Irrationality in the housing market?

An empirical analysis of the capitalisation of local property taxes in the Norwegian housing market

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Abstract

This thesis presents new evidence on the effects of local property taxes on house prices. Since 2007 there has been a significant increase in the number of Norwegian municipalities that tax housing using the local property tax, which leads to rich variations in tax rates, both over time and between municipalities. I use data from the period 2007-2015 to examine the effects of local property tax changes on house prices, exploiting these variations.

I find that the effects from property taxes are heterogeneous, and not in line with what the theory of capitalisation would predict. Using fixed effects in a hedonic time dummy framework, I find no systematic effect of local property taxes on house prices, inconsistent with the theory. Further exploration show that the lack of a systematic effect does not rule out capitalisation in areas with specific characteristics. Using the difference-in-difference framework, I find capitalisation in urban areas, but not in the rural areas investigated. These diverging findings may be explained by the variation in salience of property taxes between rural and urban areas, a sign of bounded rationality in the housing market.

Preface

Working on this thesis have been an interesting and challenging endeavour, and a great source of new knowledge about both myself and the subject. I would never been able to finish this project without the competent guidance of so many. Some of them deserve a special acknowledgement for their valuable support and feedback.

Most of all, I have to thank my supervisor Erlend Eide Bø in Statistics Norway for invaluable comments and suggestions, and steady guidance through the months of work. André Anundsen also deserves the greatest of gratitude, for the idea, for taking a keen interest in the early days of this project, and for general inspiration. My superior and colleague in Norges Bank, Øyvind Eitrheim, is another one who deserves a huge thanks, for fruitful discussions and patience during this hectic period. Vebjørn Wiken, Julie Johnsen, Kirsti Mellbye and Frank Emil Jøssund in the Ministry of Finance also deserves gratitude for important feedback, uplifting comments, and the time they have set aside to hear about my work.

It also deserves the strongest emphasis that this thesis could never have happened without the guidance of Eyo Herstad, who has the sole responsibility for teaching my about LaTeX, STATA, coding and so much more about how to write a thesis. Sincere gratitude is in it place. Also thanks to OFS - Oslo Fiscal Studies and Ministry of Local Government and Modernisation for generous scholarships, and Statistics Norway for data, computer space and way too much coffee.

At last, there are some external people that deserve a thanks for their contribution to this thesis: Erik Bolstad, for his brilliant website with detailed geographical data, and Liv Signe Navarsete, former Minister of Local Government and Regional Development, for ensuring a clean municipality level data set, almost without mergers of municipalities midways. I have to stress that I am solely responsible for any inaccuracies or errors in this thesis. All the results produced in this thesis are estimated using STATA. The codes used in the thesis may be available on request.

Contents

Chapter 1

Introduction

In this thesis, I conduct an empirical investigation of the Norwegian house prices making use of rich Norwegian data on housing transactions, local property taxes and other municipality level variables from the period 2007-2015. I show how a systematic effect of the Norwegian property tax on house prices cannot be found using fixed effects in a hedonic time dummy framework, contrary to what standard capitalisation theory predicts. These results are nuanced by a difference-in-difference analysis of tax changes in a selection of municipalities. The difference-in-difference estimates show that capitalisation appear in certain areas, even though neither this analysis reveals a consistent effect over time and space. Most notably, capitalisation seems to be present in urban areas, and non-existent in rural municipalities. This heterogeneity also reveals a possible weakness of the hedonic time dummy approach, which primarily includes variation in property taxes in rural municipalities. Thus, I attribute the most weight to the results from the difference-in-difference estimates in my discussion of the results.

Testing the results from larger and more complex models with quasi-experimental methods are a useful exercise (Thoresen and Vattø 2013), which this divergence of results shows. The two approaches I apply work as complements, which control for biases in different ways and also return estimates with different advantages. The results from the hedonic model supply me with the necessary information to calculate a point estimate of the degree of capitalisation in the Norwegian market, while the difference-in-difference analysis, which looks at certain events, give insight into heterogeneous market behaviour and lead to a more robust understanding of the causal effect of property taxes on house prices through singling out exogenous variations in property taxes more carefully. In this thesis, I use postcode level data to achieve this, by looking at postcodes along the borders between municipalities.

The methods applied and the data available distinct this thesis from the prior work on the capitalisation of Norwegian property taxes, by Borge and Rattsø (2014). I have access to richer data, with variations in the tax rate over time inside municipalities, which allows me to control for municipality fixed effects, as well as applying the quasi-experimental difference-in-difference method. This may also be the reason I do not find systematic capitalisation, like they did.

1.1 Motivation

The effect of property taxes on house prices, which is the subject of this thesis, is best known as the capitalisation of property taxes in the public economics literature. The results in this thesis are interesting as a contribution to the capitalisation literature, but also in light of recent events in the Norwegian property market. My empirical analysis covers the period January 2007 - July 2015. This was a period where Norwegian house prices rose significantly, as shown in Figure 1.1. This has made house prices an important topic in the Norwegian public debate, as well as for policy makers and among academics.

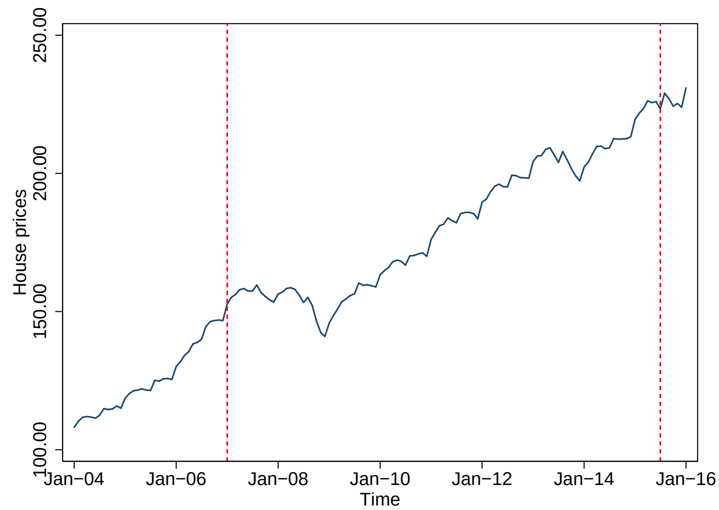

Figure 1.1: House price index, Norway

Source: Eiendom Norge. The dotted lines mark the sample period.

The major house price concern is fuelled by the fear of a housing bubble, with a consequent fall in house prices. The housing bubbles in the US and a large number of European countries prior to the Global Financial Crisis and the Great Recession are still fresh in memory, and recent research like Jordà, Schularick, and Taylor (2015) have showed how credit-financed house price bubbles historically have been a particularly dangerous phenomenon for financial stability.

In this sense, the taxation of housing may be a double-edged sword in the short-term. In theory, a gradual increase in taxation of housing will dampen the growth in house prices. This is shown in Bø (2015). On the other hand, an unexpected increase can also lead to a fall in house prices, with the consequence that will have for financial stability. This is especially relevant when the high leverage among a sub-group of homeowners are taken into consideration (Anundsen and Mæhlum 2017).

But the question of whether home buyers act like the theory predicts when they face a change in property taxes remains. For economists with knowledge of capitalisation theory or assets pricing theory it may seem natural, but for regular people, the idea that taxes affect houses prices, and even reduce them, may be counter intuitive. These potential misperceptions by the large majority of home buyers may affect how prices are set in the housing market.

1.2 Existing literature

In the public economics literature, the capitalisation of property taxes and other local characteristics has been of great interest, ever since Oates (1969) used the degree of capitalisation of property taxes into house prices as a test of the Tiebout hypothesis. The Tiebout hypothesis stems from the seminal paper on local governments' spending by Tiebout (1956). It challenged the view of Musgrave (1939) and Samuelson (1954) that there are no viable mechanism that can ensure an optimal provision of public goods, at least at the local government level. Because people can "vote with their feet" and move between competing jurisdictions, there will under certain conditions be an efficient resource allocation.

Oates (1969) suggested that one of these conditions are capitalisation of property taxes and other fiscal differentials between municipalities in the housing market. Since then, several efforts have evaluated the proposition that capitalisation implies efficient provision of public goods theoretically and tested the capitalisation of property taxes empirically (for a review, see Ross and Yinger (1999)).

A clear overweight of the empirical studies have found capitalisation, either full or partial, but there have also been some that do not find any capitalisation. The theoretical literature has on the other hand rejected the proposition that this capitalisation confirms the Tiebout hypothesis and lead to efficient allocation of public goods, as Oates (1969) suggested (Hilber 2011).

This literature is mainly based on the American local property tax. The most prominent work on Norwegian data is the work by Borge and Rattsø (2014), who estimated the capitalisation of the local property taxes in Norway with data from the period 1997-1999. They found full capitalisation. A more recent study on Swedish data by Elinder and Persson (2014) found no capitalisation for the majority of properties, but slight capitalisation in sub-markets where a high share of the agents have higher education. Contrary to other countries, the Swedish property tax is uniform, and is decided by the central government.

Elinder and Persson (2014) explain their findings with the bounded rationality of home buyers and the low salience of the property tax. While the literature on bounded rationality is related to the newer literature of behavioural economics, the visibility of taxes have been an issue in economics since John Stuart Mill's 1848 *Principles of Political Economy*. Newer examples of the theory of bounded rationality and salience of taxes being applied in the tax literature are Chetty, Looney, and Kroft (2009), Chetty (2009) and Finkelstein (2009). These issues are further discussed in chapter 5.

1.3 The Norwegian property tax

In Norway, the property tax is decided and collected by the municipalities. Norway has three levels of government: state, counties and municipalities. The municipalities spend around 18 per cent of mainland GDP each year, which constitutes a substantial share of total government spending. The municipalities finance this spending with income from locally decided taxes and duties, dividends from ownership in natural resources, and centrally decided taxes and transfers from the central government.

Of these income sources, centrally decided taxes and transfers from the central government make out an overwhelming proportion, which leaves the municipalities with a relatively small influence over their own income. The property tax is one of few revenue sources that the municipalities have discretion over. In 2015, 250 municipalities collected property taxes on housing. A summary of how these municipalities have structured the tax and how much revenue they collect is presented in table 1.1. The tax variable is denoted in per thousand[1].

Table 1.1: Summary statistics, 2015

	Obs	Min	10th	Median	Mean	90th	Max
Nominal tax rate	428	0	0	2	2.37	6.5	7
Nominal tax rate, if tax	250	2	2	3.93	4.05	7	7
Year of last valuation	250	1988	2006	2010	2010	2013	2015
Size of standard deduction	250	0	0	0	102,820	300,000	1,800,000
Expected tax on 120 m^2	250	880	1800	3,331	3,491	5,716	8,400
Income from property tax	250	464	2,133	8,894	21,629	41,027	515,101

Note: Displays detailed summary statistics of different tax variables in 2015. In the rows where the sample size is restricted to 250, only the municipalities that have introduced the tax are included. The income is denoted in 1000s NOK.

[1] 0.1 percentage point

The tax rules for the coming year are decided in the budget process of the municipalities. In December every year, the budget for the coming year is passed, as well as forecasts of the property tax for three year after that. These forecasts are notoriously imprecise and are not binding. For instance, Stavanger planed a revaluation of the properties in 2016, in their budget for 2013, but ended up increasing the nominal tax rate in 2015 instead.

But the municipalities do not have full discretion over the design of the property tax. The tax is subject to the property tax law [2], which regulates elements like how much the tax rate can be changed in one year, which buildings that can be exempted, how often the municipalities have to revalue the properties, and how the valuations of the properties can be conducted. It also caps the nominal tax rate at 0.7 percentage points of the property value.

The strict law has not stopped municipalities from breaking it. Most notably, there was a situation in Bergen around 2009, where the politicians decided to hold on to the old valuation from the 80's. The county governor of Hordaland declared the tax law breaking, but the municipality nevertheless chose to hold on to the old valuation until the tax was removed in 2012.

This unlawfulness represent a problem for the empirical analysis of this this thesis, as it leads to insecurity about the relationship between the stated nominal tax rate and the effective tax rate. The effective tax rate is the share of the value that is paid in tax, and is the treatment of interest in an econometric sense.

Table 1.2: Summary statistics, Net change from 2007-2015

	Obs	Min	10th	Median	Mean	90th	Max
Tax (Yes=1)	428	-1	0	0	0.28	1	1
Nominal tax rate	428	-5	-2.7	0	0.81	4	7
Nominal tax rate, if tax	250	-5	-3.6	2	1.53	5	7
Size of standard deduction	250	-500,000	0	0	49,038	250,000	1,000,000
Expected tax on 120 m^2	428	-3280	0	639	1,427	4,100	7,520
Income from property tax	424	-10,438	0	1,9132	7,549	17,673	285,255

Note: Displays detailed summary statistics of the changes in tax variables since 2007, the first year with the new law in place. In the rows where the sample size is restricted to 250, only the municipalities that have introduced the tax are included. The income is denoted in 1000s NOK.

The property tax law was revised in June 2006, with the changes in force from

[2]Lov om eigedomsskatt til kommunane (eigedomsskattelova)

2007. The most substantial change was that the municipalities where allowed to extend the property tax to the whole municipality, not only areas build in a townish matter. Until this change, the tax was bureaucratic and not very attractive to voters and politicians. It had primarily worked as a way to finance services in central areas, where those who paid the tax lived.

Since the change, more and more municipalities have utilised the property tax as a revenue source. Notably, big municipalities like Oslo [3] have introduced it. As can been seen in table 1.2, both the number of municipalities that have introduced a property tax on houses, the average nominal tax rate for the 250 municipalities that had introduced a property tax on houses, and the average income from the tax have increased. One can also see that there are municipalities that have removed or decreased the tax, but that this applies to a minority. Following from this is that tax increases makes out a substantial share of the tax variations in this analysis.

1.4 The capitalisation model

As mentioned above is capitalisation of property taxes the term that is used in the public economics literature to describe the effect property taxes have on house prices. Capitalisation is a general term, used to describe the effect certain goods, often subject to public policy, have on house prices. This can be everything from transportation opportunities or quality of schools to air quality or neighbourhood safety.

In models of capitalisation, as described by Palmon and Smith (1998) and Elinder and Persson (2014), house prices are set by agents who consider everything that comes with a house in their valuation of it. This includes the characteristics of the house, location and neighbourhood, local amenities as well as factors that affect the cost of living. The market value of these characteristics, in present time and all future periods, determine the market price.

The local property tax is one of these factors that are capitalised into the price, and when it is increased, this affects the market price of houses negatively. In the short run, where the supply of land and housing is fixed, the market price will decrease with the net present value of the expected increase in present and

[3] In 2016, so this change is not included the sample

future tax payments (Oates 1969), given that the housing market is efficient, and individuals use all relevant information in order to value a house.

