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# Land Taxes and Housing Prices

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**Abstract:**
We use a unique data-set to examine to what extent changes in the Danish land tax are capitalized into house prices. The Danish local-government reform in 2007, which caused tax increases in some municipalities and tax decreases in others, provides plenty of exogenous variation, thus eliminating endogeneity problems. The results imply full capitalization of the present value of future taxes under reasonable assumptions of discount rates. Consequently it gives an empirical confirmation of two striking consequences of a land tax: Firstly, it does not distort economic decisions because it does not distort the user cost of land. Secondly, the full incidence of a permanent land tax change lies on the owner at the time of the (announcement of the) tax change; future owners, even though they officially pay the recurrent taxes, are not affected as they are fully compensated via a corresponding change in the acquisition price of the asset.

**Keywords:** Land tax, Housing Prices, Treatment effect models
**JEL:** C21, E62, H22

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## 1. Introduction

According to economic theory, land taxation has several striking features. From a public finance perspective, it is one of the very few existing taxes which can be considered non-distortionary, opposed to other taxes which distort decisions of labour supply, savings, investment, consumer choice, etc. Secondly, and related to this, the incidence effects of land taxation are striking: According to simple supply theory, a supposedly permanent change in land taxation (or any other asset with a fixed supply) will be capitalized fully in the market price of land, cf. Oates (1969). This implies that the owner of the land plot at the time of the (reliable) announcement of the tax change will bear the full burden of tax increases and receive the full gain of tax decreases through the corresponding change in the land price. A person who buys a plot of land on which there is a land tax will formally pay these taxes in future, but he will be effectively compensated by a corresponding fall in the acquisition price of the asset.

This simple reasoning may be questioned for several reasons, however. It relies on the assumption that the relevant land area is fixed so that the tax changes do not alter land supply. Also, it presupposes a very long-run horizon among the agents on the land market. Myopic agents would not take the costs of future land taxes considerably into account, causing the capitalization to be less than complete.

More formally, the user cost of a unit of land $P_t^{UC}$, whether used for residential or other purposes, can be written as:

$$P_t^{UC} = (r_t + T_t)P_{t-1}^L - (P_t^L - P_{t-1}^L),$$

where $r_t$ is the interest rate of a relevant alternative investment, $T_t$ is the land tax rate, and $P_t^L$ is the market price of a unit of land at the end of period *t*. The equation states that the relevant total cost of owning a unit of land consists of the opportunity cost (the forgone interest of an alternative investment) plus the tax paid minus the capital gain obtained if the price of the land plot rises. Full capitalization implies that the land price $P_t^L$ adjusts sufficiently in the case of a tax change to make the future total user cost unchanged (except for the period in which the price adjustment itself takes place, which affects the last term on the right-hand side). Hence, in the case of full capitalization, the future relative price between land and building investments (or land and other permanent goods) is not distorted at all. Less than 100 per cent capitalization, however, would in turn have serious consequences for the efficiency effect of the land tax: If the tax is

not capitalized into prices, changing the land tax will alter the user cost of land. This may change the relative price between land and building investments and consequently distort the input mix in the production of new dwellings, cf. Sørensen and Vastrup (2015).

The present paper performs an econometric analysis to examine capitalization effects of land tax changes. It utilizes a unique opportunity in the form of a local-government reform in Denmark in 2007. Denmark has a long tradition (since 1926) of mandatory, but locally decided taxes on the value of all land areas. In 2007 several municipalities were merged into larger units, implying a standardization of the typically diverse rates of the different constituent parts of the new administrative units. Consequently, some land owners experienced a rise and others a fall in their future taxation. Employing prices for home sales before and after the reform was announced and carried out and controlling for a number of other potentially important factors, we examine the effect of the tax changes upon home sales prices. The conclusion is very clear, indicating a statistically significant change in sales prices compatible with a 100 per cent capitalization of the future land tax changes using a reasonable discount rate.

