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Income vs. property tax competition: A normative comparison*

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Abstract

Income and property taxation are among the most prevalent policy instruments to finance local expenditure in countries with a high degree of decentralization. However, little is known about their relative efficiency and redistributive properties. This paper compares both tax instruments within the same framework and investigates their relative attractiveness to finance local expenditure. It further allows for inter-municipal spillovers and rivalry in the consumption of the publicly provided good. The analytical model identifies the different inefficiencies in both tax regimes which include intra- and inter-municipal free-riding. In a numerical illustration, the model is solved for the resulting equilibria. This allows to quantify the gross welfare loss from decentralization and also reveals a decomposition of the welfare loss into its components.

JEL Codes H3, H7, R1, R2;

Keywords Tax competition; normative analysis; income taxation; property taxation; segregation; decentralization; welfare decomposition.

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1 Introduction

This paper concentrates on tax competition at the local level with residence-based taxes. The most common examples are taxes on a household's income and on the value of a household's property (or indirectly on housing rents). The 'local level' implies that households are free to choose their location and justifies the assumption of exogenous income, since it can be argued that a household has a job within a central business district but is free to choose from a set of municipalities around this district, all with comparable commuting costs. Other distinct features of this setup are that housing prices are heterogeneous at the municipal level and that local tax rates are determined endogenously by majority voting. This typically gives incentives for rich households to vote for low tax rates while 'protecting' themselves from being followed from poorer households by choosing small municipalities with high housing prices such that the attractiveness of the tax-expenditure package is capitalized in the housing price (for the case of income taxation, see, e.g., Schmidheiny 2006).

My analysis builds on two papers in particular: On the one hand, Calabrese et al. (2012) form the basis for the case of property taxation. They also pioneered the normative analysis in this class of models; on the other hand, I extent the work of Kuhlmey & Hintermann (2016), who considered income taxation and introduced imperfect rivalry and inter-municipal spillovers of the publicly provided good. Both papers describe the first-best as well as the decentralized solutions for the cases of property and income taxation, respectively, and also conduct a decomposition of the welfare loss to quantify the relative importance of the inherited inefficiencies (and of the imperfect redistribution) in the decentralized equilibria. Little, however, is known about the relative merits of both tax instruments.

The contribution of this paper, therefore, is twofold: First, in Section 2, I develop a general model that incorporates both tax instruments explicitly. This allows to analyze income taxes and property taxes and a combination thereof within a common framework. By doing so, this paper is also the first to integrate inter-municipal spillovers and imperfect rivalry of the publicly provided good into a model of property taxes. To identify the welfare loss from decentralization, I further describe a first-best version of this model which serves as an efficiency benchmark. Second, in Section 3, I quantify the welfare losses of both scenarios using a numerical illustration of the model and also include a decomposition of the respective welfare losses.[1]

2 Model

In this paper, I extend the model of Kuhlmey & Hintermann (2016) to allow not only for income taxation but also for property taxation. The income tax scheme is assumed to be linear and the tax base is the income of a household. The property tax rate also applies linearly to a household's expenditure on housing consumption.

2.1 Setup

I consider two different model setups. First, in the decentralized version of the model, decisions are taken at the local level and households are free to choose their place of residence. This setup reflects the situation in a federal country. Second, I define a social planner version of the model. Here, a utilitarian social planner determines the distribution of the households and dictates tax rates.

The basic setup is that a mass of heterogeneous households distributes among a set of municipalities. Households differ by their exogenous level of income, which is assumed to be continuously distributed between some lower and upper bound according to a well-defined probability density function. A household gains utility from consuming a numeraire consumption good, housing, and a publicly provided good offered by the municipality it had chosen to reside in. The model is inherently spaceless, i.e., households are perfectly mobile, there are no commuting costs or any other effect on a household's income that depends on the locational choice. Further, it is a static model, which implies that I am only interested in the equilibrium characteristics but cannot say anything about the path leading to this equilibrium. It is solved by backward-induction and assumes the following timing of events. First, the households choose their municipality of residence by buying housing (property) in the corresponding municipality. Second, the municipality-specific tax rates are determined by majority voting of the respective residents of each municipality. Third, consumption takes place.

Concerning the decentralized version, the residential choice of a household depends on the

[1]The 'combined' version of using income and property taxes at the same time turned out to have zero property taxes and is therefore subsumed under the case of using income taxes.