This theory is closely related to the User Cost Theory (Himmelberg, Mayer, and Sinai 2005) and the Asset-Market Approach to house prices (Poterba 1984). Palmon and Smith (1998) present this generalised version of the capitalisation model:

$$P_j = \frac{S(Z_{ij})}{\phi_n + \beta_\tau \tau_j} \tag{1.1}$$

where P_j is the price of the house, $S(Z_{ij})$ is a hedonic function of the value of owning the house for one period, and ϕ is the net user cost, τ the tax rate for owning the house for the same period and β the degree of capitalisation. In other words will a β of 1 imply full capitalisation and rational home buyers.

This model can be transformed to the partial semi-elasticity of house prices to property taxes (Svensson 2013), showing what partial semi-elasticity that is implied by the model

$$\frac{\partial ln(P_j)}{\partial \tau} = \frac{\partial}{\partial \tau}\left(ln(S(Z_{ij})) - ln(\phi_n + \beta_\tau \tau_j)\right) \tag{1.2}$$

$$\frac{\partial ln(P_j)}{\partial \tau} = -\left(\frac{\beta}{\phi_n + \beta_\tau \tau_j}\right) < 0 \tag{1.3}$$

This is negative, given that $\beta > 0$. The partial semi-elasticity of house prices to property taxes should thus be negative when some degree of capitalisation holds[4].

[4]To fully correct for the non-linearity of the semi-elasticity is beyond the scope of this thesis.

Chapter 2

Data

The empirical analysis in this thesis combines data from several sources. Covering the years 2007 to 2015, I have data on the local property tax and housing transactions in Norway, as well as control variables like local unemployment and child care coverage. I present the housing transaction data in 2.1, the local property data in 2.2, and the control variables in 2.3.

2.1 Transaction data

To study the of property taxes effect on house prices, I utilise a data set with a rich set of transactions, which is a compilation of data from official records, and Finn.no, an advertisement firm. It spans from January 2007 to July 2015, covers about 60 per cent of all dwelling-sales on the open market, and is comparable to the micro data that makes the basis of Statistics Norway's house price index[1]. In addition to information concerning the transactions, like the dates of registration of the transactions in official registers and the sell prices, it also contains information on the dwellings sold. This includes information about the address, the size, the number of rooms and the floor[2].

To remove errors, not-arms-length transactions, outliers and invalid entries, I have to trim the data set substantially. A concern is that outliers in price and price

[1] https://www.ssb.no/en/bpi/

[2] A weakness is that the price do not include the joint debt and the joint costs associated with the unit.

per m^2 are primarily determined by factors not covered by the hedonic attributes covered in my data. Because of this, I am fairly strict on outliers. This means that I exclude every transaction with a price over 10,000,000 NOK or under 400,000 NOK. I also exclude all transactions with a price per square meter over 120,000 NOK or under 10,000 NOK, and all transactions where the size quoted is less than 10 square meters or more than 300 square meters[3]. This leaves 455,303 transactions. When I also exclude transactions where the numbers of rooms are not available and where there is no information about lot size, I have 365,964 observations.

Table 2.1: Summary statistics, transactions

	Percentriles, median and mean					
	10th	25th	Median	Mean	75th	90th
Price	1,225,000	1,650,000	2,300,000	2,590,877	3,200,000	4,350,000
Size	53	70	97	109.4	138	187
Price per m^2	12,813	16,574	22,893	26,115	32,051	43,253
Rooms	2	3	3	3.6	4	5
Observations	455,303					

Note: This table shows the distribution of price, size, price per square meter and the number of rooms in the trimmed data set.

In table 2.1, key variables in the trimmed data set are summarised. The distribution of the different types of houses, detached, semi-detached, row houses and apartments, and the years of transaction is shown in table 2.2.

[3] 1342 extra units are included if I increase the 10,000,000 cap to 20,000,000.

Table 2.2: Summary statistics, year and type

	Number	Percentage	Number	Percentage
2007	46,930	10.3	37,599	10.3
2008	45,560	10.0	36,513	10.0
2009	44,834	9.9	36,141	9.9
2010	49,015	10.8	38,835	10.6
2011	55,851	12.3	44,268	12.1
2012	60,184	13.2	48,348	13.2
2013	61,252	13.4	49,760	13.6
2014	61,268	13.4	49,730	13.6
2015	30,409	6.7	24,770	6.8
Detached	127,538	28.0	83,241	22.8
Semi-detached	59,169	13.0	46,184	12.6
Rowhouse	96,306	21.1	79,347	21.7
Apartment	172,290	37.9	157,192	42.9

Note: This table shows the distribution of transactions over time and types of houses. The columns to the left show the distribution for the large sample, while the columns to the right show the distribution for the units where the number of rooms are reported.

2.2 Property tax

The KOSTRA data set

Statistics Norway collects data on a range of different local activities, like finances, schools and health, in the KOSTRA database. This database also includes information on the property tax, and for the year 2007 and since, the property tax in every Norwegian municipality is described in detail in the KOSTRA database. The data is structured as a balanced panel of the different characteristics, including both dummy variables and discrete variables. For the full list of the variables included in the KOSTRA data set, see table C.1 in the appendix.

The KOSTRA database is based on reporting from municipalities, where errors and misentries may appear. There is nothing that guarantees that these errors are picked up and corrected by Statistics Norway. Therefore, I have corrected for several more or less obvious mistakes and wrong entries, but there may still be undetected errors in the data. The data do also have some known inconsistencies, which I am unable to correct for. In many municipalities, houses are not revalued for tax purposes through individual assessment, but by a fixed adjustment. The fixed adjustment is called an "office adjustment", and means that instead of a realistic revaluation, all values are increased by a revaluation factor, for instance 10 per cent.

The revaluation factor is more often than not set after political considerations, and not to accurately mimic the actual price increases that have taken place since the last valuation. These adjustments are not reported in the database, and are thus a source of noise in my data set, which makes it harder to find a good measure of the effective tax rate. Another source of noise is that some municipalities operate with discounts on the property valuation instead of a lower nominal tax rate. This is not reported either, but is not very common, and thus not a problem of the same magnitude as the office adjustments.

The real property tax, nominal and effective

As described, the KOSTRA database does not provide the exact property tax that applies to each property, the effective tax rate. What it gives is detailed information on the property tax, as the standard deduction, the deduction for new buildings, and the deduction for historical buildings, which are useful when estimating an approximation of the effective tax rate, but the variation in valuation methods between municipalities, and as mentioned above, the office adjustments, make it hard to find a good, universal measure of the effective tax rate.

To get around the heterogeneity of the effective tax rate, I test my specification with several different tax variables in the hedonic time dummy model, and perform the difference-in-difference analysis, where only one change in the tax rate is considered at a time.

2.3 Other data

Unemployment

Since 2007, Norwegian municipalities have seen large swings in economic activity and unemployment. In the last ten years, the Norwegian economy has been hit by both the Global Financial Crisis and the sharp drop in oil prices. And in the time in between, characterised by a record high oil price, the Norwegian economy experienced what has been called a golden age.

The drop in oil prices has been challenging, nonetheless because of the structural nature of the downturn. Especially some regions in the west of Norway, with strong connections to the oil industry, have experienced high levels of unemployment in the years after the oil price drop.

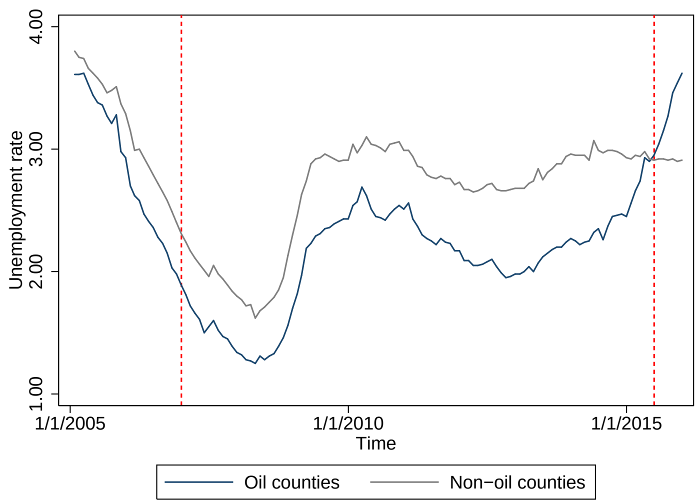

Figure 2.1: Registered unemployment by county, seasonally adjusted

Oil counties: Hordaland, Møre og Romsdal, Rogaland and Vest-Agder

Source: NAV and Norges Bank. The dotted lines mark the sample period.

To include unemployment on the municipality level for the whole period, I have to combine the reporting of the same measure from two different data sources, NAV and Statistics Norway. Statistics Norway reported the rate of registered unemployment[4] monthly until 2014, but only for the month of November afterwards. Therefore, I have amended the Statistic Norway numbers with NAV's numbers for the same measure of unemployment for 2015. These are only reported at the municipality level in 2012 and after.

To examine the impact of the discontinuity between 2014 and 2015, I compared the numbers for November 2015 and 2016 provided by NAV and Statistics

[4]This is the measure informally known as the 'NAV numbers', not the headline LFS(AKU) numbers.

Norway. This showed an average negative bias of the NAV numbers of 0.038 percentage points in 2015 and 0.018 percentage points in 2016. This is so low that the discontinuity should not bias my results, especially since there is no reason to believe that the deviation between Statistics Norway's and NAV's numbers are anything else than noise.

To match the frequency of the unemployment variable with the other control variables, I transform my monthly data to year averages. This also makes them more robust for big short-term movements, seasonality and the fact that there are missing values for those observations where the number of registered unemployed in a municipality is 4 or less.

Childcare

Providing childcare is one of the main services of Norwegian municipalities. The KOSTRA database provides yearly data on the number of children in kindergarten, as well as the number for children in kindergarten age, which enables me to include the child care coverage in the municipality. The importance of child care coverage for house prices is shown in Borge and Rattsø (2014).

Population

In the years of this analysis, Norway experienced a substantial increase in population, but with large heterogeneity between regions and municipalities. The cities and the areas surrounding them have experienced large increases, while some municipalities in rural areas have even experience a population decrease between 2007 and 2015.

ROBEK status

ROBEK is a registry of municipalities and counties that are in fiscal distress, established by the Ministry of Local Government and Modernisation. When a municipality are in the registry, resolutions to raise loans or to enter long-term renting contracts are not valid until approved by the County Governor or the Ministry. It also involves that the Ministry will control the legality of all budget related resolutions. (Regjeringen 2007)

The data set on ROBEK status provided by the Ministry gives a score from 0 to 1 for each year, depending on the proportion of the year the municipality was on the list. So if a municipality did have a positive ROBEK status for the six first months of 2015, the score for that year is 0.5. In my analysis, I have transformed this variable to a dummy, which is 1 for every year the municipality have appeared on the ROBEK list.

Commuter data

Among Statistics Norway's registry data on employment, there are also data on commuting patterns. These include the municipality of residence for all workers in a municipality, and the municipality of work for all workers living in a municipality. This is a large and detailed data set, which is hard to restructure for use in the empirical analysis, but some of these statistics are displayed in the appendix as context for the discussion.

Chapter 3

Identification strategy

To reach identification, I make use of two different empirical strategies, the hedonic time-dummy approach and the difference-in-difference approach. In this chapter, I discuss how each of them are structured, what decisions I make with regard to sample selection and which variables I include, and to what degree this leads to identification of causal relationships. The hedonic time dummy approach is presented in section 3.1, while the difference-in-difference method is described in section 3.2.

3.1 The Hedonic Time Dummy Approach

Building on Anundsen and Larsen (2016), I develop a hedonic time-dummy model for the Norwegian property market that includes a property tax variable. Hedonic models are primarily used to correct for the varying qualities of differentiated goods by including different characteristics of the good as variables, and with that placing an implicit partial market price on the different characteristics. In the case of housing, they correct for the different characteristics home buyers value when they buy a house, for example the size, the number of rooms et cetera (Palmquist 1984).

These kind of models originated with Ridker and Henning (1967) and Rosen (1974), and the hedonic time dummy models are today most commonly used to create house prices indexes. This makes them useful as core models when working with micro data and not only indexes, especially because of the heterogeneous nature of housing.

Core model

My core hedonic model to explain $ln(P_{i,t})$, the observed price on log form, is a modified version of Anundsen and Larsen (2016). As Anundsen and Larsen's model, it includes a quadratic specification of the size on log form, a vector of the house's attributes, $\mathbf{H}_i$, a vector of spatial variables, $\mathbf{S}_p$, and a vector of time variables, $\mathbf{M}_t$. Having i indexing unique houses, p indexing houses grouped on postcode level, and t indexing periods of time, I get this equation.

$$ln(P_{ipt}) = a + b_1 ln(s_i) + b_2(ln(s_i))^2 + \mathbf{c}'\mathbf{H}_i + \mathbf{d}'\mathbf{S}_p + \mathbf{e}'\mathbf{M}_t + \mathbf{f}'\mathbf{R}_p\mathbf{M}_t + \epsilon_{ipt} \quad (3.1)$$

The house specific characteristics, $\mathbf{H}_i$, describe the qualities of the house sold. These are the number of rooms, the period in which the construction of the house took place, a dummy for houses where the lot is more than 1000 square meters, a dummy for each of the different house types (Detached, Semi-detached, Row houses, Apartment), and interaction variables between the type dummies and the size on log form.

$\mathbf{S}_p$ is a vector of spatial variables. Here, I use postcode and region dummies to identify spatial differences. The postcode controls for factors like the neighbourhood, the distance to city centre and borough services. In addition, the postcodes are municipality specific, so they also control for invariant municipality effects. The region specific invariant effects are also controlled for by the postcode vector, but I still include the region dummies in the model, because of their value together with the time vector.

As implied by the name of the method, the vector of time variables, $\mathbf{M}_t$, is a vector of monthly dummies. To correct for differences between the housing markets in the different regions, I also include interactions between these time dummies and the nine region dummies, $\mathbf{R}_p$.

Full model

The full model is where I introduce the tax, and the one I use in my estimation. I amend the core model with a tax vector, $\mathbf{T}_{ipt}$, and municipality specific, time-varying variables, $\mathbf{A}_{pt}$, which gives this model.

$$ln(P_{ipt}) = a+b_1 ln(s_i)+b_2(ln(s_i))^2+\mathbf{c}'\mathbf{H}_i+\mathbf{d}'\mathbf{S}_p+\mathbf{e}'\mathbf{M}_t+\mathbf{f}'\mathbf{R}_p\mathbf{M}_t+\mathbf{h}'\mathbf{T}_{ipt}+\mathbf{i}'\mathbf{A}_{pt}+\epsilon_{ipt} \tag{3.2}$$

The vector of tax variables, $\mathbf{T}_{ipt}$, takes into account the different tax variables that can be included. I try out different specifications of this tax vector, as will be explained in the results part. $\mathbf{A}_{pt}$ is a vector of time-varying municipality specific variables. This vector includes the variables population size, the child care coverage rate, the unemployment rate and a ROBEK list dummy.

