitalize at higher rates toward the interior of the urban area than at the edge. Brasington (2002) confirms this hypothesis with data from the United States. Hilber and Mayer (2009) provide additional support by showing with data from Massachusetts that capitalization of school spending significantly decreases when a jurisdiction has more developable land. Indeed, housing supply cannot be elastic if land for construction is scarce. However, it will not necessarily be elastic if land for construction is available. Housing supply reactions are likely to be influenced by other factors which distinguish Europe from the United States, such as political zoning decisions, uncertainty concerning the stability of fiscal differences between communities, opposition of existing property owners. Thus, available land for construction is only a necessary but not sufficient condition for housing supply reactions to occur and our results indicate that capitalization of fiscal variables may persist even in communities with ample construction opportunities.

The sequel of this paper is organized as follows: Taking account of the intensive discussion in the literature we develop a simple theoretical model in Section 2 that shows the link between demand and supply in the housing market with capitalization of income taxes and public services. Section 3 presents two approaches to identify differences in capitalization between communities where land is available and communities where land is scarce. The main variables for capitalization used in the literature as well as additional controls are employed in our setting. Section 4 summarizes the results and concludes.

2 Basic model

To illustrate the different ideas of the capitalization debate, we present a simple model with income taxes which puts together the two competing strands of literature.[1] We consider a metropolitan area composed of I jurisdictions and inhabited by N residents who are perfectly mobile and have identical tastes and incomes. A household's income $\bar{y}$ in a jurisdiction i can be spent on a homogenous consumption good x_i with unit price and on housing services h_i with price p_i. The household has to pay income taxes $T_i = t_i \bar{y}$. In return it receives public services g_i. When choosing a residential location, the household considers the level of taxes and public services as given. In other words, a representative household maximizes a separable utility function

$$U = u(x_i, h_i) + \gamma(g_i), \tag{1}$$

with standard properties,[2] taking account of the budget constraint

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1 Similar models with property taxes have been used by Epple and Zelenitz (1981) and Hilber and Mayer (2002).

2 The separability assumption simplifies the analysis as it ensures that a change in public service level does not affect the demand for housing.

$$y = x_i + p_i h_i, \tag{2}$$

where $y = \bar{y} - T$ is the disposable income. Following Yinger (1982) the community's budget constraint is not included in the household's maximization problem. When looking for a jurisdiction to live in, households consider tax-expenditure combinations as given. The household's maximization problem yields the indirect utility function $V(y, p_i, g_i)$. Due to perfect mobility, utility must be equal and fixed in all jurisdictions (see Epple and Zelenitz, 1981):

$$V(y, p_i, g_i) = V(y, p_j, g_j),\ i = 1, \ldots, I,\ j \neq i. \tag{3}$$

All N residents of the metropolis must be housed such that

$$\sum_{i=1}^{I} n_i = N, \tag{4}$$

where n_i is the number of households residing in jurisdiction i. Equilibrium requires that housing market clears in each jurisdiction

$$n_i h_i(p_i) = H_i(p_i),\ i = 1, \ldots, I, \tag{5}$$

where $h_i(p_i)$ denotes housing demand per resident and $H_i(p_i)$ aggregate housing supply in community i. As noted by Hilber and Mayer (2002), the use of aggregate housing supply simplifies the analysis but is analogous to the case of an elastic supply of land. Substituting (5) in (4), we obtain

$$\sum_{i=1}^{I} \frac{H_i(p_i)}{h_i(p_i)} = N. \tag{6}$$

Equations (3) and (6) implicitly define equilibrium house prices as a function of disposable income and thus taxes, public goods as well as price elasticities of housing supply and demand. To analyze the impact of public goods on housing prices in a jurisdiction i, we therefore differentiate (3) and (6) with respect to g_i:[3]

$$-h_i \frac{\partial p_i}{\partial g_i} + h_j \frac{\partial p_j}{\partial g_i} = -MRS_i, \tag{7}$$

$$\frac{n_i}{p_i}(\eta_i - \varepsilon_i)\frac{\partial p_i}{\partial g_i} + \sum_{j \neq i} \frac{n_j}{p_j}(\eta_j - \varepsilon_j)\frac{\partial p_j}{\partial g_i} = 0, \tag{8}$$

where $MRS_i = \frac{\partial V / \partial g_i}{\partial V / \partial y_i}$ is the marginal rate of substitution between public goods and income, $\eta = \frac{\partial H}{\partial p}\frac{p}{H} > 0$ is the price elasticty of housing supply, and $\varepsilon = \frac{\partial h}{\partial p}\frac{p}{h} < 0$ is the price elasticity of housing demand. Substituting (7) in (8) and solving for $\partial p_i / \partial g_i$ yields:

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[3] Detailed steps for all equations of the model are shown in the joint supplementary material at the end of this paper.

$$\frac{\partial p_i}{\partial g_i} = \frac{\Omega MRS_i}{\frac{n_i}{p_i}(\eta_i - \varepsilon_i)h_j + \Omega} > 0, \tag{9}$$

where $\Omega = \sum_{j \neq i} \frac{n_j}{p_j}(\eta_j - \varepsilon_j)h_i > 0$. Under standard assumptions regarding housing demand and supply elasticities ($\eta - \varepsilon > 0$) and the utility function ($MRS > 0$), public goods capitalize positively into housing prices. Derivation of the tax capitalization effect is similar to the public goods case. We find that

$$\frac{\partial p_i}{\partial t_i} = -\frac{\Omega \bar{y}}{\frac{n_i}{p_i}(\eta_i - \varepsilon_i)h_j + \Omega} < 0, \tag{10}$$

an increase in tax rate capitalizes negatively. Equations (9) and (10) are equivalent to the results of Hilber and Mayer (2002) when there are only two communities in the metropolitan area.

As already argued by Yinger (1981, 1982) for inelastic housing supply, public goods capitalize positively whereas taxes capitalize negatively. However, if enough land for construction is available, supply may be perfectly elastic, i.e. $\eta_i \to \infty$ and we obtain:

$$\lim_{\eta_i \to \infty} \frac{\partial p_i}{\partial g_i} = 0, \tag{11}$$

$$\lim_{\eta_i \to \infty} \frac{\partial p_i}{\partial t_i} = 0. \tag{12}$$

Thus, for perfectly elastic supply, the model predicts that capitalization of fiscal variables does not persist, as argued by Edel and Sclar (1974), Hamilton (1976a, 1976b) or Henderson (1985).

The supply elasticity in a community may increase when more land is available. We can compute the effect of an increase in housing supply elasticity on capitalization by differentiating (9) and (10) with respect to η_i.

$$\frac{\partial^2 p_i}{\partial g_i \partial \eta_i} = -\frac{(\Omega MRS_i)\left(\frac{n_i}{p_i}h_j\right)}{\left(\frac{n_i}{p_i}(\eta_i - \varepsilon_i)h_j + \Omega\right)^2} < 0, \tag{13}$$

$$\frac{\partial^2 p_i}{\partial t_i \partial \eta_i} = \frac{(\Omega \bar{y})\left(\frac{n_i}{p_i}h_j\right)}{\left(\frac{n_i}{p_i}(\eta_i - \varepsilon_i)h_j + \Omega\right)^2} > 0. \tag{14}$$

Thus, we find that housing supply elasticity negatively affects the extent of capitalization of public goods and taxes.

3 Estimation of differences in capitalization

3.1 Data

For our purposes, we use a panel dataset of 171 communities from 1998 to 2004 on the Swiss Canton of Zurich which includes a comprehensive list of controls for public expenditures, mobility issues concerning individuals as well as location specific characteristics. The variables, their definition, sources, medians, means and standard deviations are given in Table 1. The metropolitan area of Zurich has approximately 1.3 million inhabitants which makes it the most populous of all 26 Swiss cantons. Moreover, it is also one of the most densely populated areas in Europe. The City of Zurich is the economic core of the agglomeration and the biggest city in Switzerland. Including commuters, around a million people either work or live there.[4] Because of their high degree of autonomy, the communities of the canton of Zurich are an ideal laboratory in order to test the influence of differences in capitalization rates of local government expenditures and taxes.