There exist few other studies of land taxation. However, capitalization of property taxes (typically levied on the total value of building and land plot) has been studied in a number of cases. The method used in the present study is inspired by Borge & Rattsø (2014) who study capitalization of Norwegian property taxes during 1995-97. They also find evidence of complete capitalization. As the authors note themselves, however, examining the relationship between tax rate and house price changes may generally result in endogeneity problems, which they try to avoid using various instrumental variables. The present study is immune to this problem because the Danish local-government reform of 2007 exogenously imposes the tax rate changes.

Oates (1969) in a seminal paper tested the empirical validity of the hypothesis of full capitalization. He concluded that in the case of an isolated tax increase, “the bulk of the rise” would be capitalized in house prices. Oates’ study has inspired a large flow of literature, confirming a negative effect on property values by future tax liabilities, but failing to reach a consensus on the extent of the capitalization. Carpozza, Green and Hendershot (1996) and Palmon and Smith (1998) also find support for full house price capitalization of changes in property taxes. Hilber (2015) surveys a number of earlier studies of house price capitalization of local taxes as well as provision of public goods. He examines studies indicating full capitalization as well as studies implying partial capitalization, depending among other things on the supposed supply elasticity of housing. Hilber notes that the extent of capitalization of property taxes should depend crucially on

the long-run supply elasticity of housing: The more inelastic is supply, the larger is the capitalization effect. This makes an analysis of land taxes as opposed to more general property taxes (taxing the total value of land including structures situated upon the land) interesting, land being completely inelastic as opposed to buildings, etc., which may change over time due to depreciation as well as new investment.

It can be difficult to carry out an in depth empirical analysis of capitalization of land tax because detailed information of sales prices are needed. However, Denmark has nationwide registers with detailed information for a long time span about all sales prices; size, location, public assessment etc. on all owner-occupied dwellings. The data cover all local governments with large variations in housing markets. The information in the registers is considered to be of high quality because it is mandatory to report information to the authorities. We have information of the effective land tax for all owner-occupied houses. It is thus possible to investigate whether changes in land taxes are capitalized in the property value with Danish data.

The results of the paper are relevant not least because of the increasing pressure upon the tax system in many countries. Globalization means that capital and labour are becoming more internationally mobile, and therefore the tax bases are becoming more vulnerable to international tax competition. A higher reliance on land taxation might alleviate this pressure. So far, however, only a few countries including Denmark, France, Australia, New Zealand, China and Brazil have a land tax, cf. Almy (2014). In addition, several Eastern European countries instituted a land tax during the 1990s when the tax system was redesigned after the collapse of the communist regimes. Other countries might see an advantage in following in their footsteps.

The paper is organized as follows. In section 2, the institutional background for the analysis is described, i.e. the properties of the Danish land tax system and local-government organization and the reform of 2007. In section 3, the methodological approach for the analysis is set. Section 4 presents and explains the econometric model used, and section 5 demonstrates the results. Section 6 concludes and discusses policy implications of the results.

## 2. Institutional background

In Denmark land tax rates are locally set by the municipal boards and levied on the land value of the plot on which a property lies. The land value is officially assessed every two years together with the total property value (and implicitly consequently the value of the buildings and structures upon the land plot, constituting the difference between

the value of the land plot and the total property value). The assessment procedure is the responsibility of the central government and common for all municipalities, using statistical valuation methods based upon property sales prices and individual housing characteristics, supplemented by discretionary judgements by individual property valuers.[1] The municipal board can set a land tax rate between 16 and 34 per mille of the assessed land value. Land tax rates differ substantially across the country and even between neighbouring municipalities.