Causal interpretation and weaknesses

In the modern econometric literature, the goal is not to produce a perfect "true model", but to capture the causal effect. Angrist and Pischke (2017) describes a regression as an empirical control strategy designed to capture causal effects. This is the motive that lay behind the above econometric strategy as well. This means that the variables in the hedonic time dummy model serves as control variables only, and have no interest besides that. I will therefore not discuss the quality of the model in light of its ability to predict and explain house prices, but as a model that can control for the bias that arises from the heterogeneity of housing. I can put a causal interpretation into the estimates when the control variables give hold to the conditional independence claim.

To achieve conditional independence, the model has to control for confounding factors, by including variables that control for differences in house prices between municipalities and over time. This can be variation in the attributes of houses sold, the locations of houses sold, and variation in other factors like the job market or interest rate.

To eliminate the bias from variation in house specific attributes, I control for the different characteristics of the house sold. They are not a comprehensive set of housing characteristics, which weakens the casual interpretation of the results, but are the best thing available to describe the quality of houses. A weakness with this method is that it do not pick up the time since last refurbishment. I try to control for this by including a vector of dummies for the decade build, but it is not perfect.

Another weakness is that it corrects for each factor independent of the location of the house. This means that, for example, one square meter is assigned the same marginal value if it is added in Holmenkollen in Oslo or in Røyrvik in Nord-Trøndelag. The postcode dummies correct for fixed effects related to location, but these are the same independent of the characteristics of the house.

The postcode dummies function as both postcode and municipality fixed effects, controlling for both the spatial qualities of the house and for the invariant local amenities and services available in the municipality. This also includes the invariant supply side factors. These municipality fixed effects distinguish this analysis from earlier analyses of the Norwegian property tax (Borge and Rattsø 2014), as they correct for the differences in quality and extent of local services and amenities.

Some of the factors that are not specific to the house, but are common for the municipality, varies over time. To control for this variation, I have included unemployment, which controls for changes in the local job market, the childcare coverage rate, which controls for changes in one of the most important local services, population size, which control for centralisation and other demographic changes, and ROBEK, which operates as a proxy for the fiscal situation in the municipalities.

I do not explicitly control for the variation in factors that are the same for all locations, but varies over time, through their own variables. This can seem surprising, as these are obviously very important for house prices. The reason is that the monthly dummies, which functions as time fixed effect, control for all of these factors, including interest rates, wealth and income tax rules, national building codes and the like. Through the interaction with the regional dummies, they also control for the difference in trends between regions, as I assume that these factors affect house prices within a region in a similar way.

3.2 Difference-in-Difference Approach

Approaches like the hedonic time dummy method, that includes the variation between a large number of municipalities or jurisdiction, are the most widespread in the capitalisation literature, but a new literature of quasi-experimental approaches offers new ways to reach identification.

Already in the 80's, researchers like Cushing (1984) tried to estimate the capitalisation by comparing the price of units sold in comparable blocks of housing on opposite sides of the border of two jurisdictions with different property tax rates. Inspired by Cushing (1984), I have isolated bordering municipalities with interconnected housing and job markets, to analyse the causal effect when one of the municipalities change their property tax. For this, I make use of the difference-in-difference method.

Difference-in-Difference regression

Through the difference-in-difference method, I am able to control for unobserved factors, as long as they are common between the two areas. And as mentioned, it also is not vulnerable for uncertainty around the comparability of tax rates between municipalities in the same way as the hedonic time dummy approach, as I only look at one tax change at the time.

A general presentation of the difference-in-difference method with price on log form, $ln(P_{ipt})$, as the dependent variable, can look like this (Angrist and Pischke 2008).

$$ln(P_{ipt}) = a + bD_{pt} + cT_p + dP_t + \mathbf{e}'\mathbf{C}_{ipt} + \epsilon_{ipt} \tag{3.3}$$

Here, T_p is the treatment variable, being 1 for observations in the treated jurisdictions, and 0 for the control jurisdictions. P_t is the treatment period variable, and is 1 for the period during treatment, and 0 for the preceding. The coefficient of interest to me is the coefficient of D_{pt}, which equals $T_p * P_t$, and is an interaction variable that is 1 for observations in the treated jurisdictions in the treatment period, and 0 for the rest of the observations. T_p and P_t controls for the municipality and time fixed effects respectively, which makes the coefficient of D_{pt} show the difference in difference.

$\mathbf{C}_{ipt}$ is a vector of control variables, which control for the remaining confounding factors observed. I use the right hand side of a modified version of the core hedonic model (3.1) as my control variables to correct for the qualities of the different houses sold. Some difference-in-difference papers use the same individuals/houses in different time periods to control for the qualities of houses. I am not able to do this, as there are not enough observations of repeated sales that can be used inside the difference-in-difference framework I have chosen. Thus, the internal validity of my difference-in-difference analysis depends on the precision in which the hedonic core model explains house prices. Because of the substantial heterogeneity of different houses, this is important for the causal interpretation of the results.

The model and set-up

As mentioned in the previous section, I find my full difference-in-difference model by combining the standard difference-in-difference set-up and the core model (3.1). This gives

$$ln(P_{ipt}) = a + bD_{pt} + cT_p + dP_t + e_1 ln(s_i) + e_2(ln(s_i))^2 + \mathbf{f}'\mathbf{H}_i + \mathbf{g}'\mathbf{M}_t + \epsilon_{ipt} \quad (3.4)$$

Here, I have adjusted the core model to fit the difference-in-difference framework. The postcode dummies are excluded, as the assumption of the difference-in-difference method is that it covers homogeneous areas, and the postcode dummies would control for the variation I use for identification. I also replace the monthly dummies that I use in the hedonic time dummy model, that are unique for each year, with seasonality correcting dummies for each month. This gives a different time vector than in the model used for the hedonic time dummy regressions.

I set up my difference-in-difference around the tax change, with the 12 months after[1] as the treatment period, and the 12 months before as the control period. As mentioned in the introduction, the tax is decided in late December, while it is in action from January the next year. I have chosen this time period as a natural time span, as taxes can change yearly. Even shorter treatment and control periods

[1]Six months after for 2014-2015, because the sample is restricted to the first seven months of 2015.

would make the common trend assumption more likely to hold, but that would leave me with too few observations.

Common trend

The key identifying assumption of the difference-in-difference method is the existence of a common trend between the treatment group and the control group. That is, the trend growth of the variable I want to explain have to be the same in the treatment and control group, so that in the absence of treatment, they would develop correspondingly (Angrist and Pischke 2008). A common trend is, together with the validity of the hedonic controls, central for the validity of this analysis.

An illustration of how the common trend assumption inside the difference-in-difference framework makes it possible to correct for different biases is in the case of simultaneity bias. Simultaneity bias arises when the house prices or the expectations of future house prices affects the decisions around the property tax, so the change in property tax is not exogenous. When a common trend is in place, the effect I measure in a difference-in-difference framework will not be affected by this simultaneity bias, as the control group provide the counter factual. Even if the tax change in itself is endogenous, for example if the policymakers have differing views about future house prices, the counter factual will provide control as if the decision was exogenous.

There is no precise way to test the common trend assumption, but the probability of it holding can be examined graphically. For this analysis, the graphical examinations are complicated by the heterogeneity of houses, which makes it hard to graph a precise trend without also creating an index. To get around this, I graph the median price on log form for each quarter, before and after the tax change. These graphs can be seen in appendix B. I have also extracted summary statistics for the prices at the postcodes involved in the year before treatment, to check the homogeneity. These can also be seen in the appendix B. I will discuss these more closely in the result chapter.

Difference-in-difference municipalities

I have structured my difference-in-difference analysis around single tax changes, where I compare the municipality treated with the tax change to neighbouring municipalities, more specific the near border postcodes in the municipality treated to the near border postcodes in one or more control municipalities. To perform this exercise, I need neighbouring municipalities with sizeable postcodes of similar kind close to the border and a distinct change in tax level or a revaluation in my data period, at the same time as the neighbouring municipalities keep their property tax unchanged. Based on the data available, I choose a variety of municipalities to include. In the selection process, I had to look for municipalities that could supply enough observations, in addition to fulfilling the conditions stated above.

To identify bordering municipalities with intertwined neighbourhoods or living areas at the border, I use the web site of Erik Bolstad [2], that supply a geographical pinpointing of the location of Norwegian postcodes. I also choose rural comparable municipalities, so I can compare the effect in these to the effect in the more central municipalities. To do this, I have to deviate from the conditions of comparability on postcode level.

Table 3.1: Overview, Difference-in-difference municipalities

	Treated	Control
Medium towns	Ålesund	Sula
	Skien	Porsgrunn
	Skedsmo	Lørenskog
Larger cities	Bergen	Askøy and Fjell
	Stavanger	Sandnes
	Stavanger	Randaberg
Rural towns and areas	Nes	Eidsvoll, Sørum, Ullensaker and Aurskog-Høland
	Gjesdal	Time and Klepp

Ålesund and Sula are two neighbouring municipalities, where Ålesund is a city with around 45,000 inhabitants, while Sula is a smaller, but relatively densely populated municipality, with a population of 9,000. Sula function as a suburb of Ålesund, and in 2014, 41 percent of the working populations living in Sula worked in Ålesund, as can be seen in table B.16 in the appendix. They are both reckoned as a part of the urban area Ålesund by Statistics Norway[3].

Skien and Porsgrunn is another example of two municipalities that together make an urban area. Contrary to Ålesund and Sula, they are relatively equal in

[2]http://www.erikbolstad.no/geo/noreg/postnummer/

[3]http://www.ssb.no/286024/tettsteder.folkemengde-og-areal-etter-kommune.1.januar-2016

size, and both have town centres. The urban area is thus called Skien/Porsgrunn, which is the centre of the district Grenland. The postcodes I use in this analysis are on the border between them, close to the centre of Porsgrunn.

Skedsmo is one of several large municipalities situated outside Norway's capital, Oslo. The centre of Skedsmo is the city Lillestrøm, but my main focus is on the town Strømmen, that is situated in both Skedsmo and the bordering municipalities Lørenskog and Rælingen. In my analysis, I compare postcodes at the Skedsmo and Lørenskog side.

Bergen is the second largest city in Norway, with a population of 278,556. Just west of Bergen, the two populous island municipalities Fjell and Askøy are situated. Both are connected to Bergen by bridge connections, and both function as suburbs to Bergen. This is underlined by the commuting flows shown in table B.16.

The urban area Stavanger/Sandnes, also known as Nord-Jæren, includes the municipalities Stavanger, Sandnes, Sola and Randaberg, and is the third largest urban area in Norway. I split my analysis of this urban area in two, as I look at postcodes in Randaberg together with those situated in Northern Stavanger, and the houses with postcode in Northern Sandnes together with those in Southern Stavanger.

The rural municipalities, which I only evaluate at the municipality level, have been complicated to find, as I have to strike a balance between comparability and enough observations and rural characteristics. In western Norway, I pick Gjesdal, Time and Klepp, which all are a part of the agricultural area Sør-Jæren in Rogaland. Gjesdal, the treatment municipality, is situated east of Time, while the other control municipality, Klepp, is west of Time. Thus, Klepp and Gjesdal are not de facto bordering municipalities, but still have strong similarities. I also pick Nes and the bordering municipalities Ullensaker, Eidsvoll, Aurskog-Høland and Sørum, in the eastern and more rural part of the district Romerike, north-east of Oslo.

Chapter 4

Results

This chapter presents the results from the empirical investigation. I go through the results from the hedonic time dummy method in section 4.1, and the difference-in-difference results in section 4.2.

4.1 The Hedonic Time Dummy Approach

The hedonic time dummy framework depends on a common tax rate to find a reliable point estimate of the effect. Thus, the choice of tax variables plays an important role. I consider a range of different tax specifications that correct for different sides of the property tax rules. For each tax specification, I run ordinary least squares regressions on the full model, and on supplementing specification of the full model, where I exclude different control variables to check the consistency of the model. A clear pattern emerges from the results: there are no sign of a significant effect from property taxes on house prices. This applies to all specifications. To control for the correlation of standard errors inside municipalities, I run the regressions with robust standard errors clustered on the municipality level (Cameron and Miller 2015).

Baseline tax specification

As my baseline specification, I use a tax variable that corrects the nominal tax rate for the number of years since last valuation[1]. From now on, I call this the baseline tax rate. Revaluations play a significant part in the Norwegian property tax system, and in many municipalities, the tax burden goes up at the same time as the tax rate goes down when there is a revaluation. Table 4.1 shows the difference between the nominal tax rates before and after I adjust it for valuation year.

Table 4.1: Summary statistics, tax rates, 2015

	Obs	Mean	St.dev	Min	Max
Baseline tax rate	428	1.82	1.80	0	6.35
Nominal tax rate	428	2.37	2.41	0	7
Baseline tax rate, if tax	250	3.11	1.23	0.98	6.35
Nominal tax rate, if tax	250	4.05	1.77	2	7

Note: The table summarise the level of the baseline tax measures and the nominal tax rate in 2015.

Table 4.2 provides regression results using the baseline tax rate as the tax variable. None of the specifications return results that support the capitalisation hypothesis. Column (1) reports the estimates from the full model (3.2). The coefficient on the tax variable is 0.0079, meaning that an increase in the tax of a tenth of a percentage point, which is the unit the tax rate is denoted in would increase the house prices with 0.79 per cent. This is the opposite of what one would expect in the case of capitalisation, but with a standard error of 0.0051, this estimate is uncertain, and cannot be read as a reliable point estimate.

A sizeable share of the observations do not state the number of rooms in the unit sold, so to check whether including these makes a difference, I run the full model without the number of rooms variable. This is presented in column (2). This alternative specification returns a marginally smaller coefficient, 0.0058, with a marginally smaller standard error.