< Table 1 here >

As dependent variable, we use the price of a standardized single family house with five rooms, two bath rooms, 450 square meters garden area, 750 cubic meters volume, end-terrace house, and one garage space. Such a price is available for every community over the years 1998 to 2004. The data was obtained from the Cantonal Bank of Zurich, the largest real estate bank in the canton, which evaluates houses by the sales comparison approach based on actual transactions. The sales comparison approach is a commonly used valuation method in real estate appraisals. The Cantonal Bank of Zurich uses a set of over 15000 house sales in the canton to determine the magnitude of construction specific attributes only, such as the number of rooms, the age of the house, the number of bathrooms etc. on property values in the canton's communities. The comparable single family house for each community with the same construction attributes is derived from the estimates and used for economic decisions including mortgage provisions. Bourassa et al. (2008) make a case for using house price measures based on actual transaction by showing with Swiss data from 1985 to 2006 that medians of list prices may overstate price changes. By looking at comparable houses for each local jurisdiction we can focus on differentials between communities and house characteristics such as the age of the housing stock may be neglected.[5]

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4 For further information see the Statistical Office of the Canton of Zurich on http://www.statistik.admin.ch.

5 Capitalization studies such as Stull and Stull (1991), Palmon and Smith (1998) or Brasington (2001) look at heterogeneous houses and consequently have to control for housing characteristics such as the age of the house, number of rooms, the size of the house. Studies such as Oates (1969), Ketkar (1992)

Our independent variables were obtained from the Statistical Office of the Canton of Zurich, the Secretary for Education of the Canton of Zurich, the Financial Statistics of the Canton of Zurich and the Cantonal Bank of Zurich. The variables include an array of different public expenditure categories, income tax rates, a number of demographic as well as location specific controls.

Table 1 shows that we dispose of a number of fiscal variables including taxes and different expenditure categories that allow us to analyze fiscal bundles as proposed by our model. The canton's local jurisdictions are autonomous: Swiss communities have the possibility to levy income taxes via a municipal tax rate (collection rate) fixed by the community itself at a yearly basis. The collection rate is added to the cantonal base tax (in German: allgemeine Staatssteuer) which varies from canton to canton.[6] Minimum standards for public goods are often set by the canton or the federal government.[7] To some extent, this reduces the drawbacks of controlling for public good provision by different proxies which can be a problem according to Palmon and Smith (1998). Following the introduction of a harmonized public accounting system for bookkeeping and budgeting, reliable and consistent municipal financial data for different expenditure categories are available for all communities in our dataset. The literature often focuses on education aspects and school characteristics when analyzing house prices (see, for example, Brasington, 1999 or Figlio and Lucas, 2004). We include a measure of the distance to the next school in meters and control whether the school is managed by the community itself or a separate school community.[8] Furthermore, we take account of the class size in primary schools.[9]

In the empirical analysis, it is common to control for median incomes, population density and the fraction of elderly people in the community. Besides, we take account of mobility issues by including the fraction of commuters that leave the community every day. The unemployment rate and the fraction of foreigners are also used for robustness tests and represent additional controls for population and demographic effects. Finally, our dataset allows us to control for location specific variables. These include the view of the lake, south and west exposition in the community, the distance to Zurich main station and therefore to the economic core, distance to the next shopping center and the pollution

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or Reback (2005) use the median or average value of a house in a district. Estimation results with comparable houses improve comparability and robustness.

6 In the US, property taxes are usually analyzed. For Swiss communities the main municipal tax is imposed on incomes. Stull and Stull (1991) analyze income taxes in the Philadelphia area and refer to the increasing importance of this revenue source for US local governments.

7 In the field of environmental policy, for example, the federal government systematically issues legal rules for the preservation of the ecosystem. On the local level these rules usually affect water resources, sewage treatment, garbage collection, and air control measures.

8 See Frey and Eichenberger (2002) for a theoretical discussion of functional organization of jurisdictions.

9 Strict minimum standards as well as clear and comparable study curricula result in the fact that educational quality differences between public and private schools in Zurich are minor.

level.[10] Municipal characteristics concerning location specific attributes such as demographic structure and unemployment rates show a lot of variance between the communities and over time. To test our main prediction, we use available construction area as a proxy for housing supply elasticity. Available construction area ranges from communities with almost zero square meters per capita to communities with approximately 140 square meters per capita, enabling us to analyze the effects of construction possibilities on capitalization rates.

In our analysis, we do not include cities of Zurich and Winterthur. As opposed to the other communities they are considered as cities and have a different structure: Zurich and Winterthur have each a number of separate districts that form these cities. The districts differ in important aspects such as median incomes, unemployment rates, and the fraction of foreigners. Furthermore, Zurich is the center of the canton and we control for the distance to the center in order to treat mobility issues. Most importantly, the two cities are large with respect to the rest of the communities in the canton.[11]

3.2 Analysis of separate samples

Our theoretical model shows that the extent of capitalization declines when the elasticity of housing supply increases. Unfortunately, we do not dispose of direct measure of housing supply elasticity. However, two different methods allow us to identify differences in capitalization of fiscal variables over space. Each of the approaches uses an amenity model setting which is common in the literature (see, for example, Brasington, 2000, 2002).

The first approach is to divide the dataset into two distinct samples. Average available construction area in the year 1998 over all 169 communities in the dataset was 55.425 square meters per capita. Communities with less than 55.425 square meters of available construction area per capita form the "No space available" set while communities with more than (or equal to) 55.425 square meters per capita form the "Space available" set. A dummy variable denoted $DummyLandAvailable_i$ identifies the communities as belonging to the former ($DummyLandAvailable_i = 0$) or the later set ($DummyLandAvailable_i = 1$).[12] Intuitively, if housing supply reacts to differences in tax-public good packages,

[10] For an additional and detailed empirical motivation for all variables see Stadelmann (2009) who uses a Bayesian Model Averaging in order to find the most important independent variables for capitalization and reduce omitted variable problems.

[11] Polinsky and Shavell (1976) show that using cross-section regressions to analyze the effect of amenities on house values is valid when the communities are considered "small" and there is mobility within and among them. The City of Zurich and Winterthur had an average number of 337262 inhabitants and 89757 inhabitants over the years 1998 to 2004. The average number for the other 169 municipalities was approximately 4700 inhabitants. Consequently, the reduced sample of communities studied here is likely to approximate the theoretically optimal conditions fairly well. Robustness tests show that our main insights remain valid without excluding these observations.

[12] In robustness tests, we will consider changes in the definition of this dummy variable.

capitalization should be significantly higher in the "No space available" set than in the "Space available" set. Table 2 gives the results of the estimated amenity model and allows identifying differences in capitalization due to land availability. We control for year fixed effects in all regressions[13] and apply community clustering in some specifications.

< Table 2 here >

Taking a look at coefficient estimates of specifications (1) and (2) we find, like Oates (1969), Stull and Stull (1991) and other authors that the tax rate has a negative and significant influence on house prices.[14] Similarly, aggregate public expenditures increase house prices significantly. While class size has a significant negative impact on house prices for both samples, the distance to the next school has a negative and significant effect only in the "Space available" sample. The form of school organization in separate school communities does not have any significant impact. House prices react positively and significantly to higher median incomes as commonly documented in the literature. More densely populated areas with a higher fraction of elderly people have higher prices too but the significance depends on the sample chosen. Commuting imposes costs on individuals and capitalizes negatively and significantly in the "Space available" sample. Unemployment rate negatively affects house prices in the "No space available" sample. The fraction of foreigners has a positive and significant influence on house prices in both specifications because of a large number of well educated expatriates in the Canton of Zurich. All location specific controls have the expected signs: The average view on the lake and good exposition increase prices, distance to the center and the next shopping facility as well as the level of air pollution decrease them.

Oates (1969) estimations were criticized by Henderson and Thisse (2001) and by a number of other authors who argued that capitalization rates should tend to zero because of housing supply reactions. As more land for construction is available, housing supply can react more easily to differences in fiscal packages. Consequently, capitalization of fiscal variables is expected to be lower in communities with ample construction possibilities. Looking at the results for specifications (1) and (2), we find that a one percent increase in the mean income tax rate reduces house values by 1298.80 Swiss francs in the "No space available" set and by 745.40 Swiss francs in the "Space available" set. Thus, tax capitalization is lower in communities where housing supply can react due to more available land. Similarly, a one percent increase in aggregate expenditures raises house values by 669.80 Swiss francs when fewer construction areas are available and by 560.00 Swiss francs when more construction areas are available.

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[13] Single family house prices in Zurich were generally rising during the first part of the period from 1998 to 2004 and then fell slightly after 2002.

[14] Next to significant coefficients of the ordinary least squares regressions we compute the impact of a one percent increase in the mean of the respective independent variable on the dependent variable house prices.