In 2007 a local government reform reduced the number of municipalities from 270 to 98, requiring an alignment of the locally determined land tax rates within these new municipalities. 33 municipalities were not affected by the reform. The remaining 237 municipalities were divided into 250 different areas which were then merged into 65 new municipalities. 225 of the 237 old municipalities were merged without further changes, but 11 of the old municipalities were divided between two new municipalities and one was divided between three new municipalities. Because some old municipalities were split it is necessary to distinguish between areas instead of old municipalities.

As shown in table 1, the local government reform resulted in an increase in land tax rates in 139 areas. In these areas, land taxes rose on average by 3.4 per mille points. The tax rate decreased in 105 areas by an average of 2.6 per mille points. We base our identification of the capitalization effects on these changes in land tax rates, which we regard as exogenous.

**Table 1**, Average* change in land tax rates in areas

| | Areas | Tax rate before | Tax rate after | Change in tax rate |
|---|---|---|---|---|
| | Number | ---------- Per mille ---------- | | |
| Increase | 139 | 20.6 | 24.0 | 3.4 |
| Unchanged | 6 | 28.0 | 28.0 | 0 |
| Decreased | 105 | 26.1 | 23.5 | -2.6 |
| Total | 250 | 23.1 | 23.9 | 0.8 |

*Note*: *Unweighted average over areas.

The local government reform was brought into effect on 1 January, 2007, but announced already in June 2004. In 2005 it was decided which municipalities should be

[1] Besides pure land taxes, the property assessment values are used for separate taxation of the value of owner-occupied real property and of commercial buildings.

merged and in autumn of 2006, the new land tax rates were determined.[2] It is therefore likely that real estate prices were affected by the expectation of changes even before the mergers took place. We thus expect that the local government reform had a gradual effect on prices through the formation of expectations of future changes in tax rates.

This is supported by figure 1 which depicts average prices for single family homes in areas where taxes increased and decreased, respectively. Up until the announcement in 2004, indicated by the first dotted line, the development of prices of single-family homes was roughly similar in the two groups. From the announcement and until the implementation in 2007, indicated by the second dotted line in the figure, prices increased less in areas where the land tax was increased, than in areas where it was decreased. After the implementation of the local government reform the differences in prices stabilizes through 2007 and 2008. The average prices of single family homes are consistently higher in areas where the land tax rates decreased.

**Figure 1**, Development in prices for single family homes experiencing respectively a decrease and an increase in land tax rates.

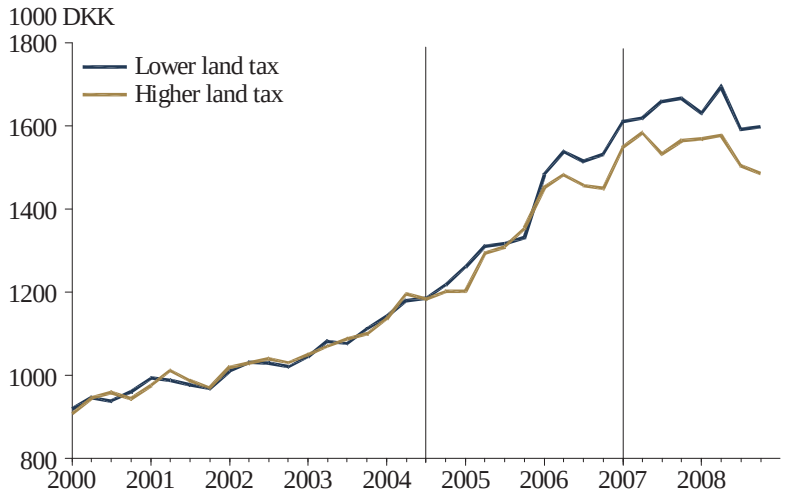


Table 2 compares the prices for single family homes before and after the reform. In 2003 before the announcement of the reform, prices were on average 2,000 DKK lower in the areas that would later experience an increase in land value taxes compared to those areas, where taxes later decreased. In 2007 after the announcement and implemen-

[2] The central government stipulated an upper bound for the new land tax rates for 2007 as a weighted average of the land tax rates of the old municipalities. The vast majority of the new municipalities chose to set land tax rates equal to the upper bound set by the government. Only a single municipality, Holbæk, chose a land tax rate which was more than a half per mille below the upper bound.

tation of the reform, the same difference had grown to 78,000 DKK. Prices for single family homes had on average increased by 76,000 DKK less in the areas that experienced an increase in taxes amounting to 7 percentage points lower price growth in those areas. Thus, there was a substantially lower price growth in areas where taxes rose.