(relative) evaluation of the attractiveness of the set of municipalities, where each household correctly anticipates the equilibrium concerning the distribution of the population, the housing prices, and the tax rates. At this stage, and from the perspective of a household, municipalities differ with respect to the gross-of-tax housing price, the consumption level of the publicly provided good and the income tax rate. Allowing for both taxes simultaneously keeps the model three-dimensional since the property tax rate adds to the net-of-tax housing price and therefore does not add another dimension of heterogeneity. This is important to note as the set of necessary restrictions on the households' preferences identified for the case of income tax competition (i.e., the case of a three-dimensional moving decision problem) remain unchanged. Each of these characteristics is determined endogenously within the model. At the voting stage, households take the distribution of the households as given. This implies that the tax base (aggregate income and aggregate housing demand for income and property taxation, respectively) is known, which in turn allows to translate a proposed tax rate into a level of public consumption.

Concerning the social planner version of the model, I naturally assume that the social planner decides on the distribution of households and sets tax rates. In addition I allow for individual lump-sum taxation and therefore supply non-distortionary tax instruments as well as an individual redistribution scheme. This renders the model to be first-best.

2.2 Decentralized Solution

Households are heterogeneous with respect to the exogenously given level of income y, which is distributed between $\underline{y}$ and $\overline{y}$ according to the probability density function $f(y)$. Preferences are restricted such that households sort among the $j = 1, \ldots, J$ municipalities according to income. This is a common assumption in these kind of models and means that municipality j is inhabited by all households of a single interval on the domain $[\underline{y}, \overline{y}]$. I label by $\underline{y_j}$ and $\overline{y_j}$ the poorest and richest household in municipality j, respectively. If I (without loss of generality) assume that municipalities are ordered by ascending order of average income, it follows that the richest household in municipality j is equally rich than the poorest household in municipality $j + 1$. Since this holds for all $j < J$, every 'border household' $\widetilde{y_{j,j+1}}$ is therefore indifferent between two adjacent municipalities such that $\widetilde{y_{j,j+1}} = \overline{y_j} = \underline{y_{j+1}}$. For municipality J it holds that $\overline{y_J} = \overline{y}$.

Denote by G_j the budget of municipality j, which is spent to produce a publicly provided good, and by $N_j \equiv \int_{\underline{y_j}}^{\overline{y_j}} f(y)\mathrm{d}y$ the population mass in j. The good might spill over to the other municipalities, such that the per-capita consumption level of this good is given by

$$g_j = \frac{G_j + \sigma \sum_{i \neq j} G_i}{\left(N_j + \nu \sum_{i \neq j} N_i\right)^{\rho}}, \tag{1}$$

where σ and ν describe the degree to which the good spills in from the other municipalities and spills out to be consumed by the residents of the other municipalities, respectively, and ρ determines the degree of rivalry in consumption of the good. All parameters are well-defined between 0 and 1.

The level of G_j is determined by the revenue of municipality j from both income and property taxes. Tax rates are assumed to be linear and denoted t_j^y and t_j^p, respectively. For a given tax rate, tax revenue is determined by multiplying the tax rate with the respective tax base. In the case of income taxation the tax base is the aggregate income of the residents in j and in the case of property taxation it is the aggregate value of housing demand. This gives

$$G_j = t_j^y Y_j + t_j^p p_j^{net} H_j^D, \tag{2}$$

where $Y_j \equiv \int_{\underline{y_j}}^{\overline{y_j}} y f(y)\mathrm{d}y$ is aggregate income in j, p_j^{net} is the net-of-tax housing price in j, and $H_j^D \equiv \int_{\underline{y_j}}^{\overline{y_j}} h^j(y) f(y)\mathrm{d}y$ is the aggregate housing demand in j, for which $h^j(y)$ is the optimal housing demand of the household with income y for a given set of municipality characteristics.