Specifications (3) and (4) use diverse public expenditure categories instead of aggregate public expenditures. Again, we find that taxes capitalize less in jurisdictions with more construction space. Similarly, a one percent increase in public expenditures for culture raises house values by 222.70 Swiss francs when land for construction is scarce as opposed to 162.40 Swiss francs when construction possibilities are available. For social expenditures the effects are less robust as capitalization of this category is lower in the "No space available" set. Capitalization for administrative expenditures is negative and not significant in both samples. Finally, health expenditures have again a marginally larger impact when construction space is scarce.

Even though estimates for separate samples indicate that capitalization is lower in communities with more construction areas per capita, it is unclear whether these differences are statistically significant. Point estimates of tax coefficients in columns from (1) to (4) are significantly different from zero but not necessarily significantly different from each other. For public expenditures, point estimates are relatively close. To formally test for such significant differences in capitalization across communities, the dummy variable for land availability is interacted with tax rates, aggregate public expenditures as well as different public expenditure categories. Housing supply can be sufficiently elastic only if construction space is available. Moreover, if housing development reacts to capitalization we expect tax interaction coefficients to be positive and expenditure interaction coefficients to be negative, i.e. capitalization in communities with supply reactions should be lower. In columns (5) and (6), we estimate a dummy interaction model to test whether the differences in capitalization in the sets are statistically significant. The identifier whether construction areas are scarce or easily available, $DummyLandAvailable_i$, is interacted with the tax and aggregate public expenditure variables in specification (5) and with tax and different expenditure categories in specification (6). Taxes themselves capitalize negatively and significantly in both cases. The interaction between taxes and the identifier for available land is positive but insignificant. Consequently, supply reactions do not tend to diminish capitalization of taxes in a statistically significant manner when more construction areas are available. Results for aggregate expenditures as well as different expenditure categories show a similar picture. The interaction between aggregate expenditures and the available land dummy is negative but not significant as shown in column (5). Cultural expenditures and health expenditures also capitalize insignificantly less while social expenditures seem to capitalize at an insignificantly higher rate when more space for new constructions is available. Expenditures for administration do not have any significant effect. Thus, capitalization is not significantly different when comparing jurisdictions with more land for construction with jurisdictions having less available land.

To make sure these results are not only valid for the chosen threshold of the identifier $DummyLandAvailable_i$ we investigate the relationships when the threshold changes by +/- 15 %. We analyze the data in the same way as presented in Table 2 and find essentially the same results (see Table A1 in the Appendix for a short overview of these results). Generally, capitalization is lower when more construction area is available but the effects are never significant. Thus, capitalization seems to be robust even if supply reactions are possible.

3.3 Linear Interaction Model

Our second method to evaluate differences in capitalization of fiscal variables is to analyze a linear interaction model. The empirical model interacts a standardized measure for available construction area with taxes and expenditure variables.[15] If housing supply reacts significantly to fiscal packages then the interaction of taxes with available construction areas should be positive while the interaction of public expenditures with available construction areas should be negative, i.e. capitalization tends to decrease with more construction space within the communities. Table 3 shows the results.

< Table 3 here >

The base effect of taxes in column (1) has a significant and expected sign. Their impacts expressed in Swiss francs on house prices are comparable to previous estimates. The interaction effect for taxes and the standardized measure for available construction area have a positive sign but are insignificant. The interaction effect for aggregate expenditures is negative and insignificant. Thus, capitalization of fiscal variables is not significantly different when more space for construction is available.

In specification (2), we estimate the interaction model with disaggregate expenditures. Expenditures for culture, social welfare and health have a positive and significant impact on house prices while administrative expenditures capitalize negatively but insignificantly. All interaction effects are insignificant and consequently no housing supply reactions can be found even though more space for construction was available.

So far, we only reported results from OLS estimations. However, such estimates could suffer from possible simultaneity bias.[16] Available construction areas do not only depend on geography but also on political decisions by citizens, and thus on their property values. Even though available construction space in the Canton of Zurich changed slightly over

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[15] The standardized construction area is equal to available construction area in jurisdictions *i* minus the average construction area available, i.e. $LandAvailable_i - \overline{LandAvailable}$. Standardization is performed to facilitate interpretation of the interaction effects.

[16] Most recent articles on capitalization do not focus on endogeneity problems (see for example Stull and Stull, 1991, Palmon and Smith, 1998). Bajari and Kahn (2005) call this a common practice in the hedonic literature. We shall maintain this view.

time, it is not necessarily exogenously given but might be the result of fiscal preferences. It could be possible that high house prices induce communities to either restrict the amount of land for construction to preserve house values or induce them to increase the amount of land for construction to make additional profits by selling land. In either case, additional land for construction could emerge endogenously. This, of course, would leave our coefficient estimates for available land and the interaction effects biased. To address this problem, we estimate 2SLS regressions in columns (3) and (4). We use, as instruments, geographical variables which are independent of local political decisions. The first instrument indicates whether the community is next to the cities of Zurich or Winterthur and consequently forms part of the densely populated center. As a second instrument, we look if the community lies in the cantonal border where densities are lower and more farming land might be rezoned and used for construction. Finally, we take the fraction of traffic area as a measure for communal development as well as communal importance. This measure is stable over time and usually only influenced by cantonal instead of local decisions. All instruments do not have a directly discernible influence on house prices and on fiscal variables when controlling for measures of density and distance to the center. Concerning the quality of the instruments, F-Tests for the first stage variable are highly significant for explaining available land.[17] The J-statistics which deal with the overidentifying restrictions confirm the quality of the instruments. The coefficients of the fiscal variables and the interaction effects are similar to the OLS estimates. Taxes capitalize negatively and significantly while aggregate expenditures as well as the different expenditure categories capitalize positively and significantly.[18] The hypothesis that housing supply reacts more when construction space is available can be rejected as none of the interaction effects is statistically significant.

Finally, to ensure that these results do not only depend on a specific time frame chosen, we investigate the relationships for each year individually. The respective specifications (1) and (2) of Table 3 are estimated separately for the years 1998 to 2004 in Table A2 in the Appendix. The base effects for taxes remain negative and significant. Public expenditures usually have a positive and significant influence. None of the interaction terms with available land for construction and fiscal variables ever turns significant. Thus, housing supply does not influence capitalization of fiscal variables when more construction area is available.

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[17] F-Tests for the first stages of the interaction effects which are also instrumented are also highly significant.

[18] An exception is capitalization of administrative expenditure which has a negative coefficient and is insignificant.

4 Conclusion

Capitalization occurs when households bid higher prices for houses in communities with lower taxes and better public services. Many empirical papers show that fiscal variables capitalize into house prices. Part of the theoretical literature argues that fiscal variables capitalize owing to the scarcity of construction space in metropolitan areas. However, some authors argue that capitalization is only a demand side phenomenon. If house developers react to differences in fiscal packages, they will provide houses in fiscally attractive communities. Due to such supply reactions, capitalization may not occur in equilibrium. According to both views, the question of whether capitalization exists in equilibrium is a central issue of the theory of local public finance (see Yinger et al., 1988).

We have brought the arguments of the two sides together and have shown how capitalization depends on the elasticity of housing supply. Assuming an inelastic and upward-sloping supply function, capitalization of taxes and public expenditures occurs. When housing supply is perfectly elastic, capitalization does not persist. Using a set of 169 communities from 1998 to 2004 in the Swiss Canton of Zurich we bring our theoretical insights to the data.

We find support for the pro-capitalization faction at common statistical significance levels. If housing supply reacts to fiscal differences, supply reactions should be stronger in communities with a higher amount of available construction space. A linear interaction model shows that tax capitalization is not significantly lower when more land for construction is available. Similarly, public services do not capitalize significantly less in communities with more construction possibilities. Estimates for interaction terms between fiscal variables and available land point to somewhat smaller capitalization. However, a high variance does not allow us to draw supportive conclusions for the no-capitalization faction. Housing supply does not react significantly more in communities with more developable land and capitalization of fiscal variables is not significantly lower in such communities. The yes-capitalization faction has a point as house developers do not seem to react to a large extent to fiscal differences over space even if land is available. Capitalization of fiscal packages persists even if new housing construction is possible. Available land for construction is only a necessary but not sufficient condition for supply reactions to occur. The elasticity of supply is likely to be influenced by other factors too, such as zoning decisions, uncertainty concerning changes in fiscal variables, and existing homeowners opposition.

Our results are complementary to those of Brasington (2002) and Hilber and Mayer (2009) who find that capitalization decreases when space is more readily available in a community. While their studies are based on data for the United States, we focus on a European metropolitan area. For the United States, the availability of land seems to be sufficient to induce more elastic supply. Our result indicate that in the European case, different landscape topography, zoning regulations, fiscal uncertainty and other factors may prevent housing suppliers from reacting despite the availability of land for construction. Our results highlight that more research is needed to identify the driving forces behind housing suppliers' reactions.