**Table 2**, Average* prices for single family homes before and after the reform

| | 2003 | 2007 | Difference |
|---|---|---|---|
| | ---------- 1,000 DKK ---------- | | |
| Areas with land tax increase | 1,076 | 1,557 | 481 |
| Areas with land tax decrease | 1,078 | 1,635 | 557 |
| Difference | -2 | -78 | -76 |

*Note*: *Unweighted average over areas.

Figure 1 and table 2 indicate that the land tax changes had a clear capitalization effect on prices for single family home. However, it cannot a priori be ruled out that other factors might differ systematically between the two groups of single family homes and explain the different developments in prices. To further test and quantify the capitalization effect a formal econometrical analysis is conducted below.

## 3. Methodological approach

The mechanism behind capitalization can be understood in a framework of household mobility and the housing market, cf. Brueckner (1982). This framework is presented in the following section in a way similar to the approach of Borge and Rattsø (2014). Households are assumed to have identical preferences, but different incomes. The stock of housing is taken as given, and housing value is entirely demand determined. Mobility contributes to equalize the after-tax unit price of housing. If two municipalities differ only with respect to land tax rates, then the municipality with higher land tax rates should have correspondingly lower housing prices. Taxes are fully capitalized on prices if the difference in housing prices is equal to the present value of all future differences in tax payments.

Let households derive utility from housing services, H, municipal services Q, amenities, A, and a private numeraire good, X. This implies a utility function of the form $U = U(H, Q, A, X)$. In equilibrium, the household must obtain the highest possible utility level corresponding to its income level. This yields the equilibrium condition:

$$U^*(Y) = U(H, Q, A, X), \tag{1}$$

where the consumption of the numeraire good can be written as income less expenditure on housing and housing taxes, $X = Y - R - T$. Thus, the equilibrium condition defines the household's bid rent for housing $R$ as a function of housing services, municipal services, amenities, and income. The after-tax value derived from living in a property for one period of time is thus:

$$V_t = R(H, Q, A, Y) - T. \tag{2}$$

In the case of land value taxes $T = LTR \cdot L$, where $LTR$ denotes land tax rates and $L$ the land value. The value of a property $V$ is then the present value of all future $V_t$. Assuming a constant discount rate $r$ and a very long time horizon gives the following expression for the value of a property:

$$V = \frac{R(H, Q, A, Y) - LTR \cdot L}{r}. \tag{3}$$

The land tax is only levied on the land value and not the value of the property, the ceteris paribus effect of changes in the land tax rate on the value of the property is given by:

$$\Delta V = -\frac{\Delta LTR \cdot L}{r}. \tag{4}$$

In equation (4) it is assumed that the land value is unaffected by the changes in tax rates. It is plausible that lower property prices following an increase in taxes lead to lower land value assessments. This can create a downward bias in the coefficient on land taxes in a regression and thus understate the degree of capitalization. As the bias points to less than full capitalization, it does not pose a problem against the conclusion of full capitalization in section 5. Equation (4) is equivalent to the definition of full capitalization introduced above. If the land tax rate increases, the value of the property must fall equally to the present value of all future additional land tax payments.