The optimal housing demand of a household with income y in municipality j follows from maximizing its utility function with respect to the housing demand and the numeraire consumption bundle, subject to the budget constraint. Plugging the optimal demand functions for this private consumption bundle back into the utility function yields the indirect utility function

$$\begin{aligned} V(p_j^{net}, t_j^y, t_j^p, g_j; y) = &\max_{x,h} \quad U(x^j, h^j, g_j) \\ &\text{s.t.} \quad y(1 - t_j^y) = x^j + p_j h^j, \end{aligned} \tag{3}$$

where $U(x^j, h^j, g_j)$ is the utility function and $p_j \equiv (1 + t_j^p)p_j^{net}$ is the gross-of-tax housing price.

Allowing for property taxes does not change the structure of two out of the three equilibrium conditions in the model: Both the housing market clearing and the moving equilibrium conditions remain unchanged. Housing supply, which I label $H_j^S(p_j)$, in every municipality has to be equal to housing demand, which, mathematically, implies that in every j

$$H_j^S - H_j^D = 0. \tag{4}$$

Concerning the moving equilibrium and as mentioned above, I restrict the preferences to comply with the sorting conditions identified by Schmidheiny (2002). Therefore, the indifferent 'border household' between municipalities j and $j+1$ is defined by the utility difference between both municipalities being zero for this household; all other households strictly prefer one municipality over the others. Mathematically, the sorting of households according to income means that

$$\forall\ y \in [\underline{y_j}, \overline{y_j}]: \quad V(p_j^{net}, t_j^y, t_j^p, g_j; y) - V(p_i^{net}, t_i^y, t_i^p, g_i; y) \geq 0 \ \ \forall\, i \neq j, \tag{5}$$

where the equality only holds for the border households. This implies that the definition of the moving equilibrium boils down to identify $J-1$ indifferent border households, which are, for all $j < J$, defined by

$$V(p_j^{net}, t_j^y, t_j^p, g_j; \widetilde{y_{j,j+1}}) - V(p_{j+1}^{net}, t_{j+1}^y, t_{j+1}^p, g_{j+1}; \widetilde{y_{j,j+1}}) = 0, \tag{6}$$

where $\widetilde{y_{j,j+1}} = \overline{y_j} = \underline{y_{j+1}}$.

The third set of equilibrium conditions determines the consumption levels of the publicly provided goods in every j. Here, the existence of a second tax instrument changes the structure of the equilibrium condition, as it introduces a second choice instrument. The aforementioned timing of the model implies that, when voting, households assume that their vote will cause no household to change location or its level of housing consumption. I further assume that voting takes place simultaneously in all municipalities and therefore I identify a Nash equilibrium. The corresponding maximization problem of the voter with income y who chose to be at home in j therefore reads as

$$\max_{t_j^y, t_j^p, g_j} \quad V(p_j^{net}, t_j^y, t_j^p, g_j; y) \quad \text{s.t.} \quad g_j = \frac{t_j^y Y_j + t_j^p p_j^{net} H_j^D + \sigma \sum_{i \neq j} G_i}{\left(N_j + \nu \sum_{i \neq j} N_i\right)^{\rho}}. \tag{7}$$

After substituting g_j into the indirect utility function, the corresponding first order conditions for the income and property tax rates are

$$\frac{\partial V^j}{\partial t_j^y} + \frac{\partial V^j}{\partial g_j} \frac{Y_j + t_j^p p_j^{net} H_{t_j^y}^D}{\left(N_j + \nu \sum_{i \neq j} N_i\right)^{\rho}} = 0 \tag{8}$$

$$\frac{\partial V^j}{\partial t_j^p} + \frac{\partial V^j}{\partial g_j} \frac{p_j^{net} H_j^D + t_j^p p_j^{net} H_{t_j^p}^D}{\left(N_j + \nu \sum_{i \neq j} N_i\right)^{\rho}} = 0, \tag{9}$$

respectively, where I used V^j as shorthand-notation for $V(p_j^{net}, t_j^y, t_j^p, g_j; y)$. The expressions $H_{t_j^y}^D$ and $H_{t_j^p}^D$ are the partial derivatives of the aggregate housing demand in j with respect to the corresponding tax rates.

For every j, equations (8) and (9) determine the equilibrium tax rates in every j when viewed from the perspective of the median voter, i.e., if $y = y_j^m$.[2] Together with the J housing market equilibrium conditions, (4), and the $J - 1$ conditions which determine the indifferent households, (6), this gives a system of $4J - 1$ equilibrium conditions and the same number of unknowns. As usual, neither uniqueness nor existence of a solution to this system of equations can be established. However, this set of equilibrium conditions is used in the numerical part to illustrate equilibria for given parameter combinations and for specific functional forms.