[1]Baseline tax rate = nominal tax rate * $\frac{1}{1.05^{\theta}}$, where θ is the number of years since last revaluation. The discount rate of 5 per cent is chosen based on the historic growth in housing prices

Table 4.2: Baseline

	(1)	(2)	(3)	(4)	(5)	(6)
Baseline tax	0.0079	0.0058	0.0003	0.0070	0.0065	0.0039
	(0.0051)	(0.0049)	(0.0079)	(0.0050)	(0.0048)	(0.0041)
Logsize	-0.1294	0.1875	-0.8213***	-0.1376	-0.1382	1.1194***
	(0.1145)	(0.1910)	(0.1540)	(0.1153)	(0.1152)	(0.1350)
Logsize^2	0.1091***	0.0680***	0.1929***	0.1100***	0.1101***	-0.0634***
	(0.0138)	(0.0244)	(0.0176)	(0.0138)	(0.0138)	(0.0144)
Rooms	0.0077***		0.0077***	0.0077***	0.0077***	
	(0.0012)		(0.0016)	(0.0012)	(0.0012)	
Detached	2.6562***	2.2484***	2.7530***	2.6608***	2.6638***	
	(0.1066)	(0.2195)	(0.1116)	(0.1059)	(0.1060)	
Semi-detached	1.9874***	1.9349***	1.7995***	1.9924***	1.9920***	
	(0.1041)	(0.2291)	(0.1166)	(0.1041)	(0.1039)	
Row house	1.1700***	1.0654***	1.0230***	1.1701***	1.1680***	
	(0.0810)	(0.1458)	(0.0789)	(0.0809)	(0.0809)	
Biglot	0.0629***	0.0618***	0.0801***	0.0628***	0.0625***	
	(0.0226)	(0.0231)	(0.0200)	(0.0226)	(0.0225)	
Logsize*Detached	-0.5659***	-0.4729***	-0.6188***	-0.5668***	-0.5676***	
	(0.0239)	(0.0490)	(0.0252)	(0.0238)	(0.0238)	
Logsize*Semi-detached	-0.4509***	-0.4349***	-0.4363***	-0.4519***	-0.4519***	
	(0.0236)	(0.0518)	(0.0262)	(0.0236)	(0.0236)	
Logsize*Row house	-0.2768***	-0.2510***	-0.2617***	-0.2768***	-0.2765***	
	(0.0194)	(0.0346)	(0.0181)	(0.0194)	(0.0194)	
Unemployment	-0.0076	-0.0086*	-0.1125***	-0.0078		
	(0.0050)	(0.0050)	(0.0199)	(0.0050)		
Population	0.0013***	0.0013***	0.0008***	0.0013***		
	(0.0001)	(0.0001)	(0.0001)	(0.0001)		
ROBEK dummy	0.0083	0.0104	-0.0321	0.0063		
	(0.0084)	(0.0087)	(0.0237)	(0.0082)		
Childcare coverage	0.0308	0.0567	1.3302***			
	(0.0770)	(0.0758)	(0.2495)			
Postcode dummies	✓	✓		✓	✓	✓
Monthly dummy	✓	✓	✓	✓	✓	✓
Observations	365058	410118	365058	366193	366928	454181
Adjusted R^2	0.7655	0.7547	0.6556	0.7655	0.7654	0.7247

Note: Columns 1 - 6 presents regressions of the full model (1), the full model excluding the rooms variable (2), the full model excluding the postcode dummies (3), the full model excluding child care coverage (4), the full model excluding all municipality specific variables (5), and a regression of the log of price on the baseline tax rate, controlling for the log of size quadratically, postcode dummies and monthly dummies (6). The tax variable is denoted in thousands, not per cent. Population is denoted in per thousand. Municipality clustered (robust) standard errors in parentheses. */**/*** denote significance at a 10/5/1 per cent confidence level.

When I exclude the postcode fixed effects from the full model instead, in column (3), the estimated effect goes to almost zero, while the standard error increases to 0.0079. I also see both the significance and the magnitude of the effects from the child care coverage rate and unemployment rate to increase significantly, as one would expect.

In column (4) and (5), I exclude first the childcare coverage rate, and then rest of the varying municipality level variables as well. Both of these specifications return a similar coefficient and standard error as the full model, showing that controlling for the variations in municipality specific variables do not change the result much. This may be read as a sign that the omission of unobserved varying municipality specific factors like local services other than child care does not bias the results in a substantial magnitude.

In column (6), I only include the size, the postcode and the monthly dummies as control variables. This is to check whether the hedonic specification affects the results in any way. Also here, the sign of the estimate is positive and the estimate highly uncertain.

Alternative specification and robustness

To check the robustness of my choice of baseline tax specification, I also repeat the exercises with alternative tax variables. In table 4.3, I have reported the results for the full model, corresponding to the specification in column (1) of table 4.2, for the different alternative tax specifications. The full results are reported in appendix B, as well as regression results for the nine different regions.

As can be seen in table 4.3, none of the alternative tax specifications yields a negative sign, which is what capitalisation, in any degree, would imply. [2] If anything, an increase in the tax burden related to owning a house will lead to an increase in house prices, which goes against what theory can explain.

[2] As proved in section 1.3.

Table 4.3: Tax variable robustness

	(1) Baseline	(2) Tax dummy	(3) Nominal	(4) Nominal	(5) Alt. tax 1	(6) Alt. tax 2	(7) 2007-2010	(8) 2011-2015
Tax variable	0.0079	0.0112	0.0024	0.0004	0.0211***	0.0004	0.0176**	0.0157**
	(0.0051)	(0.0080)	(0.0022)	(0.0030)	(0.0070)	(0.0026)	(0.0076)	(0.0075)
Standard deduction and valuation year				✓				
House attributes	✓	✓	✓	✓	✓	✓	✓	✓
Municipality specific	✓	✓	✓	✓	✓	✓	✓	✓
Postcode FE	✓	✓	✓	✓	✓	✓	✓	✓
Monthly dummy	✓	✓	✓	✓	✓	✓	✓	✓
Observations	365964	365964	365964	180743	365964	365964	149088	216876
Adjusted R^2	0.7655	0.7655	0.7655	0.7441	0.7666	0.7655	0.7571	0.7605

Note: Columns 1 - 9 presents regressions of the full model, where the baseline tax variable is the tax variable (1), a dummy for tax introduced is the tax variable (2), the nominal rate is the tax variable (3), the nominal rate, a standard deduction dummy, the size of the standard deduction and the number of years since last revaluation works as the tax vector (4), alternative tax rate 1 is the tax variable (5), alternative tax rate 2 is the tax variable (6), the baseline tax rate is the tax variable, but the sample is restricted to 2007-2010 (7), and where the baseline tax rate is the tax variable, but the sample is restricted to 2011-2015 (8). The tax variable is denoted in per thousand, not per cent. Population is denoted in thousands. Municipality clustered (robust) standard errors in parentheses. */**/*** denote significance at a 10/5/1 per cent confidence level.

For some of these alternative specifications, the coefficient of the tax variable is lower than in the baseline specification, and for some it is close to zero. When I do not adjust the nominal tax rate for the age of valuation, I get the coefficient 0.0024. And when I amend the nominal tax rate specification with control variables for valuation year and the standard deduction size, and a standard deduction dummy, the coefficient falls to 0.0004[3]. I also get 0.0004 as the coefficient when I replace the baseline tax with alternative tax 2[4], which is adjusted for the new building exemption that some buildings get.

When I use the tax dummy or the alternative tax 1[5] as tax rates I get a larger coefficient than in the baseline scenario. Similarly, if I run the baseline tax with a reduced sample size by splitting the time period in two I also get a larger coefficient than in the baseline scenario.

Alternative tax 1 is an attempt to find the effective tax rate, corrected for the standard deduction, and is thus endogenous with the left hand side, the sale price. The result from the part-sample specification and the tax dummy specification,

[3]It should be noted that this specification excludes observations where no tax is in place.

[4]Alternative tax 2 = Nominal tax rate * $\frac{1}{1.05}^{\sigma}$, where σ is the number of years with new building exemption remaining.

[5]Alternative tax 1 = Nominal tax rate * $\frac{\text{price - standard deduction size}}{\text{price}}$

where the variation of the tax rate inside jurisdictions have been reduced because of shorter time horizon and binary nature of the dummy respectively, indicates that there may be negative effects from variations inside jurisdictions, but a larger positive effects associated with variation between jurisdictions, that is not controlled for properly.

Summation

The results from the different specifications of the hedonic time dummy model consistently show a non-negative effect on house prices from increases in property taxes. As evident from the discussion in section 1.4, these results, which show a partial semi-elasticity of house prices to property taxes in the range between and 0.004 and 0.2, are not consistent with the standard theory of capitalisation. These estimates are insignificant at normal confidence levels, which makes it hard to say with confidence that the effect is positive.

4.2 Difference-in-Difference Approach

The aim of this difference-in-difference analysis is not to explore the capitalisation in the Norwegian housing market in general, but to investigate the heterogeneity and nuances, and either validate or contradict the results in the previous section, on the hedonic time dummy model. The estimates should not be seen as precise point estimates of the semi-elasticity, but indications of whether there is a significant effect on house prices from changed property taxes or not.

As stated in the identification chapter, a common trend is crucial for the validity of the difference-in-difference results. To examine the common trend and the homogeneity of the treatment and control municipalities and postcodes, I produce summary statistics for the pre-treatment period and graph the median price on log-form on quarterly basis, before and after the tax change. These are reported in appendix B, together with data on tax changes in the municipalities.

I will go through the results from these examinations of the common trend in this chapter, together with the difference-in-difference estimates. To highlight the different types of municipalities and the nuances between them, I go through the results municipality type by municipality type.

Medium towns

The medium towns are characterised by a relatively dense population compared to non-urban areas, but without covering large areas like the largest cities. Ålesund and Skien/Porsgrunn function as regional centres, while Strømmen is a suburb outside Oslo. The relatively large and dense population lets me work at postcode level, where my main interest is. It is also at the postcode level I primarily look for common trends.

For Ålesund and Sula, I have looked at the relationship back to 2012 when evaluating the common trend, as there was no tax change in either municipality in this period. I find a robust common trend, which is backed up by relatively homogeneous prices in the 2014, indicating that the postcodes along the border are comparable. From 2015, the new valuations became operational in Ålesund, which led to a steep increase in the tax burden, while Sula continued with no tax at all [6]. In the difference-in-difference analysis, I find a negative effect from the introduction of the new valuations, both on the municipality and the postcode level. The coefficient at the postcode level, -0.0813, is larger than the coefficient on the municipality level, and statistically significant at the 5 per cent level.

Table 4.4: Difference-in-difference estimates, medium towns

	Ålesund 2015	Skedsmo 2015	Skien 2009	Skien 2013
Municipality	-0.0348	-0.0533**	-0.0847***	0.0129
	(0.0326)	(0.0230)	(0.0265)	(0.0232)
Observations	1678	2870	1450	2094
Postcode	-0.0813**	-0.0506	-0.1912**	-0.0954
	(0.0401)	(0.0524)	(0.0769)	(0.0656)
Observations	464	541	111	180

Note: Municipality clustered (robust) standard errors in parentheses. */**/*** denote significance at a 10/5/1 per cent confidence level. The left hand side variable is price on log form, and the results displayed are the coefficient b in equation (3.4).

Like in Ålesund, Skedsmo revalued the property values, with the new valuation coming into effect from 2015. As can be seen in Figure B.2, the trend in the year before this is parallel, both for the municipalities and the postcodes. At the postcode level, the coefficient is -0.0506, which compares to an effect of 5 per cent lower prices at the Skedsmo side of the border because of the tax. In contrast to the Ålesund/Sula case, this is not higher than at the municipality level, but similar. The standard error is lower for the municipality level estimation, which result is statistically significant at the 5 per cent level. The postcode level coefficient is on the other hand not significant.

For Skien/Porsgrunn, I find a robust common trend in the year before 2009, but an uncertain one in 2012. In both cases, Skien increased the tax, while Porsgrunn kept theirs steady. Around the first event, where it seems to be a common trend, I find strong effects, both on municipality level and postcode level. The effect is here stronger at the postcode level again, and both estimates are statistically significant at the 1 per cent and 5 per cent level respectively. Around the second case, the effect is evident only at the postcode level, but is not statistically

[6] Information on tax rates, standard deduction, valuation year and tax income is provided in appendix B.

significant. This even though there are more observations available around this event than the first.

Larger cities

The larger cities distinct themselves from the medium towns in that they are even denser populated and stronger centres in their region. This leaves even more observations for the difference-in-difference analysis.

Bergen removed the property tax in 2012, after having reduced it in 2009. This was a central campaign promise by the ruling coalition, which got re-elected in the fall of 2011. In the fall of 2014, the same coalition had to propose a reintroduction of the tax[7], as the municipality had great financial troubles. In Fjell and Askøy on the other hand, the tax has not been introduced in the sample period.

Because of the special budget process in Bergen, where they, as the only municipality in this analysis, have a parliamentary system at the local level, I have modified the set up, so that the event is not the introduction of the tax, but the presentation of the proposed budget in September.

From figure B.4 in the appendix, one can see that the postcode level common trends diverge before both 2011Q4 and 2014Q4, which weakens the validity of these estimates. For the year after 2011Q4, I would expect a positive effect, as the tax was removed. I find a small negative effect of -0.0266, with a standard error of 0.0517, which implies no effect. After the reintroduction in 2014Q4, the estimate shows an effect of -0.1047, statistically significant at the 10 per cent level[8]

[7] http://www.bt.no/nyheter/lokalt/Byradet-gjeninnforer-eiendomsskatt-268749b.html

[8] Interestingly, one can see a common trend at the municipality level in the year before 2011Q4. For this event, the coefficient is 0.0338, in line with theory, and statistically significant at the 5 per cent level.

Table 4.5: Difference-in-difference estimates, larger cities

	Bergen 2012	Bergen 2015	Stavanger S 2015	Stavanger N 2009	Stavanger N 2015
Municipality	0.0338**	-0.0087	-0.0073	-0.0666**	-0.0366
	(0.0133)	(0.0142)	(0.0151)	(0.0294)	(0.0487)
Observations	9315	8177	5571	4261	3763
Postcode	-0.0266	-0.1047*	-0.1533***	0.0025	-0.1747***
	(0.0517)	(0.0604)	(0.0589)	(0.0322)	(0.0525)
Observations	544	497	232	610	679

Note: Municipality clustered (robust) standard errors in parentheses. */**/*** denote significance at a 10/5/1 per cent confidence level. The left hand side variable is price on log form, and the results displayed are the coefficient b in equation (3.4).

Stavanger does not have the parliamentary model, so for this analysis, I go back to using the turn of the year as the event of interest. Among the three municipalities of interest, Sandnes is the only one that did not tax housing in the period 2007-2015. Stavanger increased theirs in 2015, while Randaberg revalued the properties in 2009 and removed the tax in 2015.

The graphs of median prices on log form return a convincing common trend between Southern Stavanger and Sandnes in 2014. The difference-in-difference analysis returns a robust and statistically significant effect, implying an impact of 15.3 per cent lower prices, at the postcode level, but only a small and statistically insignificant effect on the municipality level.