If both sides of (4) is divided with the value of the property $V$, it is seen that the relative effect on the value of a property caused by a change in the land tax rate depends only on the fraction of the land value to the value of the property:

$$\frac{\Delta V}{V} = -\frac{\Delta LTR}{r} \cdot \frac{L}{V}. \tag{5}$$

Define the effective land tax rate as:

$$ELTR = LTR \cdot \frac{L}{V}. \tag{6}$$

(6) states that the effective land tax rate is the ratio of the total property value paid in land tax. Taken together (5) and (6) defines a linear causal relation between changes in effective land tax rates and changes in property prices:

$$\frac{\Delta V}{V} = -\frac{1}{r}\,\Delta ELTR. \tag{7}$$

Equation (7) is crucial to the analysis. It implies that the relative effect of changes in effective land tax rates on property prices is constant. The local government reform provides a multitude of exogenous changes in tax rates and combined with the linear restriction implied by (7), the effect of changes in effective land tax rates on property prices can be estimated.

If land taxes are fully capitalized, there is a negative relation between property prices and effective land tax rates of a magnitude in accordance with (7). That is, the coefficient on $\Delta ELTR$ in the analysis below should be inversely proportional to the discount rate of the households. As the discount rate indicates how households value future cash flows, it should be in accordance with the long term financial instruments available to the households. No single interest rate can be said to reflect the actual discount rate of households. However, comparing interest rates on primary sources of lending and savings for household indicates boundaries on the discount rate. A major source of lending for household is Danish mortgage bonds with fixed interest rates and 30 year maturity.

The average real interest rate of Danish mortgage bonds with fixed interest rate and 30 years maturity was 3.5 per cent in the period 2001 to 2008.[3] This can be seen as an indication of an upper boundary on the level of the discount rate of the households. Danish treasury bonds with 10 year maturity are generally considered to be a safe long term investment in Denmark and can be used to indicate a lower bound on the discount rate of households. From 2001 to 2008, the average real interest rate on treasury bonds was

[3] The interest rate is deflated by the consumer price index.

2.2 per cent. It was possible for household to lend and save at both lower and higher interest rates, but this would generally imply a shorter maturity or a higher risk. Thus, the presented interest rates indicate that households faced real interest rates around 2 to 3 per cent.

A real interest rate and thus an expected discount rate of 2 to 3 per cent is consistent with the literature. Borge and Rattsø (2014), who use an approach similar to ours, find implied discount rates in the interval 2.3 to 2.9 per cent. They compare their estimates with real interest rates on bank deposits and loans and find these discount rates consistent with full capitalization. Giglio, Maggiori, and Stroebel (2015) compare differences in prices between freeholds and leaseholds on the UK and Singaporean housing markets. Their result implies a discount rate for 100-year claims of 2.6 per cent. Do and Sirmans (1994) exploit evidence from a tax expected to be fully capitalized into property values in the south-western part of San Diego County, California. They find that households discount future tax payments with a nominal interest rate of 4 per cent. Depending on the inflationary expectations of San Diego households, their approach similarly implies a real interest rate and therefore a discount rate around 2 to 3 per cent.

Based on the prevailing interest rates and the evidence from the literature, we find it reasonable to expect a discount rate of 2 to 3 per cent. Thus, the coefficients on the changes in effective land tax rates estimated below should imply a discount rate around 2 to 3 per cent, if we are to conclude full capitalization of changes in land taxes on housing prices.

## 4. Data and econometric model

The approach adopted in this paper is a before, during, and after treatment setup due to the likely gradual formation of expectations of future tax rates described in section 2. This requires data on property prices for single family homes prior to the implementation of the reform as well as prior to the announcement of the reform. Single family homes sold from 2001 and up to the announcement in the second quarter of 2004 are used as a pre-treatment group. Single family homes sold between the third quarter of 2004 and the implementation of the reform on January 1, 2007 constitutes a during treatment group. The mergers and new tax rates were decided and announced during this period. Lastly the after treatment group consists of houses sold during 2007 and 2008.