2.3 Social Planner Solution

In the previous section I have illustrated the decentralized second-best setup of the model and sketched its solution. I now turn to the solution of a social planner. In the most powerful version, the planner chooses the distribution of the households as well as the tax rates and therefore also controls the consumption levels of the publicly provided good. He further has access to individual lump-sum taxation, which implies that he can internalize all externalities

[2]Note that the restrictions on the households' preferences required for the sorting of households are sufficient to also establish the monotonicity of preferences for the preferred tax rates, such that the median voter in j, y_j^m, is simply the median income household in j.

and can also address redistribution. For this first-best setup it is irrelevant, what kind of second-best tax instruments are available in the decentralized setup since they are not used anyway.

To identify the (relative) importance of the different sources of the overall welfare loss from decentralization, I then gradually deny the planner access to lump-sum taxes and also deny him the right to choose tax rates and to choose the distribution of the population. For these 'constraint-efficient' setups, the set of second-best, i.e., distortionary, tax instruments becomes relevant. Using the same notation principles as Kuhlmey & Hintermann (2016), the maximization problem of the planner is

$$\max_{a_j(y), r(y), R, t_j^y, t_j^p, T_j, p_j^{net}, g_j} \quad \sum_{j=1}^{J} \left\{ \int_{\underline{y}}^{\overline{y}} \omega(y) V^j(y)\, a_j(y) f(y) \mathrm{d}y + \omega_R \left(\frac{R}{J} + \int_0^{p_j^{net}} H_j^S(z) \mathrm{d}z \right) \right\} \tag{10}$$

$$\text{s.t.} \quad t_j^y Y_j + t_j^p p_j^{net} H_j^D + T_j N_j + \sigma \sum_{i \neq j} G_i - g_j \left(N_j + \nu \sum_{i \neq j} N_i \right)^{\rho} = 0 \quad \forall\, j \tag{11}$$

$$H_j^S - H_j^D = 0 \quad \forall\, j \tag{12}$$

$$R + \int_{\underline{y}}^{\overline{y}} r(y) f(y) \mathrm{d}y = 0. \tag{13}$$

I assign the following Lagrange multipliers: λ_j for (11), η_j for (12), and Ω for (13). This gives the following first order conditions, which define the optimal choice of the social planner. Start with the derivative with respect to $a_j(y)f(y)$, which gives the marginal social value of adding a household with income y to municipality j:

$$\begin{aligned} MSV^j(y) =& \omega(y) V^j(y) \\ & + \left(\lambda_j + \sigma \sum_{i \neq j} \lambda_i \right) \left[t_j^y y + t_j^p p_j^{net} h^j(y) + T_j \right] \\ & - \rho \left\{ \lambda_j g_j \left(N_j + \nu \sum_{i \neq j} N_i \right)^{\rho - 1} + \sigma \sum_{i \neq j} \lambda_i g_i \left(N_i + \nu \sum_{k \neq i} N_k \right)^{\rho - 1} \right\} \\ & - \eta_j h^j(y). \end{aligned} \tag{14}$$

Note that (14) is generally non-zero even in the optimum since for income segregating equilibria $a_j(y)$ is either 0 or 1 and therefore at a corner solution. The social planner thus equalizes the marginal social value of the border household between any two adjacent municipalities. The

FOCs with respect to both redistribution instruments, $r(y)$ and R, can be combined to

$$\sum_{j=1}^{J} \omega(y) V_r^j(y) a_j + \sum_{j=1}^{J} \eta_j h_r^j(y) a_j = \omega_R \tag{15}$$

where I suppressed the argument in $a_j(y)$. The remaining FONCs are

$$L_{T_j} = 0 = \int_{\underline{y}}^{\overline{y}} \omega(y) V_{T_j}^j(y) a_j f(y) \mathrm{d}y + N_j \left(\lambda_j + \sigma \sum_{i \neq j} \lambda_i \right) + \eta_j H_{T_j}^D, \tag{16}$$

$$L_{t_j^y} = 0 = \int_{\underline{y}}^{\overline{y}} \omega(y) V_{t_j^y}^j(y) a_j f(y) \mathrm{d}y + Y_j \left(\lambda_j + \sigma \sum_{i \neq j} \lambda_i \right) + \eta_j H_{t_j^y}^D, \tag{17}$$