For Northern Stavanger and Randaberg, the postcode level common trends seems okay prior to 2015, but non-existing before 2009. Therefore, I put the most weight on the 2015 estimates. These are in line with both theory and the results from Southern Stavanger and Sandnes at the same time, as I find a small effect at the municipality level and a substantial effect at the postcode level in 2015. The coefficient at the postcode level is -0.1747, which is an even stronger effect than in Southern Stavanger. This is in line with theory, as the tax increase in Stavanger coincided with the removal of the tax in Randaberg, which give larger relative change in tax than further south. The estimate for 2009 shows a small, non-significant effect at the postcode level, which may be because the revaluation did not lead to a very large increase in tax burden, as can be seen in table B.9.

Rural areas

The exception from the postcode focus is the rural area municipalities, where I only look at the municipality level effects and trends. I can do this because the rural municipalities are smaller and more homogeneous. The reason I deviate from the postcode analysis is that I want to compare the results against those from central areas. I look at Nes, which introduced a property tax in 2009, and Gjesdal which did the same in 2011.

Table 4.6: Difference-in-difference estimate, rural towns and areas

	Nes 2009	Gjesdal 2011
Municipality	0.0081	-0.0137
	(0.0229)	(0.0259)
Observations	2894	1406

Note: Municipality clustered (robust) standard errors in parentheses. */**/*** denote significance at a 10/5/1 per cent confidence level. The left hand side variable is price on log form, and the results displayed are the coefficient b in equation (3.4).

For these municipalities, I find credible common trends for both Nes and control municipalities, and for Gjesdal and Time and Klepp. The prices in the pre-treatment do also point to relatively homogenous treatment and control areas, especially for Gjesdal, Time and Klepp. Contrary to what I find in central areas, the difference-in-difference for Gjesdal and Time and Klepp and for Nes and Eidsvoll, Sørum, Ullensaker and Aurskog-Høland show no significant effect. This is even though the number of observations is high, and the standard errors are low. For Gjesdal, the coefficient is -0.0137, with a standard error of 0.0259, and for Nes, the coefficient is 0.0081, and the standard error 0.0229.

Summation

Contrary to what I find in section 4.1, these results show that capitalisation of property taxes should not be ruled out in urban areas. In all the medium towns, I find results that imply capitalisation. These results are backed up by common trends, with one exception, and half are statistically significant. This pattern is also evident in Bergen and Stavanger. Around the events which are preceded by a common trend, the results show statistically significant effects in line with the theory.

Taking these results from the urban areas into account, it is striking that in the two rural events, which are preceded by robust common trends, I do not find any effect, something that is consistent with the findings of the hedonic time dummy regressions. I choose to put more weight on these results than the results for the hedonic time dummy model, as I will discuss further in the next chapter.

Chapter 5

Discussion

The main objective of this thesis is to investigate the capitalisation of property taxes. As discussed in chapter 1, a good estimate of the capitalisation requires data on the net user costs and the partial house price elasticity to property taxes. With the hedonic time dummy model, I estimated the effect of what is a tenth of a percentage point change in property taxes on house prices. This estimate equals a tenth of the partial semi-elasticity of house prices to property taxes. And as presented in section 4.1, this estimate of the partial semi-elasticity of house prices to property taxes is close to zero. This implies that the capitalisation is close to zero as well.

The results discussed in section 4.2 leave doubts about the consistency of this estimate, but without giving a decent alternative. Thus, I will not try to come up with a definitive point estimate of the degree of capitalisation at all. Neither will I calculate estimates of the capitalisation I find with the difference-in-difference method. Even though some of these estimates are statistically significant, the magnitude of tax changes they respond to is hard to measure.

In this chapter, I will instead discuss why I attribute most weight to the difference-in-difference results, possible explanations for why I find differing effects in the difference-in-difference analysis, and the public policy implications of these results.

5.1 Method validity

As discussed above, there is a substantial divergence between the results from the hedonic time dummy model, which do not show any sign of capitalisation, and the difference-in-difference method, which show heterogeneous responses to changes in property taxes, implying capitalisation in urban areas. A possible reason for this, and the reason that I attribute the most weight to the estimates from the difference-in-difference analysis, is that the decision of increasing the property tax may be endogenous to the expected response in the property market.

That is, there exist a significant possibility that municipalities where a change in property taxes does not induce changes in house prices will be more inclined to change, and most likely increase, the tax. If the degree of capitalisation is not homogeneous across municipalities, this may bias the results from the hedonic time dummy model, as a self-selection of tax changes included in the regressions might occur.

The proposition that the ability of local jurisdictions to increase taxes depends on their characteristics is not new. Diamond (2016) does for instance show that in areas with inelastic supply, municipalities have an increased ability to inflate taxes. In this case, it is rural municipalities, characterised by a small population, which is suspected to be able to increase taxes more than the rest. As the difference-in-difference analysis shows, there are in these municipalities I do not find capitalisation.

Table 5.1: Net change in tax rate, 2007-2015

Population	Obs	Tax (Yes=1)	Baseline	Nominal
Less than 3,000	158	0.42	1.51	1.86
Between 3,000 and 9,999	156	0.25	0.44	0.49
Between 10,000 and 50,000	99	0.15	0.02	-0.26
More than 50,000	15	0	0.13	0.09

Note: This table shows the net change in the percentage of municipalities with property taxes on housing, in the baseline tax rate and in the nominal tax rate for four different classes of municipalities, divided by population. The baseline tax and the nominal tax is denoted in per thousand.

To test the proposition that tax changes in rural municipalities are overrepresented in the hedonic time dummy model, I summarise the net changes in property taxes between 2007 and 2015 in table 5.1. As can be seen, a significant larger share of the municipalities with less than 10,000 inhabitants has introduced property taxation since 2007. They have also increased the tax rate more than the larger municipalities. If the proposition that the degree of capitalisation is depending on the size of the municipality holds, this indicates that the variation in tax is disproportionally distributed in the data set, leading to bias towards non-capitalisation.

Another bias that the hedonic time dummy model do not control for is the simultaneity bias. As described in section 3.2, simultaneity bias arises when the decision to change the property tax is affected by the house prices or the expectations of future house prices. Some municipalities may increase the tax as a response to rising house prices, while other may reduce it, because the sum needed to finance public services to not follow the house prices. I cannot test the possible occurrence of this bias in the same, transparent manner as the bias discussed above, but it is an additional reason for why I emphasise the results from the difference-in-difference analysis.

5.2 Explaining the differing effects

The divergence among the municipalities I include in the difference-in-difference analysis is also interesting in its own manner. There are many potential reasons for why these differences exist. In the following section, I discuss some of the possible reasons I find more likely than others. As thoroughly discussed in the previous section, the most striking divergences among the difference-in-difference estimates arise between the larger municipalities like Skien, Bergen and Stavanger, where signs of capitalisation are clear, and municipalities in rural areas, like Nes and Gjesdal, where capitalisation cannot be found.

One explanation of why this divergence arises can be the differences in interconnection between the treatment and control municipalities in densely populated areas and less densely populated areas. As can be seen in table B.16, almost half of the working population in the control municipalities Sula, Randaberg, Fjell and Askøy commute to Ålesund, Stavanger and Bergen every day. This is a strong proof of the interconnection between the treatment and control municipalities in the incidents where capitalisation occurs. This divergence can be explained both with rational and irrational behaviour.

Rational behaviour

A potential reason for this divergence that would be consistent with rational behaviour may be the dispersion of income and local service effects. In rural areas, commuting and transportation flows are weaker, and a larger percentage of the workers also live in the municipality. In this sense, the municipalities are more isolated, and the dispersion of economic activity and benefits from investment and spending on local facilities and services are lower. When the tax is introduced, the revenue may finance spending on just these local facilities and services. My empirical identification only controls for the invariant local facilities and services, and not the strengthening or weakening of most services, other than through the ROBEK dummy[1] and child care coverage rate in the hedonic time dummy model.

Irrational behaviour

Another possible explanation for non-capitalisation in rural areas, but not in urban areas, can be found in the theory of bounded rationality and the salience of taxes. As mentioned in the literature, newer tax literature have empirically shown how the salience of taxes affects how agents respond to them, and discussed how this can be explained by the theory of bounded rationality. This may apply to my findings as well.

In 2015, the expected property tax for a 120 m^2 house was somewhere between 880 and 8,400 NOK a year in Norwegian municipalities, with 3,491 NOK as the average. This is comparable to Elinder and Persson (2014), who also did not find systematic capitalisation. They investigated a reform where the average yearly reduction in tax liabilities amounted to SEK 4,900, as a cap of SEK 6,000 a year was introduced. [2]

Finkelstein (2009) describes a fully salient tax as a tax where individuals are aware of actual taxes as they make economic and political decisions. When the

[1] Signals financial distress or not, not the general condition.

[2] May 5th, 2017, 100 SEK was equivalent of 98 NOK.

tax is less salient, individuals will not be aware of the tax, but have an alternative perception of it. That property taxes should not be salient may sound counterintuitive. The tax is not paid over the paycheck, but through a bill the home owners receive four times a year. This makes for instance Cabral and Hoxby (2012) state that “property taxes are likely the most salient taxes in the U.S.”, and call it "the hated property tax".

But that the property tax is visible when it is paid does not mean that it will be in the mind of home buyers at the time of purchase. The concept of bounded rationality means that consumer may neglect less salient or less important costs and benefits when making a purchasing decision. This may include the local property tax, as it is not paid in connection to the purchase, and is fairly low. [3]

There are several reasons to suspect that if salience and bounded rationality play a role in explaining non-capitalisation of property prices, it will also contribute to explain the divergence between the capitalisation of property taxes in rural areas and urban areas. As discussed in the previous subsection, urban areas are highly connected, and, especially in the postcode areas near the border, home buyers will be more likely to consider houses in several municipalities. This makes the home buyers compare the different municipalities, which again will increase the salience of the property tax.

Another factor, which Elinder and Persson (2014) also discuss, is the average education level of the home buyers. They did not find systematic capitalisation, but in sub-markets with a high share of buyers with a high income and high level of education, they found some. If high education levels lead to less bounded rationality, this can explain why capitalisation is evident in urban areas, where the average income and education levels also are higher. In addition to this, there is also a bigger market for local news, leading to better coverage of local politics and more attention around changes in the property tax in densely populated areas, which may make it more salient.

A potential reason not related to salience, but expectations, may be that Norwegians have relatively strong trust in their politicians[4], and therefore may anchor their expectations of future taxes at the level the politicians promise. If the politi-

[3] A tax that is visible at the time of purchase is the transaction tax (*dokumentavgift*), which Best and Kleven (2016) show affects housing market activity and prices.

[4] http://www.bt.no/nyheter/innenriks/Det-ser-morkt-ut-for-Lysglimt–Co-333133b.html

cians are inclined to promise that the tax is temporary and will be removed soon, this may affect capitalisation negatively. One can also speculate that in smaller, rural municipalities, the inhabitants may trust the politicians even more, which drive the divergence between rural and urban areas. The inhabitants in smaller, rural municipalities may also feel that the money they pay in property taxes goes back to them in a more direct way, which backs up this effect.

5.3 Implications for housing market and policy

As discussed in the above section, the results in this thesis may imply that there is greater irrationality in the Norwegian housing market than previously thought. If it is irrationality that leads to non-capitalisation, and the buyers do not price in the future costs of property taxes, this indicates that there may also be more costs that are not priced in. It is the sum of these costs, and the variability of these, that decides how big a risk this irrationality poses to the Norwegian economy.

Most likely, this irrationality is so insignificant that it should not affect financial stability. But there is anecdotal evidence of extreme cases where sharp increases in property taxes have surprised household and lead to financial stress. Recently, there have been examples of this in Bodø[5] and in Målselv[6]. In Bodø, the revaluation was announced a long time in advance, and was approved by the municipality council in 2015, but still surprised the taxpayers. The Norwegian property tax law include a mechanism to prevent sharp increases like these, which limits increases in the nominal tax rate to 0.2 percentage points a year. These recent examples of the importance of revaluations, and how they lead to disposable income surprises for households, may imply that stricter rules regulating the procedures of revaluing properties may be in place[7].

The non-capitalisation, explained by irrational factors or not, also matters for the incidence of the tax. A high degree of capitalisation leads to a corresponding high degree of incidence for those who own property at the day the property tax change is put in place, as their wealth decreases. And on the contrary, if there is

[5] https://www.nrk.no/nordland/xl/ma-ta-ut-datteren-av-barnehagen-for-a-betale-eiendomsskatt-pa-21.000-1.13417201

[6] https://www.nrk.no/troms/1.13406780

[7] For example by making the valuations provided by Skatteetaten mandatory.

no capitalisation, as in there are in some cases, the incidence will fall on those who pay the tax when it is due. Even though this means that the redistributional abilities of the tax is weaker, it may be more in line with what voters reckon as just, at least if the revenue finance spending in the present, and not investments or paying off old debt. Non-capitalisation does also give municipalities more leeway to introduce or increase the tax, which may lead to a higher equilibrium tax level. As mentioned, Diamond (2016) finds that in areas with inelastic supply, the municipalities have an increased ability to increase taxes. The same is likely to hold for municipalities where the tax is less salient.

In spite of the divergence between the urban and rural areas, the difference-in-difference results are not fully consistent. The effect in urban areas points in the direction of capitalisation, but the degree of capitalisation is still uncertain and to some degree unpredictable. This may indicate that municipalities, at least in urban areas, should be careful when adjusting the property tax if they want to avoid sharp movements.

5.4 Further research

This thesis exposes the heterogeneous nature of the Norwegian housing market, showing how the effects of different policies, in this case the property tax, is affected by local characteristics. This speaks for more investigations into the heterogeneity of the Norwegian housing market, and not only use of large hedonic models. A way of investigating these heterogeneities may be through more complex difference-in-difference frameworks, with better and more precise algorithms for choosing treatment and control municipalities in different areas.

Another aspect of the property tax that is beyond the scope of this thesis is to investigate the non-linearity of the capitalisation effect. As shown in section 1.3, the partial semi-elasticity of house prices to property taxes is non-linear, in the same way as for instance the partial semi-elasticity of house prices to interest rates is. A closer investigation of the non-linearity of the partial semi-elasticity of house prices to property taxes in areas with capitalisation may say something about both semi-elasticity of house prices to interest rates and property taxes.

In addition to this, a large and exciting natural experiment was made available when Oslo introduced the property tax in 2016. The data required to look at this change have not been available for this project, but will allow great insight into the response of house prices from the introduction of a property tax for later research. One can for example investigate the capitalisation through difference-in-difference methods, and see if the effect is stronger in the neighbourhoods closer to the municipality border.