As implied by (7) the changes in effective land tax rates following the local government reform are used to identify the degree of capitalization of land value taxes. The analysis

is therefore based on single family homes in municipalities affected by the local government reform sold between 2001 and 2008. The price for single family homes is for the property, i.e. building and land. Data on house sales and prices come from the Land Registration Court. The court handles the registration of all titles to land and properties in Denmark and ownership is only recognized if registered at the Land Registration Court. Data on property taxes comes from the Danish Customs and Tax Administration and other data on houses comes from the Building and Dwelling Register maintained by the Danish municipalities. The analysis is therefore based on a rich administrative dataset of a high quality.

The main econometric model is presented in (8). It resembles that of a standard diff-in-diff approach where the development of the prices for single family homes is compared before and after the local government reform. However, in our approach the binary treatment indicator is replaced by a continuous treatment, and parameter $\delta_t$ describes the effect at time t of changes in effective land tax rates $\Delta ELTR_h$ in 2008. $\Delta ELTR_h$ is calculated using (6). $\delta_t$ is estimated from the third quarter of 2004 to capture the gradual effect on prices:

$$\log P_{h,t} = \lambda_t + \alpha_j + \sum_{t=2004}^{2008} \delta_t \, \Delta ELTR_h + \sum_{t=2004}^{2008} \gamma_t \, \Delta TAX_j + \beta asmt01_h + \varepsilon_{h,j,t}. \quad (8)$$

Index $h$ denotes house, $j$ area, and $t$ time. The dependent variable $\log P_{h,t}$ is the logarithm of deflated house prices. Prices are deflated with Statistics Denmark's regional price index (11 regions) for property sales of single family homes.[4] $asmt01_h$ is the logarithm of the public property assessment in 2001. Yearly dummies $\lambda_t$ and area dummies $\alpha_j$ are included as controls.

Because we have chosen to specify our model in logarithm we assume that the percentage changes in prices for single family homes that experienced respectively a decrease and an increase in land tax would be the same in the case with no property tax reform. This assumption is violated if there are general equilibrium effects on the market for single family homes as a result of the change in land taxes. It could be the case if there is a negative cross-price-elasticity effect. For example it is possible that a demand shift

[4] The model has also been estimated with nominal prices instead of real prices with no qualitative and limited quantitative consequences for the results.

occurred towards single family homes in areas where the land taxes have decreased. It is not possible to test the assumption directly. However, it seems that the prices for the two groups in figure 1 evolve relatively parallel after 2008.

The merger led to uniform land tax rates as well as uniform service provision in the new municipalities. If a municipality with relatively high tax rates and service levels is merged with a municipality having lower tax rates and service levels, it would presumably experience a decrease in tax rates as well as services after the merger. As both tax rates and service provision will affect housing prices, ideally municipal services should be included as well as taxes in the estimation equation.

However, we do not have a consistent measure of overall service provided by the municipalities before and after the reform. The reason is that the reform did not only alter the size of the municipalities, but also abolished the former Danish counties. Some of the services provided by the counties were transferred to the new municipalities. [5] Instead changes in municipal income tax rates following the reform $\Delta TAX_j$ are included as a proxy for changes in municipal services.[6] This is based on an assumption that changes in local income tax rates are closely correlated to changes in the locally provided service. Since municipalities in Denmark are required to run a balanced budget, this seems as a plausible assumption. $\Delta TAX_j$ is interacted with yearly dummies starting from the third quarter of 2004 to capture any potential expectations of changes in future municipal services following the reform. As shown below, including tax rates have only minor effects on the estimates.

Important aspects when it comes to determining the price of a single family home are housing characteristics and proximity to public amenities, shops and infrastructure. We use the official property assessments as a proxy for these factors instead of geospatial data and lots of data on characteristics for the individual buildings. The public property assessments are based on geospatial data and on data about housing characteristics such as size, year of construction, facilities etc. from the Building and Dwelling Register and other sources. The Danish public assessment system on immovable property has been considered in an international context quite advanced and accurate, cf. Almy (2014) and OECD (2016). To avoid having the reform interfering with the assessments, the proper-

[5] Until 2007, Denmark was divided into 15 counties and 270 municipalities, each administrative level having its own responsibilities. The reform abolished the counties and introduced 5 major regions. The counties' tasks were divided between the new municipalities, the new regions and the central government.