$$L_{t_j^p} = 0 = \int_{\underline{y}}^{\overline{y}} \omega(y) V_{t_j^p}^j(y) a_j f(y) \mathrm{d}y + \left[t_j^p p_j^{net} H_{t_j^p}^D + p_j^{net} H_j^D \right] \left(\lambda_j + \sigma \sum_{i \neq j} \lambda_i \right) + \eta_j H_{t_j^p}^D, \tag{18}$$

$$L_{p_j^{net}} = 0 = \int_{\underline{y}}^{\overline{y}} \omega(y) V_p^j(y) a_j f(y) \mathrm{d}y + \omega_R H S^j + \eta_j \left[H_{p_j^{net}}^S - H_{p_j^{net}}^D \right], \tag{19}$$

$$L_{g_j} = 0 = \int_{\underline{y}}^{\overline{y}} \omega(y) V_{g_j}^j(y) a_j f(y) \mathrm{d}y - \lambda_j \left(N_j + \nu \sum_{i \neq j} N_i \right)^{\rho} + \eta_j H_{g_j}^D. \tag{20}$$

Note that a variable as subscript denotes a partial derivative. In the case of (16), e.g., $V_{T_j}^j(y) \equiv \frac{\partial V^j(y)}{\partial T_j} = \frac{\partial V(t_j^y, t_j^p, T_j, p_j^{net}, g_j; y)}{\partial T_j}$ and $H_{T_j}^D \equiv \frac{\partial H_j^D(y)}{\partial T_j} = \frac{\partial \int_{\underline{y}}^{\overline{y}} h^j(y) a_j f(y) \mathrm{d}y}{\partial T_j} = \int_{\underline{y}}^{\overline{y}} h_{T_j}^j(y) a_j f(y) \mathrm{d}y$.

With both income and property taxes used or at least available in the decentralized solution of the model, I can identify four sources that contribute to the overall welfare loss from decentralization. Three of them are also present in the case of only income taxes being available. These are (1) not to have access to lump-sum taxation, which leads to an inefficient redistribution; (2) free household mobility, which leads to a jurisdictional choice externality (JCE), also known as intra-municipal free-riding; (3) underprovision of the publicly provided good in the presence of inter-municipal spillovers, i.e., inter-municipal free-riding. Responsible for (1) are that $r(y)$ and T_j are not available in the decentralized solution, for (2) that the decentralized outcome of $a_j(y)$ must be incentive compatible, i.e., that households are free to choose their place of residence, and for (3) that the tax rates are chosen by majority voting and not determined by some benevolent authority.

The fourth source of the welfare loss in the setup at hand is the decrease of the housing demand due to the property taxation. Note that in our setup income taxation bears no comparable market-ineffiency as we rely on the assumption that income y is given exogenously. This implies an asymmetry between both taxes in terms of their imputed distorting effect: Whereas property taxes affect housing demand, income taxes do not distort the labor-leisure choice and therefore the income distribution. This means I assume no effect on the municipalities' tax base and consequently I do not consider the tax base erosion effect in the case of income taxation. Note that I am able to address this systematically unequal treatment of both tax instruments in the normative comparison: By decomposing the welfare loss into its components, I specify as one of the inefficiencies the distortion of the tax instrument.

3 Numerical analysis

3.1 Functional Forms and Parametrization

I use the following Stone-Geary utility function to describe the preferences of the households:

$$U_j(x^j, h^j, g_j) = \alpha\ln(g_j - \beta_g) + \gamma\ln(h^j - \beta_h) + (1 - \alpha - \gamma)\ln(x^j - \beta_x). \tag{21}$$

The parameters β_g, β_h and β_x are subsistence levels for g_j, h^j and x^j, respectively, and α, γ and $1-\alpha-\gamma$ determine the optimal expenditure shares. Consequently, the indirect utility function is given by

$$\begin{aligned} V(p_j, T_j, t_j, g_j; y) =& (1-\alpha)\ln[y(1-t_j) + r(y) - T_j - p_j\beta_h - \beta_x] \\ &+ \alpha\ln(g_j - \beta_g) - \gamma\ln(p_j) + c, \end{aligned} \tag{22}$$

with $c \equiv (1-\alpha-\gamma)\ln\left(\frac{1-\alpha-\gamma}{1-\alpha}\right) + \gamma\ln\left(\frac{\gamma}{1-\alpha}\right)$.