Chapter 6

Conclusion

In this thesis, I have investigated the effects of property taxes on house prices using fixed effect estimation with a hedonic time dummy model and the difference-in-difference approach. The results show a surprising heterogeneity, which may be explained by irrational behaviour by home buyers.

The hedonic time dummy approach consistently returns results indicating non-capitalisation, even though I try a range of specifications. The estimates are even positive, in diametric contrast to what theory predicts, But they are also small, and statistically insignificant at normal confidence levels. I thus conclude that I find no systematic effect from this approach whatsoever.

Contrary to what the hedonic time dummy approach find, the difference-in-difference results indicate that capitalisation of property taxes are present in urban areas. The tax change events, both in the medium towns and the larger cities, which are preceded by a common trend, return statistically significant effects in line with the theory. The findings in the two rural municipalities I include are on the other hand consistent with the finding by the hedonic time dummy regressions, and show no capitalisation.

I chose to attribute most weight to the difference-in-difference results, as there is a possibility that invalidating endogeneity arise in the hedonic time dummy model when there is heterogeneity in the degree of capitalisation among different types of municipalities.

To explain the results from the difference-in-difference analysis, I propose both rational and irrational behaviours that may lead to the divergence in capitalisation between rural and urban areas. There may for instance be that it is the low degree of dispersion of the income and benefits from investment and spending on local facilities and services in rural areas that cause the. Or there may be, as I deem most likely, bounded rationality in the market, especially outside urban areas. In other words, irrationality in the housing market.

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Appendix A

Hedonic time dummy regressions

Table A.1: Tax Dummy

	(1)	(2)	(3)	(4)	(5)	(6)
Tax dummy	0.0112	0.0139*	0.0216	0.0084	0.0034	0.0032
	(0.0080)	(0.0078)	(0.0352)	(0.0080)	(0.0078)	(0.0079)
Logsize	-0.1282	0.1882	-0.8156***	-0.1365	-0.1373	1.1199***
	(0.1148)	(0.1913)	(0.1526)	(0.1155)	(0.1154)	(0.1352)
Logsize^2	0.1090***	0.0679***	0.1922***	0.1099***	0.1100***	-0.0634***
	(0.0138)	(0.0245)	(0.0174)	(0.0139)	(0.0138)	(0.0145)
Rooms	0.0077***		0.0078***	0.0077***	0.0077***	
	(0.0012)		(0.0016)	(0.0012)	(0.0012)	
Detached	2.6560***	2.2487***	2.7504***	2.6606***	2.6636***	
	(0.1067)	(0.2195)	(0.1117)	(0.1059)	(0.1060)	
Semi-detached	1.9879***	1.9354***	1.7947***	1.9928***	1.9924***	
	(0.1044)	(0.2291)	(0.1152)	(0.1043)	(0.1042)	
Row house	1.1705***	1.0659***	1.0234***	1.1705***	1.1683***	
	(0.0811)	(0.1458)	(0.0795)	(0.0810)	(0.0810)	
Biglot	0.0628***	0.0618***	0.0801***	0.0628***	0.0624***	
	(0.0226)	(0.0232)	(0.0200)	(0.0226)	(0.0225)	
Logsize*Detached	-0.5658***	-0.4730***	-0.6181***	-0.5668***	-0.5675***	
	(0.0240)	(0.0490)	(0.0253)	(0.0238)	(0.0238)	
Logsize*Semi-detached	-0.4510***	-0.4350***	-0.4352***	-0.4520***	-0.4520***	
	(0.0237)	(0.0518)	(0.0259)	(0.0237)	(0.0237)	
Logsize*Row house	-0.2769***	-0.2511***	-0.2617***	-0.2769***	-0.2766***	
	(0.0195)	(0.0346)	(0.0183)	(0.0194)	(0.0194)	
Unemployment	-0.0075	-0.0085*	-0.1162***	-0.0076		
	(0.0049)	(0.0049)	(0.0207)	(0.0049)		
Population	0.0013***	0.0013***	0.0008***	0.0013***		
	(0.0001)	(0.0001)	(0.0001)	(0.0001)		
ROBEK dummy	0.0099	0.0111	-0.0345	0.0080		
	(0.0086)	(0.0089)	(0.0245)	(0.0084)		
Childcare coverage	0.0246	0.0531	1.3183***			
	(0.0777)	(0.0766)	(0.2578)			
Postcode FE	✓	✓		✓	✓	✓
Monthly dummies	✓	✓	✓	✓	✓	✓
Observations	365964	411040	365964	367101	367836	455303
Adjusted R^2	0.7655	0.7547	0.6558	0.7654	0.7654	0.7247

Note: Columns 1 - 6 presents regressions of the full model (1), the full model excluding the rooms variable (2), the full model excluding the postcode dummies (3), the full model excluding child care coverage (4), the full model excluding all municipality specific variables (5), and a regression of the log of price on the tax dummy, controlling for the log of size quadratically, postcode dummies and monthly dummies (6). The tax variable is denoted in per thousand, not per cent. Population is denoted in thousands. Municipality clustered (robust) standard errors in parentheses. */**/*** denote significance at a 10/5/1 per cent confidence level.

Table A.2: Nominal tax

	(1)	(2)	(3)	(4)	(5)	(6)
Nominal tax	0.0024	0.0029	0.0009	0.0021	0.0011	0.0008
	(0.0022)	(0.0022)	(0.0055)	(0.0022)	(0.0019)	(0.0019)
Logsize	-0.1286	0.1881	-0.8208***	-0.1368	-0.1374	1.1199***
	(0.1147)	(0.1912)	(0.1546)	(0.1155)	(0.1153)	(0.1352)
Logsize^2	0.1090***	0.0679***	0.1929***	0.1099***	0.1100***	-0.0634***
	(0.0138)	(0.0244)	(0.0177)	(0.0138)	(0.0138)	(0.0145)
Rooms	0.0077***		0.0077***	0.0077***	0.0077***	
	(0.0012)		(0.0016)	(0.0012)	(0.0012)	
Detached	2.6563***	2.2488***	2.7529***	2.6608***	2.6637***	
	(0.1066)	(0.2194)	(0.1117)	(0.1059)	(0.1060)	
Semi-detached	1.9880***	1.9356***	1.7991***	1.9928***	1.9924***	
	(0.1044)	(0.2290)	(0.1170)	(0.1043)	(0.1042)	
Row house	1.1705***	1.0659***	1.0228***	1.1706***	1.1684***	
	(0.0811)	(0.1458)	(0.0790)	(0.0810)	(0.0810)	
Biglot	0.0626***	0.0616***	0.0801***	0.0626***	0.0623***	
	(0.0226)	(0.0232)	(0.0200)	(0.0226)	(0.0225)	
Logsize*Detached	-0.5659***	-0.4730***	-0.6188***	-0.5668***	-0.5676***	
	(0.0239)	(0.0490)	(0.0253)	(0.0238)	(0.0238)	
Logsize*Semi-detached	-0.4510***	-0.4351***	-0.4362***	-0.4520***	-0.4520***	
	(0.0237)	(0.0518)	(0.0263)	(0.0237)	(0.0237)	
Logsize*Row house	-0.2769***	-0.2511***	-0.2616***	-0.2769***	-0.2766***	
	(0.0195)	(0.0346)	(0.0182)	(0.0194)	(0.0194)	
Unemployment	-0.0079	-0.0091*	-0.1133***	-0.0080*		
	(0.0048)	(0.0049)	(0.0189)	(0.0048)		
Population	0.0013***	0.0013***	0.0008***	0.0013***		
	(0.0001)	(0.0001)	(0.0001)	(0.0001)		
ROBEK dummy	0.0098	0.0111	-0.0326	0.0079		
	(0.0082)	(0.0084)	(0.0238)	(0.0081)		
Childcare coverage	0.0265	0.0559	1.3247***			
	(0.0776)	(0.0761)	(0.2511)			
Postcode FE	✓	✓		✓	✓	✓
Monthly dummies	✓	✓	✓	✓	✓	✓
Observations	365964	411040	365964	367101	367836	455303
Adjusted R^2	0.7655	0.7547	0.6556	0.7654	0.7654	0.7247

Note: Columns 1 - 6 presents regressions of the full model (1), the full model excluding the rooms variable (2), the full model excluding the postcode dummies (3), the full model excluding child care coverage (4), the full model excluding all municipality specific variables (5), and a regression of the log of price on the nominal tax rate, controlling for the log of size quadratically, postcode dummies and monthly dummies (6). The tax variable is denoted in per thousand, not per cent. Population is denoted in thousands. Municipality clustered (robust) standard errors in parentheses. */**/*** denote significance at a 10/5/1 per cent confidence level.

Table A.3: Nominal tax, standard dedction and year of valuation

	(1)	(2)	(3)	(4)	(5)	(6)
Nominal tax	0.0004	-0.0001	0.0011	0.0005	0.0009	0.0000
	(0.0030)	(0.0031)	(0.0055)	(0.0030)	(0.0029)	(0.0028)
Deduction	-0.0125	-0.0159	-0.0083	-0.0126	-0.0118	-0.0164**
	(0.0105)	(0.0099)	(0.0378)	(0.0105)	(0.0099)	(0.0077)
Deduction size	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Years since valuation	0.0002	0.0005	-0.0009	0.0002	0.0001	0.0003
	(0.0007)	(0.0006)	(0.0014)	(0.0007)	(0.0006)	(0.0006)
Logsize	-0.3310**	-0.0139	-0.8532***	-0.3309**	-0.3291**	1.0036***
	(0.1430)	(0.1836)	(0.1711)	(0.1430)	(0.1428)	(0.1563)
Logsize^2	0.1324***	0.0919***	0.1928***	0.1324***	0.1321***	-0.0545***
	(0.0162)	(0.0225)	(0.0200)	(0.0163)	(0.0162)	(0.0170)
Rooms	0.0113***		0.0105***	0.0113***	0.0113***	
	(0.0019)		(0.0020)	(0.0019)	(0.0019)	
Detached	2.7747***	2.3580***	2.7468***	2.7747***	2.7743***	
	(0.1086)	(0.2056)	(0.1339)	(0.1086)	(0.1086)	
Semi-detached	2.1330***	2.1831***	1.9817***	2.1330***	2.1323***	
	(0.1275)	(0.2391)	(0.1417)	(0.1274)	(0.1272)	
Row house	1.2380***	1.2138***	1.1741***	1.2380***	1.2381***	
	(0.0924)	(0.1495)	(0.1146)	(0.0924)	(0.0925)	
Biglot	0.0564**	0.0535**	0.0884***	0.0565***	0.0564***	
	(0.0217)	(0.0228)	(0.0249)	(0.0217)	(0.0216)	
Logsize*Detached	-0.6005***	-0.5042***	-0.6177***	-0.6005***	-0.6004***	
	(0.0230)	(0.0455)	(0.0291)	(0.0230)	(0.0231)	
Logsize*Semi-detached	-0.4907***	-0.4962***	-0.4769***	-0.4907***	-0.4905***	
	(0.0269)	(0.0531)	(0.0297)	(0.0269)	(0.0269)	
Logsize*Row house	-0.2979***	-0.2898***	-0.2970***	-0.2979***	-0.2980***	
	(0.0214)	(0.0347)	(0.0265)	(0.0214)	(0.0215)	
Unemployment	-0.0124**	-0.0113*	-0.0653***	-0.0123**		
	(0.0062)	(0.0063)	(0.0128)	(0.0061)		
Population	0.0017*	0.0018*	0.0018***	0.0017*		
	(0.0010)	(0.0009)	(0.0003)	(0.0010)		
ROBEK dummy	0.0049	0.0086	-0.0143	0.0054		
	(0.0089)	(0.0089)	(0.0197)	(0.0093)		
Childcare coverage	-0.0273	0.0069	1.1712***			
	(0.1294)	(0.1213)	(0.2521)			
Postcode FE	✓	✓		✓	✓	✓
Monthly dummies	✓	✓	✓	✓	✓	✓
Observations	180315	216433	180315	180315	180315	245867
Adjusted R^2	0.7441	0.7372	0.6683	0.7441	0.7440	0.6988

Note: Columns 1 - 6 presents regressions of the full model (1), the full model excluding the rooms variable (2), the full model excluding the postcode dummies (3), the full model excluding child care coverage (4), the full model excluding all municipality specific variables (5), and a regression of the log of price on the the nominal rate, the a standard deduction dummy, the size of the standard deduction and the number of years since last revaluation as the tax vector, controlling for the log of size quadratically, postcode dummies and monthly dummies (6). The tax variable is denoted in per thousand, not per cent. Population is denoted in thousands. Municipality clustered (robust) standard errors in parentheses. */**/*** denote significance at a 10/5/1 per cent confidence level.

Table A.4: Alternative tax 1

	(1)	(2)	(3)	(4)	(5)	(6)
Alt. tax 1	0.0211***	0.0214***	0.0032	0.0203***	0.0188***	0.0188***
	(0.0070)	(0.0069)	(0.0061)	(0.0068)	(0.0070)	(0.0069)
Logsize	-0.1411	0.1766	-0.8214***	-0.1490	-0.1481	1.1065***
	(0.1156)	(0.1923)	(0.1545)	(0.1163)	(0.1164)	(0.1348)
Logsize^2	0.1100***	0.0688***	0.1928***	0.1109***	0.1109***	-0.0622***
	(0.0139)	(0.0246)	(0.0176)	(0.0140)	(0.0140)	(0.0144)
Rooms	0.0077***		0.0077***	0.0077***	0.0077***	
	(0.0012)		(0.0016)	(0.0012)	(0.0012)	
Detached	2.6491***	2.2427***	2.7509***	2.6540***	2.6576***	
	(0.1043)	(0.2170)	(0.1120)	(0.1038)	(0.1039)	
Semi-detached	1.9798***	1.9300***	1.7961***	1.9848***	1.9846***	
	(0.1015)	(0.2254)	(0.1166)	(0.1017)	(0.1016)	
Row house	1.1654***	1.0608***	1.0207***	1.1657***	1.1642***	
	(0.0782)	(0.1424)	(0.0784)	(0.0782)	(0.0783)	
Biglot	0.0602***	0.0592**	0.0797***	0.0602***	0.0600***	
	(0.0226)	(0.0232)	(0.0200)	(0.0227)	(0.0226)	
Logsize*Detached	-0.5643***	-0.4717***	-0.6182***	-0.5654***	-0.5662***	
	(0.0234)	(0.0484)	(0.0254)	(0.0233)	(0.0233)	
Logsize*Semi-detached	-0.4492***	-0.4338***	-0.4354***	-0.4502***	-0.4503***	
	(0.0230)	(0.0510)	(0.0262)	(0.0230)	(0.0230)	
Logsize*Row house	-0.2759***	-0.2500***	-0.2611***	-0.2759***	-0.2758***	
	(0.0188)	(0.0339)	(0.0180)	(0.0188)	(0.0188)	
Unemployment	-0.0121**	-0.0139**	-0.1160***	-0.0121**		
	(0.0059)	(0.0060)	(0.0193)	(0.0058)		
Population	0.0016***	0.0017***	0.0008***	0.0016***		
	(0.0003)	(0.0004)	(0.0001)	(0.0003)		
ROBEK dummy	0.0022	0.0025	-0.0348	-0.0013		
	(0.0075)	(0.0075)	(0.0242)	(0.0074)		
Childcare coverage	0.0915	0.1367	1.3073***			
	(0.0830)	(0.0833)	(0.2518)			
Postcode dummies	✓	✓		✓	✓	✓
Monthly dummy	✓	✓	✓	✓	✓	✓
Observations	365058	410118	365058	366193	366928	454181
Adjusted R^2	0.7666	0.7559	0.6557	0.7664	0.7663	0.7257

Note: Columns 1 - 6 presents regressions of the full model (1), the full model excluding the rooms variable (2), the full model excluding the postcode dummies (3), the full model excluding child care coverage (4), the full model excluding all municipality specific variables (5), and a regression of the log of price on the Alternative tax 1, controlling for the log of size quadratically, postcode dummies and monthly dummies (6). The tax variable is denoted in per thousand, not per cent. Population is denoted in thousands. Municipality clustered (robust) standard errors in parentheses. */**/*** denote significance at a 10/5/1 per cent confidence level.