[6] Changes in land taxes could also affect municipal service, but is not included as a proxy for municipal service. However, it accounts for only 13 per cent of total municipal revenue, so the potential bias of this is considered to be very limited.

ty assessments from 2001 are used. This amounts to assuming that amenities, infrastructure etc. have been roughly constant during the period of estimation. It is shown below that when the public property assessments are included the estimates are a bit lower, but the qualitative results are not changed.

**Table 3**, Descriptive Statistics

| Variable | Mean | Std. dev. |
|---|---|---|
| Real house price, DDK | 1,552,322 | 983,950 |
| Public property assessment in 2001, DDK† | 1,370,254 | 665,530 |
| Change in effective land tax rate measured in per mille points‡ | 0.05 | 0.64 |
| Change in local income tax measured in percentage points‡ | -0.14 | 0.76 |
| Number of observations: 211,209 | Number of areas: 250 | |

Note: †Displayed average and standard deviation is deflated with the regional house price index. ‡Average based on houses sold after the announcement of the reform.
House prices are deflated with Statistics Denmark's regional house price index. The price level shown is for 2006.

Descriptive statistics on variables used in (8) are presented in table 3. It should be noticed that the average change in effective land tax rates is close to zero. This implies that the reform was not used to systematically raise or lower land tax revenues. Our dataset contains 211,209 observations covering 250 areas. All houses within the same area experienced the same changes in actual land tax rates following the reform. This implies that adding a new area should yield more information than adding more houses to existing areas. To control for these potential correlations within areas clustered standard errors are used, where the clusters are the areas. The consistency of the estimator of clustered standard errors depends not only on the number of observations but also on the number of clusters; cf. Angrist & Pischke (2009). The number of observations and areas reported in table 3 implies that there is on average 845 houses in each cluster. The number of clusters and the number of observations in each cluster should be sufficient to ensure consistency.

## 5. Results

In this section the results are presented and their robustness is tested. The results are summarized in table 4. First the results from the main model are presented. They indicate full capitalization of changes in land taxes. Next all controls are excluded to show that they only contribute to the efficiency of the estimates.

*Main model*

Model (1) in table 4 presents the estimated coefficients from the main model. As expected, the coefficients on effective land tax rates fall from -0.0225 in 2004 to -0.0426 in 2007, implying a gradually larger impact of the changes in tax rates on prices. This is in accordance with the expected gradual formation of expectations following the announcement of the reform. The magnitude of the coefficients is also consistent with full capitalization of changes in land taxes. Equation (7) implies that the inverse of the coefficient should equal the long term interest rate. For 2007 this implies the following discount rate:

$$\mathbf{R} = -\frac{\mathbf{0.001}}{\delta_{2007}} = \frac{\mathbf{0.001}}{\mathbf{0.0426}} = \mathbf{0.023}. \tag{9}$$

The coefficient in 2007 implies a discount rate of 2.3 per cent. All implied discount rates are reported in table 4. Given the reported standard errors, the estimated coefficient is reconcilable with a discount rate in the interval between 2 and 3 per cent. The main model thus indicates full capitalization of land value taxes on real estate prices.

The implied discount rate of 4.1 per cent in 2008 is not directly reconcilable with full capitalization. However, the year 2008 was in many ways special. In 2008 the Customs and Tax Administration introduced new assessments such that the average assessed land value in the population of single family homes used in the analysis increased by 50 per cent from 2007 to 2008, but with a considerable dispersion. Changes in assessments affect land taxes. The change in assessments coincided with the financial crisis, which affected house prices differently in various areas. These circumstances call into question what really determines the coefficient in 2008. We therefore refrain from giving the coefficients and implied discount rates in 2008 a causal interpretation.