The housing supply function is given by $L_j p_j^\theta$, in which $L_j \in [0, 1]$ is the relative size of municipality j and θ is the price elasticity of the housing supply. I assume that there are $J = 2$ municipalities of equal size, that household income is uniformly distributed between $\underline{y} = 1$ and $\overline{y} = 2$, that $\nu = \sigma$, and that municipality 1 is inhabited by the poor and municipality 2 by the rich households. The values of the remaining parameters are given in Table 1.

Table 1: Remaining parameter values for the numerical implementation.

Parameter	α	β_x	β_h	β_g	γ	ν	ρ	σ	θ	L_1	$\underline{y}$	$\overline{y}$
Value	0.2	0.2	0.2	0	0.1	σ	0.5	0.3	3	0.5	1	2

Definition of parameters. α: preference for publicly provided good; β_x: subsistence level (SL) of the numeraire; β_h: SL of housing; β_g: SL of the publicly provided good; γ: housing preference; ν: neighborhood parameter (access to publicly provided good in the other municipality), set to equal σ; ρ: rivalry parameter; σ: spillover parameter; θ: price elasticity of housing supply; L_1: (relative) land size of municipality 1 ($L_2 = 1 - L_1$); $\underline{y}$: lower bound of income distribution; $\overline{y}$: upper bound of income distribution.

3.2 Decentralized Equilibrium

The decentralized equilibrium for the case of income taxation is basically the same as in Kuhlmey & Hintermann (2016). It is summarized in the middle column of Table 2. The 'rich' municipality 2 is populated by the richest 54 % of the population, whereas the poorest 46 % prefer to live in the 'poor' municipality 1. Recall that from the perspective of the households, municipalities differ with respect to housing prices, income tax rates and the consumption levels of the publicly provided good. In an equilibrium, a municipality cannot offer the more attractive level in all three characteristics.[3] In the model economy at hand, the rich municipality has about 10 % higher housing prices and a 70 % higher income tax rate but benefits from over 60 % higher consumption levels of the publicly provided good.

If instead of income taxes the municipalities (had to) rely on property taxes, they only differ with respect to the gross-of-tax housing price $p_j \equiv (1 + t_j^p)p_j^{net}$ and the consumption level of the publicly provided good. The equilibrium in the decentralized equilibrium of the considered model economy is described in the right column of Table 2. Fewer households than in the case of income taxation gather in the rich municipality: Instead of entailing the richest 55 % of the population, only the richest 45 % have to share the municipality's soil. This means that fewer of the poorer households effectively 'chase the rich' than in the case of income taxes, which comes at no surprise: When using income taxes, those come without a 'hideout' for the rich households, in the sense that households cannot influence their tax base. This implies that intra-municipal free-riding is more directly possible and more attractive than in the case of property taxes for which the rich can avoid higher tax rates by lowering housing

[3]If a municipality is more attractive in all three of its distinct characteristics, all households would prefer this municipality over the other and therefore would like to move there; but if this municipality is the home to all households, the other has a housing price of zero, which contradicts the assumption of one municipality being more attractive with respect to all three characteristics.

Table 2: First-best and decentralized equilibria.

		First-best		**Income taxation**		**Property taxation**	
		Municipality		Municipality		Municipality	
		1	2	1	2	1	2
Income tax rate	t_j^{inc}	—	—	0.0862	0.1472	—	—
Property tax rate	t_j^{prop}	—	—	—	—	0.6288	0.9577
Uniform lump-sum tax	T_j	0.0000	0.2939	—	—	—	—
Public consumption	g_j	0.1042	0.2514	0.1141	0.1851	0.1184	0.1466
Net housing price	p_j^{net}	$= p_1$	$= p_2$	$= p_1$	$= p_2$	0.6857	0.6662
Gross housing price	p_j	0.5226	0.8227	0.6802	0.7495	1.1168	1.3043
Border household	y^{border}	1.2100		1.4567		1.5462	
SWF		0.5526		0.5405		0.5280	
Agg. Comp. Var.	*in % of Y*			2.38		3.40	