Table A.5: Alternative tax 2

	(1)	(2)	(3)	(4)	(5)	(6)
Alt. tax 2	0.0004	0.0011	0.0014	0.0000	-0.0008	-0.0022
	(0.0026)	(0.0025)	(0.0056)	(0.0026)	(0.0023)	(0.0025)
Logsize	-0.1283	0.1882	-0.8204***	-0.1365	-0.1372	1.1197***
	(0.1147)	(0.1911)	(0.1546)	(0.1154)	(0.1153)	(0.1352)
Logsize^2	0.1090***	0.0679***	0.1928***	0.1099***	0.1100***	-0.0634***
	(0.0138)	(0.0244)	(0.0177)	(0.0138)	(0.0138)	(0.0145)
Rooms	0.0077***		0.0077***	0.0077***	0.0077***	
	(0.0012)		(0.0016)	(0.0012)	(0.0012)	
Detached	2.6560***	2.2487***	2.7528***	2.6606***	2.6635***	
	(0.1065)	(0.2194)	(0.1117)	(0.1058)	(0.1059)	
Semi-detached	1.9880***	1.9354***	1.7990***	1.9928***	1.9924***	
	(0.1043)	(0.2290)	(0.1171)	(0.1042)	(0.1041)	
Row house	1.1705***	1.0659***	1.0228***	1.1705***	1.1682***	
	(0.0811)	(0.1458)	(0.0790)	(0.0810)	(0.0810)	
Biglot	0.0628***	0.0617***	0.0800***	0.0628***	0.0625***	
	(0.0226)	(0.0232)	(0.0200)	(0.0226)	(0.0225)	
Logsize*Detached	-0.5659***	-0.4730***	-0.6187***	-0.5668***	-0.5675***	
	(0.0239)	(0.0490)	(0.0253)	(0.0238)	(0.0238)	
Logsize*Semi-detached	-0.4510***	-0.4350***	-0.4361***	-0.4520***	-0.4520***	
	(0.0237)	(0.0518)	(0.0263)	(0.0237)	(0.0237)	
Logsize*Row house	-0.2769***	-0.2511***	-0.2616***	-0.2769***	-0.2766***	
	(0.0195)	(0.0346)	(0.0182)	(0.0194)	(0.0194)	
Unemployment	-0.0075	-0.0086*	-0.1138***	-0.0076		
	(0.0049)	(0.0049)	(0.0190)	(0.0048)		
Population	0.0013***	0.0013***	0.0008***	0.0013***		
	(0.0001)	(0.0001)	(0.0001)	(0.0001)		
ROBEK dummy	0.0107	0.0119	-0.0330	0.0089		
	(0.0084)	(0.0085)	(0.0238)	(0.0083)		
Childcare coverage	0.0199	0.0490	1.3209***			
	(0.0789)	(0.0777)	(0.2518)			
Postcode dummies	✓	✓		✓	✓	✓
Monthly dummy	✓	✓	✓	✓	✓	✓
Observations	365058	410118	365058	366193	366928	454181
Adjusted R^2	0.7655	0.7547	0.6556	0.7654	0.7654	0.7247

Note: Columns 1 - 6 presents regressions of the full model (1), the full model excluding the rooms variable (2), the full model excluding the postcode dummies (3), the full model excluding child care coverage (4), the full model excluding all municipality specific variables (5), and a regression of the log of price on the Alternative tax 2, controlling for the log of size quadratically, postcode dummies and monthly dummies (6). The tax variable is denoted in thousands, not per cent. Population is denoted in per thousand. Municipality clustered (robust) standard errors in parentheses. */**/*** denote significance at a 10/5/1 per cent confidence level.

Table A.6: Baseline for the different regions

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Baseline	0.0079	0.0249	-0.0097	0.0119	-0.0042	0.0161**	0.0031	0.0321	-0.0032
	(0.0051)	(0.0267)	(0.0063)	(0.0074)	(0.0030)	(0.0061)	(0.0052)	(0.0246)	(0.0090)
Logsize	-0.1294	0.0756	-0.8706***	-0.4341**	-0.6457***	0.0895	-0.7884*	0.1292	-0.1239
	(0.1145)	(0.1946)	(0.2194)	(0.1884)	(0.1210)	(0.2351)	(0.4146)	(0.1427)	(0.1411)
Logsize^2	0.1091***	0.0917***	0.1839***	0.1489***	0.1740***	0.0796***	0.1785***	0.0827***	0.1046***
	(0.0138)	(0.0220)	(0.0303)	(0.0218)	(0.0138)	(0.0277)	(0.0455)	(0.0188)	(0.0135)
Rooms	0.0077***	0.0083***	0.0098**	0.0098***	0.0035***	0.0058***	0.0097**	0.0082	0.0266***
	(0.0012)	(0.0022)	(0.0039)	(0.0034)	(0.0011)	(0.0015)	(0.0041)	(0.0050)	(0.0074)
Detached	2.6562***	2.8419***	2.0797***	2.9619***	2.8107***	2.2761***	2.7577***	3.0015***	2.8997***
	(0.1066)	(0.2625)	(0.3315)	(0.1879)	(0.2316)	(0.2094)	(0.1931)	(0.1318)	(0.2209)
Semi-detached	1.9874***	2.5014***	1.4874***	2.1879***	2.1064***	1.6181***	1.9700***	2.3245***	2.0123***
	(0.1041)	(0.2821)	(0.2888)	(0.1455)	(0.1307)	(0.1577)	(0.2583)	(0.0966)	(0.2827)
Row house	1.1700***	1.1781***	0.7948***	1.2383***	1.5391***	1.0342***	1.0471***	1.5550***	1.1598***
	(0.0810)	(0.1749)	(0.2937)	(0.1428)	(0.1457)	(0.1083)	(0.2116)	(0.0932)	(0.3016)
Biglot	0.0629***	0.0804	0.1877***	0.0154	0.1042***	0.0292	0.0365	0.0697*	0.0095
	(0.0226)	(0.0599)	(0.0614)	(0.0839)	(0.0226)	(0.0207)	(0.0639)	(0.0343)	(0.0515)
Logsize*Detached	-0.5659***	-0.6023***	-0.4530***	-0.6441***	-0.6189***	-0.4859***	-0.5889***	-0.6453***	-0.6183***
	(0.0239)	(0.0571)	(0.0790)	(0.0420)	(0.0447)	(0.0478)	(0.0419)	(0.0303)	(0.0475)
Logsize*Semi-detached	-0.4509***	-0.5544***	-0.3456***	-0.5146***	-0.5058***	-0.3763***	-0.4530***	-0.5364***	-0.4587***
	(0.0236)	(0.0608)	(0.0661)	(0.0328)	(0.0301)	(0.0366)	(0.0553)	(0.0211)	(0.0635)
Logsize*Row house	-0.2768***	-0.2714***	-0.1981***	-0.3050***	-0.3862***	-0.2521***	-0.2595***	-0.3744***	-0.2665***
	(0.0194)	(0.0386)	(0.0683)	(0.0336)	(0.0357)	(0.0271)	(0.0470)	(0.0228)	(0.0695)
Unemployment	-0.0076	-0.0214***	-0.0016	0.0174	-0.0036	0.0070	-0.0191**	-0.0165	-0.0111
	(0.0050)	(0.0074)	(0.0166)	(0.0111)	(0.0120)	(0.0118)	(0.0088)	(0.0178)	(0.0170)
Population	0.0013***	0.0069**	0.0082	0.0115***	-0.0036	0.0012**	-0.0041	0.0022	0.0072*
	(0.0001)	(0.0026)	(0.0153)	(0.0022)	(0.0027)	(0.0006)	(0.0049)	(0.0016)	(0.0041)
ROBEK dummy	0.0083	0.0015	0.0545***	0.0039	0.0263**	0.0036	0.0019	0.0346	-0.0174
	(0.0084)	(0.0122)	(0.0200)	(0.0056)	(0.0121)	(0.0337)	(0.0130)	(0.0289)	(0.0275)
Childcare coverage	0.0308	-0.3418**	0.2709	0.0831	0.1728	-0.0177	0.3753***	-0.1395	0.4735
	(0.0770)	(0.1511)	(0.2241)	(0.1279)	(0.1512)	(0.1975)	(0.1326)	(0.2807)	(0.2935)
Postcode FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
Monthly dummies	✓	✓	✓	✓	✓	✓	✓	✓	✓
Observations	365964	71827	18107	41628	18814	82244	23015	26261	27149
Adjusted R^2	0.7655	0.7800	0.7042	0.7044	0.6942	0.7271	0.7239	0.7844	0.7252

Note: Column (1) presents the regression of the full model when the sample is unrestricted. Column 2 -9 presents the regression of the full model when the sample is restricted to Østfold and Akershus (ex. Bærum) (2), Oppland and Hedmark (3), Buskerud, Vestfold and Telemark (4), Vest-Agder and Aust-Agder (5), Rogaland and Hordaland (6), Sogn og Fjordane and Møre og Romsdal (7), Nord-Trøndelag og Sør-Trøndelag (8), and Nordland, Troms and Finnmark (9). Population is denoted in thousands. The tax variable is denoted in thousands, not per cent. Municipality clustered (robust) standard errors in parentheses. */**/*** denote significance at a 10/5/1 per cent confidence level.

Table A.7: Baseline for 2007-2010

	(1)	(2)	(3)	(4)	(5)	(6)
Baseline	0.0176**	0.0168**	-0.0017	0.0155**	0.0163**	0.0143**
	(0.0076)	(0.0069)	(0.0071)	(0.0074)	(0.0073)	(0.0064)
Logsize	-0.3315**	-0.0745	-1.0612***	-0.3430**	-0.3458**	0.7680***
	(0.1514)	(0.1937)	(0.1755)	(0.1518)	(0.1516)	(0.1666)
Logsize^2	0.1329***	0.0989***	0.2233***	0.1342***	0.1346***	-0.0235
	(0.0179)	(0.0242)	(0.0200)	(0.0180)	(0.0179)	(0.0178)
Rooms	0.0061***		0.0044**	0.0062***	0.0062***	
	(0.0014)		(0.0019)	(0.0014)	(0.0014)	
Detached	2.7024***	2.3392***	2.8631***	2.7086***	2.7120***	
	(0.1163)	(0.1970)	(0.1254)	(0.1151)	(0.1151)	
Semi-detached	2.0645***	1.9861***	1.9519***	2.0780***	2.0790***	
	(0.1009)	(0.2041)	(0.1175)	(0.1016)	(0.1011)	
Row house	1.2159***	1.1321***	1.1461***	1.2180***	1.2149***	
	(0.0787)	(0.1274)	(0.0847)	(0.0792)	(0.0791)	
Biglot	0.0842	0.0771	0.0805	0.0845	0.0837	
	(0.0876)	(0.0870)	(0.0571)	(0.0877)	(0.0879)	
Logsize*Detached	-0.5734***	-0.4911***	-0.6395***	-0.5747***	-0.5756***	
	(0.0262)	(0.0437)	(0.0278)	(0.0260)	(0.0260)	
Logsize*Semi-detached	-0.4662***	-0.4458***	-0.4680***	-0.4690***	-0.4694***	
	(0.0230)	(0.0464)	(0.0264)	(0.0232)	(0.0231)	
Logsize*Row house	-0.2857***	-0.2653***	-0.2882***	-0.2862***	-0.2857***	
	(0.0191)	(0.0305)	(0.0186)	(0.0192)	(0.0192)	
Unemployment	0.0083	0.0091	-0.0870***	0.0090		
	(0.0072)	(0.0067)	(0.0205)	(0.0074)		
Population	-0.0004	-0.0004	0.0008***	-0.0005		
	(0.0004)	(0.0004)	(0.0002)	(0.0004)		
ROBEK dummy	0.0089	0.0114	-0.0057	0.0045		
	(0.0079)	(0.0088)	(0.0253)	(0.0087)		
Childcare coverage	0.0542	0.0450	1.5468***			
	(0.0786)	(0.0795)	(0.2304)			
Postcode FE	✓	✓		✓	✓	✓
Monthly dummies	✓	✓	✓	✓	✓	✓
Observations	149088	167857	149088	149955	150285	186339
Adjusted R^2	0.7571	0.7479	0.6427	0.7568	0.7568	0.7172

Note: Here, the sample is restricted to the years 2007-2010.
Columns 1 - 6 presents regressions of the full model (1), the full model excluding the rooms variable (2), the full model excluding the postcode dummies (3), the full model excluding child care coverage (4), the full model excluding all municipality specific variables (5), and a regression of the log of price on the baseline tax rate, controlling for the log of size quadratically, postcode dummies and monthly dummies (6). The tax variable is denoted in per thousand, not per cent. Population is denoted in thousands. Municipality clustered (robust) standard errors in parentheses. */**/*** denote significance at a 10/5/1 per cent confidence level.