**Table 4**, Regression results

| Model | (1) | | (2) | |
|---|---|---|---|---|
| | Estimates | Discount rate | Estimates | Discount rate |
| 2004: ΔELTR | -0.0225** | 4.4% | -0.0252* | 4.0% |
| | (0.01069) | | (0.01467) | |
| 2005: ΔELTR | -0.0346*** | 2.9% | -0.0441*** | 2.3% |
| | (0.01152) | | (0.01475) | |
| 2006: ΔELTR | -0.0364*** | 2.7% | -0.0403*** | 2.5% |
| | (0.01066) | | (0.01344) | |
| 2007: ΔELTR | -0.0426*** | 2.3% | -0.0474*** | 2.1% |
| | (0.01152) | | (0.01414) | |
| 2008: ΔELTR | -0.0246*** | 4.1% | -0.0289*** | 3.5% |
| | (0.00830) | | (0.01014) | |
| 2004: ΔTAX | 0.0069* | | | |
| | (0.00363) | | | |
| 2005: ΔTAX | 0.0052 | | | |
| | (0.00408) | | | |
| 2006: ΔTAX | 0.0122** | | | |
| | (0.00547) | | | |
| 2007: ΔTAX | 0.0148*** | | | |
| | (0.00528) | | | |
| 2008: ΔTAX | 0.0055 | | | |
| | (0.00469) | | | |
| Assessment | 0.6615*** | | | |
| | (0.01175) | | | |
| Observations | 211,209 | | 211,209 | |
| $R^2$ | 0.768 | | 0.572 | |

Clustered standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

*Without controls*

A way to examine whether the changes in land tax rates were truly exogenous is to remove all controls. The main assumption behind the conclusion of full capitalization is that the observed changes in prices are only due to the changes in land tax rates. If it is so, all other controls only serve to explain the overall level of prices and leaving them out should only affect efficiency.

The estimated coefficients from the model estimated without controls are presented as model (3) in table 4. They are only marginally larger compared to before. The standard errors, however, have all grown by roughly a third implying that the controls only contribute to efficiency.

Overall, after we have addressed all major objections against the econometric analysis the conclusion of full capitalization of changes in land taxes still holds.

## 6. Conclusion

Using a unique administrative Danish data-set for sales prices and house characteristics for single-family homes, effects upon sales prices of changes in land tax rates are analysed. The analysis utilizes the Danish local-government reform in 2007 when numerous smaller municipalities were merged into larger ones, resulting in changes in land tax rates for several local areas. Altogether, 237 out of 270 original municipalities containing about 75 per cent of all Danish one-family homes were merged during the process, the vast majority experiencing a resulting change in land tax rates. The reform thus provides plenty of exogenous variation, eliminating potential endogeneity problems. The results demonstrate a clear effect on sales prices of the observed changes in land tax rates. Furthermore, the magnitude of the changes implies full capitalization of the present value of the change in future tax payments for a discount rate of 2.3 per cent, which is within the range of reasonable discount rates for households during the period in question. The analysis consequently supports the hypothesis that perceived permanent land tax changes should be capitalized fully into the price of land and property.

The result supports the view that a tax on the value of all land like the existing Danish land tax does not distort economic decisions as it does not affect the user cost of land and consequently the relevant relative prices. An implication is that introducing or increasing the relative weight of land taxation in the tax system would conceivably reduce over-all distortions and create a system that is more robust to the pressure of globalization upon other sources of revenue. At the same time, however, full capitalization of land taxes implies that the owner of a land plot at the time of the announcement of a

permanent land tax change bears the whole burden of the tax change in present value terms. Hence, land tax changes may have large redistributive implications, implying a requirement to impose such changes, when desired, rather incrementally.

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