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Table 1
Data Description and Sources

Variable	*Description and source*	*Median*	*Mean*	*S.d.*
HousePrice	Price in Swiss Francs of standardized and comparable single family house. Cantonal Bank of Zurich.	787600	804500	134628
TaxRate	Mean income tax multiplier (without churches). Statistical Office of the Canton of Zurich.	119.00	113.90	14.88
ExpAgg	Aggregated expenditures for culture, health, administration and social well-being per capita. GEFIS Financial Statistics and Statistical Office of the Canton of Zurich.	484.00	541.20	242.30
ExpCulture	Expenditure for culture in Swiss Francs per capita. GEFIS Financial Statistics and Statistical Office of the Canton of Zurich.	77.00	93.17	63.55
ExpSocial	Expenditure for social well-being in Swiss Francs per capita. GEFIS Financial Statistics and Statistical Office of the Canton of Zurich.	264.00	295.50	158.65
ExpAdmin	Expenditure for administration in Swiss Francs per capita. GEFIS Financial Statistics and Statistical Office of the Canton of Zurich.	355.00	375.30	142.68
ExpHealth	Expenditure for health in Swiss Francs per capita. GEFIS Financial Statistics and Statistical Office of the Canton of Zurich.	138.00	152.50	83.24
LandAvailable	Unused construction area in m2 per capita. Statistical office of the Canton of Zurich.	46.49	50.01	23.66
DistSchool	Average distance to next school in meter. Cantonal Bank of Zurich and Statistical Office of the Canton of Zurich (GIS system).	852.50	864.70	226.49
ClassSize	Average class size in primary school. Secretary for Education of the Canton of Zurich.	20.30	19.90	1.83
NoSchoolComm	Identification whether the school is managed by the community itself (value=1) or a separate school community (value=0). Secretary for Education of the Canton of Zurich.	0.00	0.20	0.40
MedianIncome	Median income to tax of natural persons. Statistical Office of the Canton of Zurich.	46550	47280	5762
Density	Population per square kilometer. Statistical Office of the Canton of Zurich.	400.80	597.70	598.27
Elderly	Fraction of population over 65 years. Statistical Office of the Canton of Zurich.	12.30	12.58	2.99
Commuters	Fraction of commuters outgoing over labor force in community. Statistical Office of the Canton of Zurich.	0.70	0.69	0.07
Unemployment	Unemployment rate. Statistical Office of the Canton of Zurich.	2.00	2.23	1.24
Foreigners	Fraction of foreigners. Statistical Office of the Canton of Zurich.	12.00	13.24	7.59
Lakeview	View on lake in number of hectare. Cantonal Bank of Zurich and Statistical Office of the Canton of Zurich (GIS system).	11.85	362.10	869.60
SWExposition	Percentage of hectare with south and west exposition. Cantonal Bank of Zurich.	0.40	0.43	0.27
DistCenter	Average time in minutes to Zurich main station. Cantonal Bank of Zurich and Statistical Office of the Canton of Zurich (GIS system).	26.73	26.81	8.57
DistShop	Average distance to shopping center in meter. Cantonal Bank of Zurich.	965	1220	722
NO2Pollution	Environmental damage as NO2 in microgram per cubic meter. Cantonal Bank of Zurich.	17.00	17.77	4.17
CommunityCenter	Community has common border with cities of Zurich or Winterthur. Statistical Office of the Canton of Zurich (GIS system).	0.00	0.17	0.38
CommunityBorder	Community is at the cantonal border. Statistical Office of the Canton of Zurich (GIS system).	0.00	0.37	0.48
AreaTrafficFrac	Fraction traffic zones of communal area. Statistical Office of the Canton of Zurich (GIS system).	4.90	5.77	3.39

Source: as mentioned in table
The median, mean and standard deviations are based on 1183 observations which are 168 municipalities from 1998 to 2004.

Table 2

Testing for Decreasing Capitalization over Space when Land available (Dummy)

Variable	*No space available ExpAgg* (1)	*Impact* in CHF*	*Space available ExpAgg* (2)	*Impact* in CHF*	*No space available Categories* (3)	*Impact* in CHF*	*Space available Categories* (4)	*Impact* in CHF*	*Interaction ExpAgg* (5)	*Impact* in CHF*	*Interaction Categories* (6)	*Impact* in CHF*
Intercept	726306[a]		926000[a]		753932[a]		946800[a]		799903[a]		815713[a]	
	(69760)		(85185)		(71690)		(88030)		(133300)		(140500)	
TaxRate	-1140.61[a]	-1298.8	-654.60[b]	-745.4	-1100.86[a]	-1253.5	-568.50[c]	-647.3	-1111.83[b]	-1266.0	-1007.80[b]	-1147.5
	(424.70)		(308.92)		(421.90)		(312.00)		(490.20)		(492.70)	
*Int(Tax * DummyLandAvailable)*									446.44		361.31	
									(621.50)		(633.60)	
ExpAgg	123.78[a]	669.8	103.50[a]	560.0					119.376[a]	646.0		
	(16.51)		(22.68)						(25.400)			
*Int(ExpAgg * DummyLandAvailable)*									-5.344			
									(37.350)			
ExpCulture					239.010[a]	222.7	174.340[a]	162.4			241.349[a]	224.9
					(41.610)		(42.71)				(87.450)	
*Int(ExpCulture * DummyLandAvailable)*											-197.535	
											(124.100)	
ExpSocial					75.043[a]	221.8	86.730[a]	256.3			69.971[c]	206.8
					(20.430)		(30.510)				(37.170)	
*Int(ExpSocial * DummyLandAvailable)*											27.613	
											(50.400)	
ExpAdmin					-10.445	-39.2	-13.070	-49.0			-5.006	18.8
					(17.980)		(11.500)				(40.420)	
*Int(ExpAdmin * DummyLandAvailable)*											-37.983	
											(40.190)	
ExpHealth					156.163[a]	238.1	152.200[a]	232.1			149.108[a]	227.3
					(31.800)		(45.860)				(50.300)	
*Int(ExpHealth * DummyLandAvailable)*											-52.117	
											(75.260)	
DummyLandAvailable									-64692		-40989	
									(83340)		(85870)	
DistSchool	-10.534		-24.760[a]	-214.1	-5.609		-26.690[a]	-230.8	-20.066		-18.900	
	(8.640)		(8.676)		(8.594)		(9.095)		(15.940)		(15.520)	
ClassSize	-2140.63[b]	-426.03	-3354[a]	-667.5	-2110.14[c]	-420.0	-2889.00[b]	-575.0	-183.74		-87.98	
	(1082.93)		(1127.49)		(1120.26)		(1132.42)		(1822.42)		(1791.78)	

NoSchoolComm	8781.69		-15070		9480.51		-1461.12		2517.86		3111.98	
	(9623.91)		(14303)		(9513.23)		(4556.12)		(9786.34)		(9678.56)	
MedianIncome	7.034[a]	3325.21	6.051[a]	2860.6	6.408[a]	3029.4	5.866[a]	2773.3	6.942[a]	3281.9	6.408[a]	3029.6
	(0.694)		(0.813)		(0.694)		(0.841)		(1.373)		(1.362)	
Density	4.506		66.500[a]	397.4	2.748		63.730[a]	380.9	5.899		7.703	
	(5.041)		(12.839)		(5.335)		(12.920)		(12.010)		(12.650)	
Elderly	7142.40[a]	898.39	1069		6799.57[a]	855.3	999.70		5158.53[a]	648.9	4836.06[a]	608.3
	(862.600)		(1099.588)		(882.900)		(1137)		(1462)		(1512)	
Commuters	-44849.11		-209300[a]	-1442.3	-37727		-216800[a]	-1493.7	-41268.66		-45713.13	
	(36270)		(38034)		(36690)		(38080)		(66770)		(68260)	
Unemployment	-5858.10[b]	-130.71	-2868.00		-5025.42[c]	-112.1	-3267		-6567.72[b]	-146.5	-5776.05[c]	-128.9
	(2925)		(3375.842)		(2804)		(3304)		(3197)		(3062)	
Foreigners	1720.39[a]	227.73	1397.01[b]	-184.9	1729.14[a]	228.9	-1320.01[b]	-174.7	1166.40		1208.61[c]	160.0
	(462.700)		(625.466)		(437.010)		(585.956)		(766.100)		(708.30)	
Lakeview	34.488[a]	124.87	39.250[a]	142.1	34.380[a]	124.5	41.140[a]	149.0	34.631[a]	125.4	34.670[a]	125.5
	(1.784)		(8.281)		(1.811)		(8.594)		(4.574)		(4.545)	
SWExposition	70983[a]	304.02	41800[a]	179.0	71252[a]	305.2	41780[a]	178.9	70235[a]	300.8	71564[a]	306.5
	(7025.01)		(9778.96)		(6777.03)		(9486.02)		(14110)		(13380)	
DistCenter	-4987.05[a]	-1336.82	-7429.02[a]	-1991.4	-4989.37[a]	-1337.4	-7583.02[a]	-2032.7	-5915.44[a]	-1585.7	-5993.76[a]	-1606.7
	(434.30)		(520.09)		(433.30)		(541.80)		(791.90)		(792.30)	
DistShop	-19.731[a]	-240.68	-0.360		-21.277[a]	-259.5	-1.291		-11.595[c]	-141.4	-12.545[c]	-153.0
	(3.615)		(3.366)		(3.591)		(3.434)		(6.853)		(6.774)	
NO2Pollution	-6097.82[a]	-1083.37	-6754.02[a]	-1200.0	-5983.09[a]	-1063.0	-6593.03[a]	-1171.4	-6591.39[a]	-1171.1	-6528.81[a]	-1159.9
	(613.30)		(1407.73)		(641.40)		(1610.47)		(1418.94)		(1487.03)	
YearFixedEffects	YES		YES		YES		YES		YES		YES	
Community Clusters	NO		NO		NO		NO		YES		YES	
Adj. R2	0.903		0.824		0.904		0.826		0.894		0.896	
N	783		400		783		400		1183		1183	