"SWF" gives the value of the utilitarian social welfare function as assumed for the social planner in Section 3.3. "Agg. Comp. Var." gives the aggregate level of the compensating variation in percent of total income in the economy. If it is positive, it indicates that more money has to be spent to compensate the losers of decentralization than what can be taken from the winners of decentralization.

demand and are therefore only indirectly affected by a higher tax rate. And this, in turn, gives higher incentives for the poor to crowd in the rich municipality for the case of income taxation. The housing price in the rich municipality is almost 17 % higher than in the poor, but the inhabitants also profit from consuming almost 24 % more of the publicly provided good. The overall consumption level of the publicly provided good is lower in the case of property taxes than in the case of income taxes, which can be explained by the inelastic income tax base, i.e., the absence of the tax base erosion effect in the case of income taxation.

Note that the model I set up in Section 2.2 allows to have both income and property taxation simultaneously. In this case households vote simultaneously on both tax rates. I also implemented this setup numerically and actually found that households choose to use only income taxation to finance the public consumption. They vote for $t_j^p = 0$, choose the same border household and the same level of income tax rates, which means that, at least for the limited scope of this paper, the decentralized equilibrium does not change when allowing for property taxation besides income taxation. Apparently, households consider the distorting effect of property taxes on the housing demand and that the corresponding distortion in the case of income taxation is (in the case at hand) non-existent.

3.3 Welfare Loss from Decentralization

To quantify the welfare loss from the decentralized equilibria discussed above, I first have to present the efficient, i.e., first-best solution of a social planner. I assume a utilitarian social welfare function with equal welfare weights for every household and I choose the weight of the absentee landlords such that it is optimal from the planners' perspective to choose $R = 0$. For this welfare function, the corresponding levels of it in the decentralized equilibria can be computed.

Since in first-best the planner has access to distortion-free lump-sum tax instruments, he chooses $t_j^p = t_j^y = 0$. He uses lump-sum head taxes T_j to finance the publicly provided good and chooses the individual transfers $r(y)$ for every y.[4] This also implies that the first-best equilibrium for both the income and property tax cases is the same. The efficient solution is described in the left column of Table 2. The monetarized welfare loss, measured as the aggregated level of compensating variation, is considerably larger for the case of property taxation (3.4 % of Y) than for the case of income taxation (2.4 % of Y). Note, however, that this comparison is only meaningful to the limiting extent that I do not model a tax base erosion effect for the case of income taxes, which might explain at least part of this difference.

3.4 Decomposition of the Welfare Loss

I am now able to decompose the welfare loss from decentralization for both tax regimes. For the case of income taxation, the results are already presented and discussed in Kuhlmey & Hintermann (2016), but is also attached as Table A1 in the appendix of this paper to help the reader with the discussion of the differences. For the given parameter constellation, the imperfect redistribution, intra-municipality free-riding, and inter-municipality each account for about one-third of the total welfare loss. The distortive effect of the income taxes is barely existing, as it is restricted to the fact that a combination of negative lump-sum taxes and positive income tax rates can be used to redistribute.

For the case of property taxes the results of the decomposition are summarized in Table 3. Again, I decompose the total welfare loss of 3.4 % of aggregate income into imperfect redis-

[4]The choice of $r(y)$ is not further discussed here; please be referred the discussion in Kuhlmey & Hintermann (2016).

Table 3: Decomposing the welfare loss of decentralization for the case of property taxes.

		First-best		**I** $r(y)=0$		**II** (I) & $T=0$		**III** (II) & voting		**Decentralized** (III) & mobility	
		Municipality		Municipality		Municipality		Municipality		Municipality	
		1	2	1	2	1	2	1	2	1	2
Property tax rate	t_j^p	—	—	0.1185	0.0000	0.0000	1.1234	0.0275	1.0066	0.6288	0.9577
Lump-sum tax	T_j	0.0000	0.2939	-0.0239	0.2771	—	—	—	—	—	—
Public consumption	g_j	0.1042	0.2514	0.1044	0.2430	0.0948	0.2154	0.0743	0.1829	0.1184	0.1466
Net housing price	p_j^{net}	$=p_1$	$=p_2$	0.5191	0.8240	0.5088	0.7753	0.5756	0.7574	0.6857	0.6662
Gross housing price	p_j	0.5226	0.8227	0.5806	0.8240	0.5088	1.6462	0.5915	1.5199	1.1168	1.3043
Border household	y^{border}	1.21		1.18		1.16		1.25		1.5462	
SWF		0.5526		0.5495		0.5395		0.5360		0.5280	
Agg. Comp. Var.	*in % of Y*	3.40		2.60		1.84		1.12			
Relative size of welfare loss				23.6 % Imperfect redistribution		22.2 % Distortive taxation		21.3 % inter-		32.9 % intra-	
								municipal free-riding			