Source: own calculations

* The impact of a one percent increase of the mean of the respective independent variable on property prices.

The left-hand-side variable in all regressions is the average price of a comparable single family house for the respective years 1998 to 2004 across 169 municipalities. Robust standard errors in parenthesis.

[a] indicates a significance level of below 1 %; [b] indicates a significance level between 1 and 5 %; [c] indicates significance level between 5 and 10 %.

Table 3
Testing for Decreasing Capitalization over Space when Land available (Interaction + IV)

	OLS ExpAgg		*OLS Categories*		*IV ExpAgg*		*IV Categories*	
Variable	*(1)*	*Impact* in CHF*	*(2)*	*Impact* in CHF*	*(3)*	*Impact* in CHF*	*(4)*	*Impact* in CHF*
Intercept	781600[a]		826300[a]		764997[a]		864100[a]	
	(48990)		(129800)		(132100)		(141200)	
TaxRate	-976.300[a]	-1111.7	-961.100[b]	-1094.4	-812.618[a]	-925.3	-848.600[a]	-966.3
	(164.000)		(431.300)		(214.600)		(283.800)	
*Int(Tax **	6.174		6.612		17.919		10.330	
LandAvailable)	(4.048)		(12.640)		(27.940)		(24.390)	
ExpAgg	123.300[a]	667.0			102.178[a]	553.0		
	(11.280)				(31.050)			
*Int(ExpAgg **	-0.343				-1.513			
LandAvailable)	(0.285)				(1.788)			
ExpCulture			168.100[b]	156.6			133.100[a]	124.0
			(77.610)				(30.790)	
*Int(ExpCulture **			-2.145				-2.100	
LandAvailable)			(2.186)				(7.338)	
ExpSocial			82.150[a]	242.8			104.300[a]	308.2
			(31.200)				(37.880)	
*Int(ExpSocial **			0.342				2.231	
LandAvailable)			(0.984)				(2.517)	
ExpAdmin			-0.636				-2.132	
			(28.850)				(29.260)	
*Int(ExpAdmin **			-1.314				-2.701	
LandAvailable)			(0.816)				(3.414)	
ExpHealth			182.500[a]	278.3			153.700[b]	234.3
			(47.070)				(61.860)	
*Int(ExpHealth **			-2.055				-0.719	
LandAvailable)			(1.332)				(4.414)	
LandAvailable	-1150.02[b]	-575.2	-704.600		-988.206		267.600	
(standardized)	(515.151)		(1706.12)		(3122.02)		(2861.03)	
DistSchool	-21.040[a]	-181.9	-20.930		-18.948		-27.410[c]	-237.0
	(6.787)		(14.790)		(15.620)		(15.940)	
ClassSize	-85.750		-92.090		-100.561		-67.180	
	(786.600)		(1808.00)		(1898.00)		(1971.00)	
NoSchoolComm	3208		-4104		-1059.391		2209	
	(3708)		(9913)		(10990)		(10390)	
MedianIncome	6.934[a]	3278.1	6.045[a]	2857.8	7.186[a]	3397.0	5.860[a]	2770.2
	(0.449)		(1.390)		(1.417)		(1.439)	
Density	4.744		9.078		9.640		32.630[c]	195.0
	(4.658)		(13.850)		(20.230)		(19.220)	
Elderly	5308[a]	667.7	4779[a]	601.1	4546.750[a]	571.9	4599[a]	578.4
	(675.200)		(1458)		(1510)		(1545)	
Commuters	-42460		-35490		-40659		-51860	
	(27250)		(68960)		(71070)		(74610)	
Unemployment	-6017[a]	-134.2	-4729		-5155.606		-2998	
	(2189)		(3140)		(3543)		(3255)	
Foreigners	1162.40[a]	153.9	1074.14		1373.150		673.400	
	(373.40)		(763.900)		(868.400)		(873.400)	
Lakeview	34.600[a]	125.3	34.910[a]	126.4	36.035[a]	130.5	35.140[a]	127.2
	(1.864)		(4.495)		(4.690)		(4.532)	
SWExposition	69930[a]	299.5	73020[a]	312.7	72630[a]	311.1	75800[a]	324.6
	(5251)		(12990)		(14510)		(13840)	
DistCenter	-5906[a]	-1583.2	-6152[a]	-1649.2	-6004.977[a]	-1609.7	-7081[a]	-1898.1
	(307)		(817)		(1055)		(1058)	
DistShop	-12.090[a]	-147.4	-13.030[c]	-158.9	-11.370[c]	-138.7	-10.450	-127.5
	(2.240)		(6.811)		(6.653)		(6.554)	
NO2Pollution	-6575[a]	-1168.2	-6688[a]	-1188.2	-7110.985[a]	-1263.4	-7774[a]	-1381.2
	(506.800)		(1496)		(1645)		(1547)	

YearFixedEffects	YES	YES	YES	YES
Community Clusters	YES	YES	YES	YES
Adj. R2	0.893	0.896	0.902	0.895
N	1183	1183	1183	1183
J-Test			0.458	0.122
F-Test (LandAvailable)			20.160	18.570
Instruments			*Center + Border + AreaTraffic*	*Center + Border + AreaTraffic*

Source: own calculations
* The impact of a one percent increase of the mean of the respective independent variable on property prices.
The left-hand-side variable in all regressions is the average price of a comparable single family house for the respective years 1998 to 2004 across 169 municipalities. Robust standard errors in parenthesis.
[a] indicates a significance level of below 1 %; [b] indicates a significance level between 1 and 5 %; [c] indicates significance level between 5 and 10 %.

Appendix Table A1

Testing for Decreasing Capitalization over Space: +/- 15 % Change of Land Availability Dummy

Variable	*No space available -15 % (ExpAgg)*	*Space available -15 % (ExpAgg)*	*No space available -15 % (Categories)*	*Space available -15 % (Categories)*	*Interaction -15 % (ExpAgg)*	*Interaction -15 % (Categories)*	*No space available +15 % (ExpAgg)*	*Space available +15 % (ExpAgg)*	*No space available +15 % (Categories)*	*Space available +15 % (Categories)*	*Interaction +15 % (ExpAgg)*	*Interaction +15 % (Categories)*
Intercept	750416[a]	986300[a]	774919[a]	1020000[a]	794245[a]	792296[a]	771800[a]	824100[a]	788547[a]	864300[a]	807304[a]	798481[a]
	(59700)	(103100)	(62340)	(104800)	(129100)	(133400)	(83770)	(75580)	(85940)	(77928)	(142100)	(135200)
TaxRate	-1059.517[a]	-711.500[c]	-1051.863[a]	-561.600[b]	-1081.153[b]	-899.111[c]	-1158.159[a]	-769.500[a]	-1122.194[a]	-758.200[a]	-1121.501[b]	-915.862[b]
	(199.800)	(401.700)	(199.453)	(277.300)	(466.300)	(465.700)	(257.546)	(271.200)	(252.898)	(274.452)	(530.100)	(465.500)
*Int(Tax * DummyLandAvailable)*					579.759	-122.245[b]					402.099	-94.933[c]
					(841.300)	(61.180)					(581.500)	(50.430)
ExpAgg	131.419[a]	81.180[a]			125.156[a]		132.250[a]	119.800[a]			111.380[a]	
	(14.564)	(27.830)			(24.040)		(19.280)	(19.490)			(26.130)	
*Int(ExpAgg * DummyLandAvailable)*					-22.102						-19.884	
					(43.750)						(32.590)	
ExpCulture			206.798[a]	136.250[a]		226.303[a]			190.734[a]	171.800[a]		227.580[b]
			(40.290)	(23.160)		(84.700)			(48.820)	(49.943)		(92.670)
*Int(ExpCulture * DummyLandAvailable)*						-105.580						-97.624
						(117.100)						(129.400)
ExpSocial			97.072[a]	51.490[c]		88.478[b]			52.646[b]	93.340[a]		72.881[b]
			(18.330)	(26.510)		(36.310)			(23.030)	(24.997)		(36.210)
*Int(ExpSocial * DummyLandAvailable)*						-7.890						28.066
						(56.770)						(41.340)
ExpAdmin			-4.487	-17.980		-4.967			-4.661	-9.494		-8.048
			(16.650)	(13.060)		(37.400)			(20.630)	(10.743)		(46.540)
*Int(ExpAdmin * DummyLandAvailable)*						-43.163						-31.979
						(40)						(44.950)
ExpHealth			158.148[a]	117.400[a]		156.025[a]			135.893[a]	133.600[a]		162.873[a]
			(30.910)	(34.450)		(47.340)			(34.700)	(33.645)		(49.010)
*Int(ExpHealth * DummyLandAvailable)*						-48.661						-13.720
						(74.620)						(56.390)
LandAvailable (Dummy)					-70991	-27705					-67408.96	-6817.81
					(108600)	(23730)					(77740)	(22210)
DistSchool	-21.248[a]	-15.720	-18.154[b]	-21.540	-20.654	-18.329	-19.160[c]	-17.370[b]	-13.736	-14.960[b]	-20.618	-16.534
	(6.878)	(12.390)	(7.046)	(13.240)	(15.710)	(15.240)	(10.010)	(7.561)	(9.990)	(7.439)	(15.850)	(15.170)
ClassSize	-962.555	-2643[b]	-932.328	-2046[c]	-153.500	-210.271	-3582[a]	-3025[a]	-3347.236[a]	-2505[b]	-3.955	-14.410
	(1034)	(1238)	(1076)	(1216)	(1840)	(1831)	(1195)	(1111)	(1240)	(1140.459)	(1833)	(1833)
NoSchoolComm	8467.9	2300.0	8778.45	2210.0	3150.910	4178.265	6762	-8700	7460.150	-8773[c]	3085.383	3610.933
	(8541)	(4353)	(8484)	(4971)	(9982)	(9871)	(5232)	(8215)	(5134)	(5187.352)	(9856)	(9714)

MedianIncome	6.822[a]	4.635[a]	6.262[a]	4.266[a]	6.890[a]	6.391[a]	7.273[a]	6.528[a]	6.779[a]	5.895[a]	7.056[a]	6.531[a]
	(0.627)	(1.052)	(0.645)	(0.968)	(1.391)	(1.394)	(0.828)	(0.781)	(0.816)	(0.819)	(1.396)	(1.404)
Density	2.680	92.640[a]	1.263	87.340[a]	5.887	7.186	0.168	42.440[a]	1.541	42.790[a]	7.037	8.450
	(4.978)	(15.420)	(5.267)	(15.020)	(12.110)	(12.860)	(5.411)	(12.140)	(5.665)	(12.060)	(12.100)	(12.900)
Elderly	6438.103[a]	-1494	6172.415[a]	-1671	5127.163[a]	4672.333[a]	7726[a]	2868[a]	7597.201[a]	2312[a]	5173.488[a]	4902.997[a]
	(772.800)	(1111)	(797.100)	(1108)	(1493)	(1505)	(961)	(880)	(968.400)	(850.871)	(1471)	(1501)
Commuters	-28290	-224800[a]	-29703	-23860[a]	-40242	-37193	-29490	-128500[a]	-18928	-12330[a]	-45568	-46478
	(32630)	(49040)	(33500)	(48380)	(67450)	(71220)	(44300)	(33610)	(45160)	(35061)	(66910)	(68780)
Unemployment	-4496.54[c]	1326.00	-3775.02	1416	-6019.45[c]	-5767.074	-6794.12[b]	-5350.56[c]	-5442.60	-4877.21[c]	-6512.24[b]	-5591.84[c]
	(2638)	(3979)	(2575)	(3831)	(3270)	(3139)	(3444)	(2808)	(3345)	(2695.08)	(3204)	(3131)
Foreigners	1213.170[a]	-1575[b]	1199.846[a]	-1541[b]	1039.377	1067.884	2282[a]	-813.400	2283.877[a]	-836.200	1206.670	1104.305
	(421.100)	(783.100)	(409.700)	(746.900)	(781.600)	(724)	(542)	(604.700)	(518.100)	(569.309)	(768.600)	(709.300)
Lakeview	35.543[a]	32.590[a]	35.597[a]	38.710[a]	35.068[a]	35.181[a]	33.190[a]	40.610[a]	32.632[a]	43.640[a]	34.586[a]	34.309[a]
	(1.832)	(11.410)	(1.840)	(11.220)	(4.650)	(4.682)	(1.813)	(5.923)	(1.822)	(6.185)	(4.571)	(4.550)
SWExposition	70676.454[a]	46290[a]	71638.522[a]	44570[a]	68945.384[a]	70427.342[a]	75880[a]	46850[a]	75018.593[a]	47370[a]	71814.700[a]	70253.186[a]
	(6108)	(12020)	(5985)	(10610)	(13830)	(13010)	(8277)	(8160)	(8039)	(8251.254)	(14370)	(13110)
DistCenter	-5600.569[a]	-7038[a]	-5670.456[a]	-7299[a]	-5941.547[a]	-5937.229[a]	-4985[a]	-6945[a]	-4981.802[a]	-7058[a]	-5956.137[a]	-5935.330[a]
	(385.500)	(605.300)	(396)	(662)	(805.500)	(816)	(534.500)	(477.200)	(534.600)	(492.125)	(817.200)	(791.500)
DistShop	-17.029[a]	-0.026	-17.946[a]	-1.101	-11.249	-12.120[c]	-20.360[a]	-4.305	-22.364[a]	-5.632[c]	-12.025[c]	-12.847[c]
	(3.261)	(3.855)	(3.263)	(3.888)	(6.852)	(6.720)	(4.212)	(3.063)	(4.251)	(3.135)	(6.860)	(6.847)
NO2Pollution	-6545.546[a]	-5193[a]	-6511.754[a]	-4833[a]	-6586.229[a]	-6497.936[a]	-6563[a]	-6367[a]	-6479.163[a]	-6202[a]	-6615.432[a]	-6571.660[a]
	(597.300)	(1566)	(624.800)	(1639)	(1421)	(1482)	(669.700)	(1100)	(699.800)	(1167.192)	(1462)	(1497)
YearFixedEffects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Community Clusters	NO	NO	NO	NO	YES	YES	NO	NO	NO	NO	YES	YES
Adj. R2	0.901	0.760	0.902	0.768	0.893	0.894	0.903	0.849	0.904	0.851	0.893	0.895
N	901	282	901	282	1183	1183	617	566	617	566	1183	1183

Source: own calculations

The left-hand-side variable in all regressions is the average price of a comparable single family house for the respective years 1998 to 2004 across 169 municipalities. Robust standard errors in parenthesis.

[a] indicates a significance level of below 1 %; [b] indicates a significance level between 1 and 5 %; [c] indicates significance level between 5 and 10 %.