tribution and efficiency losses due to distortive taxation and due to inter- and intra-municipal free-riding. The absence of an individual redistribution scheme, i.e., the inability to use $r(y)$, causes 23.6 % of the aggregate welfare loss (this is the move from the first-best to column I in Table 3). Almost the same share is lost due to the inability to use distortion-free head taxes (the move from I to II) and due to letting households vote on the level of property taxes. This move from II to III reveals the amount of inter-municipal free riding. The remaining third of the total welfare loss can be attributed to the free mobility of the households, i.e., to intra-municipal free-riding. In terms of the aggregated compensating variation, property taxation lead to 40 % higher welfare losses than income taxation. This means – for the case of this model economy – that even though the relative role of the welfare losses due to imperfect redistribution and inter-municipal free-riding seem smaller in relative terms, they are bigger in absolute terms, when compared to the case of income taxation.

4 Conclusions

In this paper, I have presented various versions of a model economy where local governments used either income or property taxation (or both) to finance a publicly provided good. Tax rates where subject to majority voting of the population in a given municipality and the population moved freely between the municipalities. I identified equilibria of these decentralized versions in which households sorted among the municipalities according to income such that each municipality was only inhabited by a single interval on the income distribution. In a numerical simulation and with income taxation, the tax rate, the housing price (which was also endogenous) and the public consumption level all were higher in the 'rich' municipality than in the 'poor' one. With property taxes, the rich municipality had a higher gross-of-tax housing price and a higher consumption level of the publicly provided good.

I went on to define and calculate a first-best version of this model and found that the aggregate welfare loss from decentralization is larger for the case of property taxation when measured as compensating variation (while abstracting from any benefits which might be due to information asymmetries or the like). A certain part of this, however, can be explained by the tax base erosion effect, which I assumed away in the case of income taxation, but which I considered in the form of an endogenous housing market in the case of property taxation. The welfare decomposition helped in that respect: It showed that even when abstracting from the tax base erosion effect for property taxation (i.e., the welfare loss when moving from version I to II), the welfare losses were still larger for property taxes – mostly due to higher intra-municipal free-riding.

The policy implications of this analysis are limited by the fact that I looked at a rather abstract model economy. A helpful extension would therefore be to calibrate the model to a more realistic setup (that uses either property or income taxes). From there, one could simulate to replace the existing tax instrument with the other. This should give more reliable estimations on whether such a policy change might be beneficial or not.

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Table A1: Decomposing the welfare loss of decentralization for the case of income taxation.

		First-best		**I** $r(y) = 0$		**II** (I) & $T = 0$		**III** (II) & voting		**Decentralized** (III) & mobility	
		Municipality		Municipality		Municipality		Municipality		Municipality	
		1	2	1	2	1	2	1	2	1	2
Income tax rate	t_j	0	0	1.000	0.602	0.000	0.175	0.006	0.156	0.086	0.147
Lump-sum tax	T_j	0.000	0.290	-1.080	-0.679	—	—	—	—	—	—
Public consumption	g_j	0.105	0.250	0.107	0.243	0.105	0.244	0.081	0.206	0.114	0.185
(Gross) Housing price	p_j	0.516	0.825	0.509	0.829	0.526	0.824	0.597	0.801	0.680	0.749
Border household	y^{border}	1.200		1.160		1.180		1.280		1.457	
SWF		0.5526		0.5502		0.5498		0.5456		0.5405	
Agg. Comp. Var.	*in % of Y*	2.238		1.509		1.394		0.711			
Relative size of welfare loss		32.6% Imperfect redistribution		5.1% Distortive taxation		30.5% inter- municipal free-riding		31.8% intra- municipal free-riding			

These results have been presented before in Kuhlmey & Hintermann (2016, Table 4).