Appendix Table A2

Yearly Estimates for Testing for Decreasing Capitalization over Space

Variable	*1998 ExpAgg*	*1999 ExpAgg*	*2000 ExpAgg*	*2001 ExpAgg*	*2002 ExpAgg*	*2003 ExpAgg*	*2004 ExpAgg*	*1998 Categories*	*1999 Categories*	*2000 Categories*	*2001 Categories*	*2002 Categories*	*2003 Categories*	*2004 Categories*
Intercept	684000[a]	751358[a]	759100[a]	708103[a]	769900[a]	719000[a]	824900[a]	748900[a]	750087[a]	770892[a]	734400[a]	833600[a]	817400[a]	901400[a]
	(130200)	(131800)	(147600)	(134400)	(143700)	(143300)	(144700)	(143000)	(137400)	(156300)	(139800)	(151600)	(147900)	(141300)
TaxRate	-984.50[b]	-1268.95[a]	-916.60[c]	-831.78[c]	-937.30[c]	-954.40[c]	-1137.10[b]	-989.60[b]	-1167.27[a]	-885.71[c]	-834.12[c]	-949.50[c]	-927.95[c]	-1175.02[b]
	(460.600)	(440.600)	(492.100)	(440.900)	(521.900)	(504.500)	(527)	(488.600)	(432.400)	(525.200)	(467.100)	(500.600)	(473.600)	(466.700)
*Int(Tax **	10.330	5.131	14.080	11.795	7.907	2.970	1.926	22.350	101.492	150.636	160	44.310	72.470	-96.250
LandAvailable)	(12.420)	(13.600)	(13.280)	(13.390)	(16)	(14.340)	(15.600)	(88.840)	(78.700)	(92.920)	(99.210)	(121.600)	(124.300)	(125.700)
ExpAgg	84.810[a]	92.487[a]	72.220[b]	167.721[a]	164.300[a]	167.400[a]	132.800[a]							
	(31.040)	(31.830)	(35.850)	(33.220)	(29.270)	(34.340)	(35.090)							
*Int(ExpAgg **	-0.071	-1.016	-0.573	-1.301	-0.264	-0.274	-0.124							
LandAvailable)	(0.773)	(0.862)	(0.967)	(0.969)	(0.911)	(0.915)	(0.822)							
ExpCulture								150.100[c]	155.088[c]	168.179[c]	186.800[b]	140.600[c]	163.300[c]	110.300
								(81.580)	(83.800)	(87.550)	(86.560)	(83.820)	(86.090)	(76.950)
*Int(ExpCulture **								-2.062	-3.218	-3.475	-1.242	-0.726	-2.953	-2.312
LandAvailable)								(2.471)	(2.759)	(2.604)	(2.706)	(2.257)	(2.470)	(2.335)
ExpSocial								63.160[c]	74.833[c]	49.532[c]	111.400[b]	104[b]	88.920[b]	71.600[c]
								(37.290)	(40.350)	(31.780)	(45.750)	(45.790)	(44.670)	(38.320)
*Int(ExpSocial **								-0.392	1.585	0.783	1.188	0.113	0.372	0.373
LandAvailable)								(1.449)	(1.396)	(1.779)	(1.710)	(1.436)	(1.200)	(0.949)
ExpAdmin								-62.370	-5.330	-20.866	-8.992	-4.038	-16.120	-9.178
								(39.290)	(34.410)	(35.510)	(36.570)	(32.550)	(28.250)	(28.820)
*Int(ExpAdmin **								-1.344	-1.931	-1.137	-0.620	-1.086	-1.194	-2.495
LandAvailable)								(1.037)	(1.374)	(1.136)	(1.124)	(0.853)	(0.801)	(2.921)
ExpHealth								137.500[c]	97.786[c]	88.379[c]	249.400[a]	308.300[a]	343.300[a]	337.500[a]
								(70.300)	(60.100)	(54.840)	(52.950)	(73.580)	(91.090)	(113.600)
*Int(ExpHealth **								-1.269	-2.844	-1.204	-1.162	-1.508	-2.191	-3.739
LandAvailable)								(2.712)	(3.392)	(2.962)	(1.375)	(2.427)	(3.250)	(3.271)
LandAvailable	-1532	-1387.20	-2170	-2206.45	-1244	-754.100	-85.390	335.600	309.004	830.855	2.374	131.600	162.600	665.500
(Continous)	(1535)	(1699)	(1655)	(1804)	(2038)	(1760)	(1834)	(581.300)	(696.500)	(738.900)	(799.600)	(793.900)	(868.100)	(911.600)
DistSchool	-24.080	-28.702[c]	-22.110	-20.300	-20.250	-16.730	-18.990	-22.280	-24.728	-21.737	-17.880	-18.840	-13.650	-23.850
	(15.510)	(16.870)	(16.860)	(15.420)	(16.480)	(15.550)	(15.880)	(15.260)	(16.620)	(16.430)	(16.520)	(15.600)	(14.920)	(15.250)
ClassSize	-908.400	-2729	-910.300	-27.654	-3083	-839.500	-523.400	-650	-2489	-713.158	-1128	-3257	-1361	-678.600
	(2194)	(2102)	(2252)	(2194)	(2269)	(2303)	(2419)	(2339)	(2114)	(2310)	(2551)	(2408)	(2371)	(2430)
NoSchoolComm	-76.500	1499.468	-259.600	6135.988	5403	6553	2419	1727	1575.259	376.838	8426	8834	10720	3682
	(11230)	(11430)	(11210)	(10550)	(9030)	(9293)	(9739)	(11490)	(11190)	(11220)	(9801)	(8701)	(8958)	(9228)
MedianIncome	9.053[a]	7.455[a]	7.430[a]	6.586[a]	7.318[a]	6.633[a]	6.230[a]	8.049[a]	6.963[a]	6.861[a]	6.178[a]	6.607[a]	5.137[a]	4.584[a]
	(1.718)	(1.652)	(1.719)	(1.622)	(1.410)	(1.317)	(1.203)	(1.756)	(1.656)	(1.725)	(1.652)	(1.469)	(1.448)	(1.274)

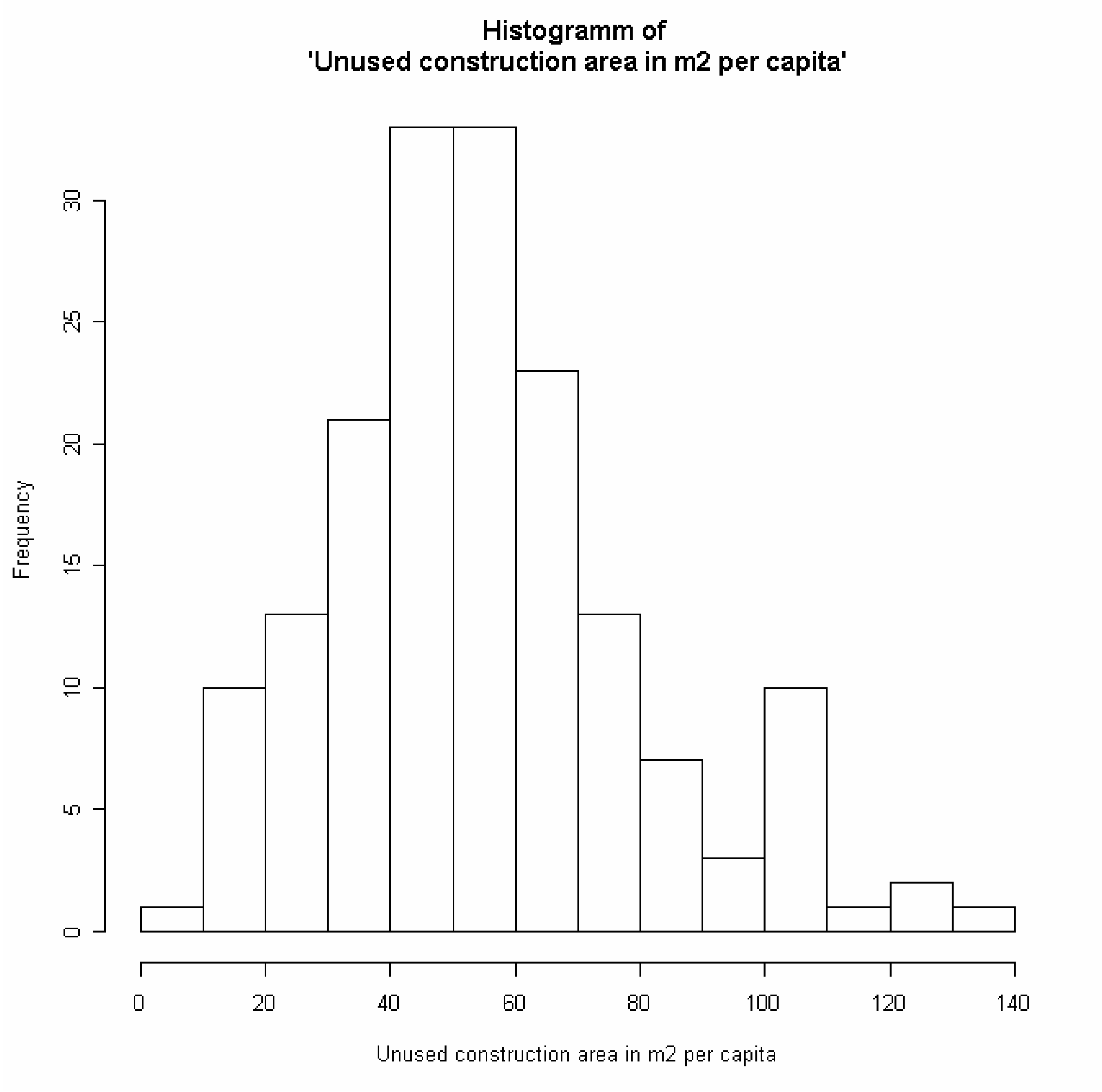
Density	3.169	5.940	10.780	4.629	1.025	-0.304	9.321	4.275	13.955	21.167	10.878	5.721	6.959	14.630
	(13.880)	(14.030)	(15.870)	(14.240)	(13.170)	(13.900)	(12.600)	(15.740)	(13.910)	(16.370)	(15.820)	(14.570)	(14.020)	(11.400)
Elderly	7162.10[a]	6927.48[a]	6494[a]	3511.88[b]	3087.23[c]	3291.15[c]	3909.45[b]	7098.68[a]	5882.91[a]	5222.32[a]	2916.89[c]	2451.65	2652.45	3264.87[c]
	(1599)	(1559)	(1683)	(1576)	(1819)	(1718)	(1884)	(1641)	(1464)	(1579)	(1507)	(1811)	(1741)	(1836)
Commuters	-61300	-86221	-83490	-18766	-27740	-39900	-62040	-31200	-60110	-65334	-48620	-62790	-77660	-75000
	(62220)	(61220)	(73180)	(73640)	(71120)	(74780)	(69680)	(63790)	(66630)	(80900)	(88180)	(77740)	(75100)	(69210)
Unemployment	2027	-4427.30	6101	-10663.8	-7747	-9335	-16360[b]	278.600	-3044.35	7778.290	-8354	-5760	-7205	-15250[b]
	(5231)	(7547)	(10620)	(10200)	(6298)	(6940)	(6469)	(5348)	(7965)	(10220)	(10400)	(5827)	(6298)	(5896)
Foreigners	1098	1270.307	557.300	936.802	1217	1263	2169[c]	752.700	1001.098	216.090	617.700	1056	1014	2255[c]
	(916.100)	(890)	(920)	(969.100)	(1010)	(1140)	(1274)	(882.400)	(858.700)	(840.800)	(893.100)	(949.100)	(1055)	(1155)
Lakeview	36.030[a]	34.108[a]	33.410[a]	32.440[a]	32.830[a]	34.420[a]	34.120[a]	36.850[a]	34.298[a]	34.078[a]	31.920[a]	31.940[a]	32.880[a]	33.240[a]
	(5.122)	(4.940)	(5.165)	(4.749)	(4.814)	(4.518)	(4.357)	(5.460)	(4.792)	(5.188)	(4.320)	(4.778)	(4.354)	(4.009)
SWExposition	75510[a]	70471[a]	70640[a]	57719[a]	63290[a]	62930[a]	75200[a]	80440[a]	75061[a]	72749[a]	51220[a]	60050[a]	63680[a]	77260[a]
	(13500)	(14260)	(14040)	(14180)	(14060)	(14670)	(14010)	(13230)	(13310)	(13260)	(13810)	(13670)	(13790)	(13080)
DistCenter	-6063[a]	-6284.35[a]	-6224[a]	-5387.41[a]	-5437[a]	-5599[a]	-6063[a]	-6398[a]	-6123.63[a]	-6144.66[a]	-5268[a]	-5584[a]	-6009[a]	-6334[a]
	(901.980)	(784.450)	(822.200)	(895.102)	(874.300)	(894.500)	(836.300)	(936.400)	(793.200)	(847.100)	(841.400)	(872.015)	(948.026)	(840.700)
DistShop	-11.290	-10.338	-13.940[c]	-12.254[c]	-12.230[c]	-11.170	-11.120	-10.620	-9.691	-12.905[c]	-12.900[c]	-12.520[c]	-13.130[c]	-11.130[c]
	(7.003)	(7.476)	(7.215)	(7.131)	(7.209)	(6.966)	(6.744)	(6.715)	(7.425)	(7.199)	(7.369)	(7.226)	(6.673)	(6.394)
NO2Pollution	-7979[a]	-7657.70[a]	-6515[a]	-6468.90[a]	-6212[a]	-5725[a]	-5835[a]	-8158[a]	-7477.22[a]	-6526.56[a]	-6502[a]	-5942[a]	-5655[a]	-5660[a]
	(1447)	(1425)	(1540)	(1401)	(1317)	(1468)	(1570)	(1470)	(1432)	(1557)	(1367)	(1354)	(1568)	(1582)
Adj. R2	0.879	0.875	0.871	0.890	0.898	0.892	0.887	0.879	0.877	0.871	0.890	0.898	0.895	0.894
N	169	169	169	169	169	169	169	169	169	169	169	169	169	169

Source: own calculations
The left-hand-side variable in all regressions is the average price of a single family house for the respective years 1998 to 2004 across 169 municipalities. Robust standard errors in parenthesis.
[a] indicates a significance level of below 1 %; [b] indicates a significance level between 1 and 5 %; [c] indicates significance level between 5 and 10 %.

Supplementary Material

(not intended for publication)

Supplementary Figure
Distribution of Unused Construction Area in m2 per capita



Source: own representation.

Derivation of equation (9)

Differentiating (3) with respect to g_i yields:

$$\frac{\partial V}{\partial p_i}\frac{\partial p_i}{\partial g_i}+\frac{\partial V}{\partial g_i}-\frac{\partial V}{\partial p_j}\frac{\partial p_j}{\partial g_i}=0 \qquad (15)$$

where prices p_j may react to changes in g_i. Applying Roy's identity and $MRS_i = (\partial V / \partial g_i)/(\partial V / \partial y)$, we obtain:

$$-h_i \frac{\partial p_i}{\partial g_i} + h_j \frac{\partial p_j}{\partial g_i} = -MRS_i. \tag{16}$$

Then differentiating equation (5) with respect to g_i gives:

$$\frac{\partial H_i}{\partial p_i}\frac{\partial p_i}{\partial g_i}\frac{1}{h_i} - \frac{\partial h_i}{\partial p_i}\frac{\partial p_i}{\partial g_i}\frac{H_i}{h_i^2} + \sum_{j\neq i}\left(\frac{\partial H_j}{\partial p_j}\frac{\partial p_j}{\partial g_i}\frac{1}{h_j} - \frac{\partial h_j}{\partial p_j}\frac{\partial p_j}{\partial g_i}\frac{H_j}{h_j^2}\right) = 0. \tag{17}$$

Using equation (5), making appear the demand and housing supply elasticity, and combining with equation (16), we get:

$$\frac{n_i}{p_i}(\eta_i - \varepsilon_i)\frac{\partial p_i}{\partial g_i} + \sum_{j\neq i}\left(-\frac{n_j}{p_j}(\eta_j - \varepsilon_j)\left(\frac{MRS_i}{h_j} - \frac{h_i}{h_j}\frac{\partial p_i}{\partial g_i}\right)\right) = 0. \tag{18}$$

Solving for $\partial p_i / \partial g_i$ yields equation (9).

Derivation of equation (10)

We proceed analogously to the public good case shown above for (9). Differentiating (3) with respect to t_i, applying Roy's identity and the definition of the MRS_i gives:

$$-h_i \frac{\partial p_i}{\partial t_i} + h_j \frac{\partial p_j}{\partial t_i} = \bar{y}. \tag{19}$$

Differentiating equation (5) with respect to t_i, using equation (5) and making appear the demand and housing supply elasticity yields:

$$\frac{n_i}{p_i}(\eta_i - \varepsilon_i)\frac{\partial p_i}{\partial t_i} + \sum_{j\neq i}\left(\frac{n_j}{p_j}(\eta_j - \varepsilon_j)\frac{\partial p_j}{\partial t_i}\right) = 0. \tag{20}$$

Combining equation (19) and equation (20), we obtain:

$$\frac{n_i}{p_i}(\eta_i - \varepsilon_i)\frac{\partial p_i}{\partial t_i} + \sum_{j\neq i}\left(\frac{n_j}{p_j}(\eta_j - \varepsilon_j)\left(\frac{\bar{y}}{h_j} + \frac{h_i}{h_j}\frac{\partial p_i}{\partial t_i}\right)\right) = 0.$$

Solving for $\partial p_i / \partial t_i$ yields equation (10).