Table A.8: Baseline for 2011-2015

	(1)	(2)	(3)	(4)	(5)	(6)
Baseline	0.0157**	0.0148**	0.0013	0.0141*	0.0152**	0.0121**
	(0.0075)	(0.0071)	(0.0097)	(0.0072)	(0.0071)	(0.0059)
Logsize	-0.0052	0.3589*	-0.6709***	-0.0089	-0.0103	1.3372***
	(0.1071)	(0.2039)	(0.1540)	(0.1073)	(0.1076)	(0.1171)
Logsize^2	0.0941***	0.0474*	0.1736***	0.0944***	0.0946***	-0.0878***
	(0.0130)	(0.0263)	(0.0177)	(0.0130)	(0.0130)	(0.0125)
Rooms	0.0087***		0.0095***	0.0087***	0.0087***	
	(0.0013)		(0.0017)	(0.0013)	(0.0013)	
Detached	2.6263***	2.1862***	2.6675***	2.6279***	2.6300***	
	(0.1115)	(0.2443)	(0.1147)	(0.1109)	(0.1110)	
Semi-detached	1.9388***	1.8949***	1.6949***	1.9357***	1.9343***	
	(0.1171)	(0.2520)	(0.1250)	(0.1166)	(0.1167)	
Row house	1.1491***	1.0282***	0.9395***	1.1468***	1.1434***	
	(0.0877)	(0.1606)	(0.0917)	(0.0872)	(0.0871)	
Biglot	0.0494**	0.0490**	0.0715***	0.0493**	0.0493**	
	(0.0194)	(0.0202)	(0.0180)	(0.0194)	(0.0194)	
Logsize*Detached	-0.5593***	-0.4588***	-0.6022***	-0.5596***	-0.5602***	
	(0.0251)	(0.0548)	(0.0262)	(0.0249)	(0.0250)	
Logsize*Semi-detached	-0.4399***	-0.4250***	-0.4143***	-0.4392***	-0.4390***	
	(0.0266)	(0.0570)	(0.0284)	(0.0265)	(0.0265)	
Logsize*Row house	-0.2721***	-0.2422***	-0.2437***	-0.2716***	-0.2710***	
	(0.0209)	(0.0381)	(0.0218)	(0.0208)	(0.0208)	
Unemployment	-0.0024	-0.0047	-0.1225***	-0.0037		
	(0.0067)	(0.0068)	(0.0217)	(0.0068)		
Population	0.0029***	0.0027***	0.0007***	0.0029***		
	(0.0004)	(0.0003)	(0.0001)	(0.0004)		
ROBEK dummy	0.0017	0.0011	-0.0559**	0.0024		
	(0.0063)	(0.0064)	(0.0272)	(0.0060)		
Childcare coverage	-0.0026	0.0289	1.1237***			
	(0.0989)	(0.1013)	(0.3342)			
Postcode FE	✓	✓		✓	✓	✓
Monthly dummies	✓	✓	✓	✓	✓	✓
Observations	216876	243183	216876	217146	217551	268964
Adjusted R^2	0.7605	0.7480	0.6363	0.7604	0.7605	0.7161

Note: Here, the sample is restricted to the years 2011-2015.
Columns 1 - 6 presents regressions of the full model (1), the full model excluding the rooms variable (2), the full model excluding the postcode dummies (3), the full model excluding child care coverage (4), the full model excluding all municipality specific variables (5), and a regression of the log of price on the baseline tax rate, controlling for the log of size quadratically, postcode dummies and monthly dummies (6). The tax variable is denoted in per thousand, not per cent. Population is denoted in thousands. Municipality clustered (robust) standard errors in parentheses. */**/*** denote significance at a 10/5/1 per cent confidence level.

Appendix B

Difference-in-difference identification

Table B.1: Property taxes, Ålesund and Sula

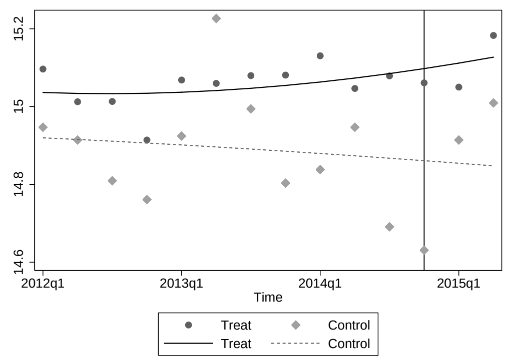
	Ålesund				Sula			
	Tax rate	Valuation	Deduction	Income	Tax rate	Valuation	Deduction	Income
2007	7	1968	No	14,750	No tax			
2015	2	2015	No	81,877	No tax			

Note: The table shows the nominal tax rates, valuation year, the size of the standard deduction and the total income from property taxes on housing (denoted in 1000s of NOK) for 2007 and the following years where one or more of the variables (excluding income) changes.

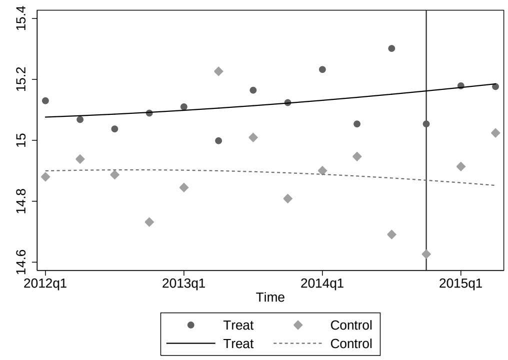
Table B.2: Transactions, Ålesund and Sula, 2014

Postcode	Obs	Mean	St. Dev.	Min	Max	Detached (%)	Semi-detached (%)	Row house (%)	Apartment (%)
Ålesund									
6010	93	2,722,505	845,719.0	1,400,000	5,350,000	15	16	33	36
6012	60	2,820,052	813,395.4	1,650,000	5,100,000	25	18	28	29
6013	42	3,031,307	938,866.7	1,300,000	5,490,000	48	21	29	2
6020	45	2,941,744	1,098,388.0	800,000	5,325,000	31	16	42	11
Sula									
6030	106	2,629,956	851,988.2	1,450,000	5,310,000	33	18	26	23
6035	20	2,793,750	635,466.8	1,910,000	4,250,000	40	35	25	0
6037	29	2,786,552	729,008.7	1,840,000	4,545,000	28	48	24	0
Total	395	2,778,607	871,804.3	800,000	5,490,000	29	21	30	20

Note: The table presents summary statistics of the transactions in the different postcodes included in the treatment and control groups in the year preceding the treatment. The left side shows price statistics, while the right side shows the percentage of each house type.



(a) Municipality level, 2014-2015



(b) Postcode level, 2014-2015

Figure B.1: Ålesund and Sula

Median log prices of detached houses, Ålesund and Sula.

The lines are fractional-polynomial prediction plots.

Table B.3: Property taxes, Skedsmo and Lørenskog

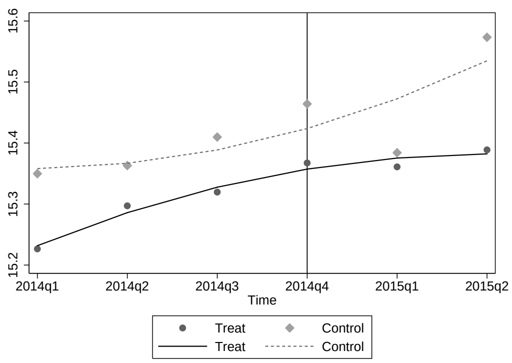
	Skedsmo				Lørenskog			
	Tax rate	Valuation	Deduction	Income	Tax rate	Valuation	Deduction	Income
2007	6	2005	100,000	26,278	No tax			
2015	2	2014	180,000	75,387	No tax			

Note: The table shows the nominal tax rates, valuation year, the size of the standard deduction and the total income from property taxes on housing (denoted in 1000s of NOK) for 2007 and the following years where one or more of the variables (excluding income) changes.

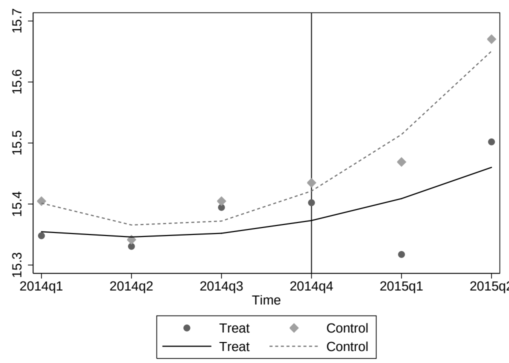
Table B.4: Transactions, Skedsmo and Lørenskog, 2014

Postcode	Obs	Mean	St. Dev.	Min	Max	Detached (%)	Semi-detached (%)	Row house (%)	Apartment (%)
Skedsmo									
2010	230	3,431,449	1,513,270	800,000	8,000,000	28	13	12	47
Lørenskog									
1472	129	3,667,597	1,555,956	1,700,000	9,020,000	33	16	27	24
1479	17	3,774,118	961,535.6	1,800,000	5,850,000	35	18	41	6
Total	376	3,527,961	1,509,768	800,000	9,020,000	30	15	19	36

Note: The table presents summary statistics of the transactions in the different postcodes included in the treatment and control groups in the year preceding the treatment. The left side shows price statistics, while the right side shows the percentage of each house type.



(a) Municipality level, 2014-2015



(b) Postcode level, 2014-2015

Figure B.2: Skedsmo and Lørenskog

Median log prices of detached houses, Skedsmo and Lørenskog.

The lines are fractional-polynomial prediction plots.

Table B.5: Property taxes, Skien and Porsgrunn

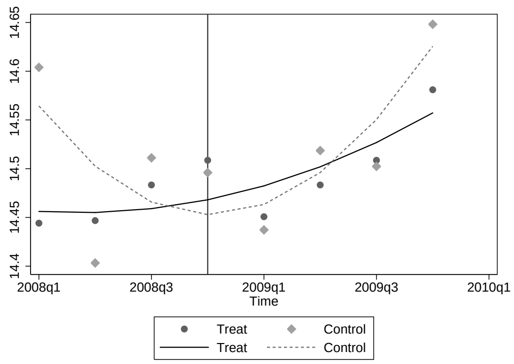
	Skien				Porsgrunn			
	Tax rate	Valuation	Deduction	Income	Tax rate	Valuation	Deduction	Income
2008	4.4	2006	No	57,807	3.6	2006	No	40,961
2009	5.7	2006	No	70,337	3.6	2006	No	41,309
2011	5.85	2006	No	93,631	3.6	2006	No	45,504
2013	6.5	2014	No	111,143	3.6	2006	No	47,071

Note: The table shows the nominal tax rates, valuation year, the size of the standard deduction and the total income from property taxes on housing (denoted in 1000s of NOK) for 2007 and the following years where one or more of the variables (excluding income) changes.

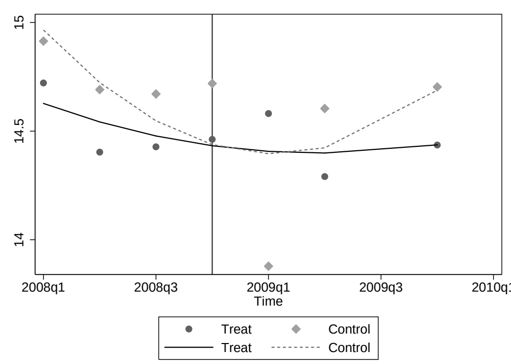
Table B.6: Transactions, Skien and Porsgrunn, 2012

Postcode	Obs	Mean	St. Dev.	Min	Max	Detached (%)	Semi-detached (%)	Row house (%)	Apartment (%)
Skien									
3737	40	1,286,250	674,817.9	800,000	3,600,000	18	0	8	74
3740	32	1,870,938	648,639.3	780,000	3,250,000	56	19	25	0
Porsgrunn									
3919	40	1,658,400	636,679	830,000	3,300,000	38	8	10	44
Total	112	1,586,214	691,084	780,000	3,600,000	36	8	13	43

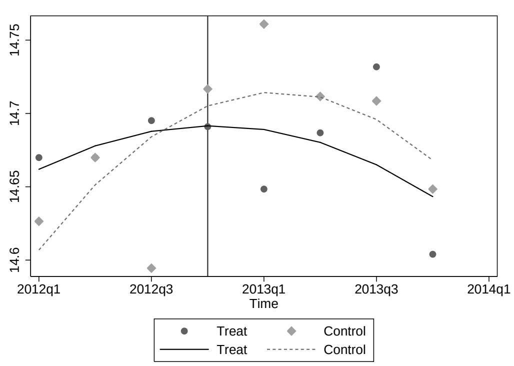
Note: The table presents summary statistics of the transactions in the different postcodes included in the treatment and control groups in the year preceding the treatment. The left side shows price statistics, while the right side shows the percentage of each house type.



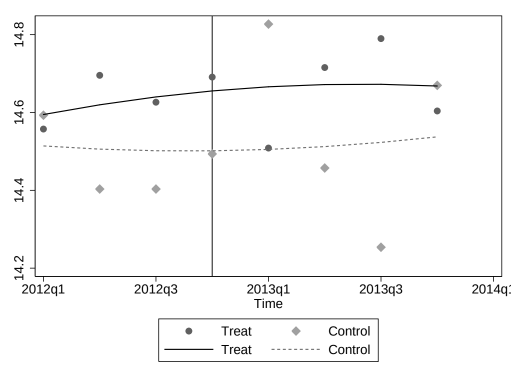
(a) Municipality level, 2008-2009



(b) Postcode level, 2008-2009



(c) Municipality level, 2012-2013



(d) Postcode level, 2012-2013

Figure B.3: Skien and Porsgrunn

Median log prices of detached houses, Skien and Porsgrunn.

The lines are fractional-polynomial prediction plots.

Table B.7: Property taxes, Bergen and Fjell and Askøy

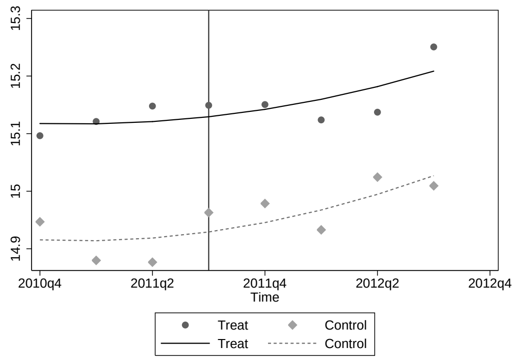
	Bergen				Fjell and Askøy			
	Tax rate	Valuation	Deduction	Income	Tax rate	Valuation	Deduction	Income
2007	6	1984	No	229,846	No tax			
2009	3	1984	No	160,516	No tax			
2012	No tax				No tax			
2015	2.6	2014	No	515,101	No tax			

Note: The table shows the nominal tax rates, valuation year, the size of the standard deduction and the total income from property taxes on housing (denoted in 1000s of NOK) for 2007 and the following years where one or more of the variables (excluding income) changes.

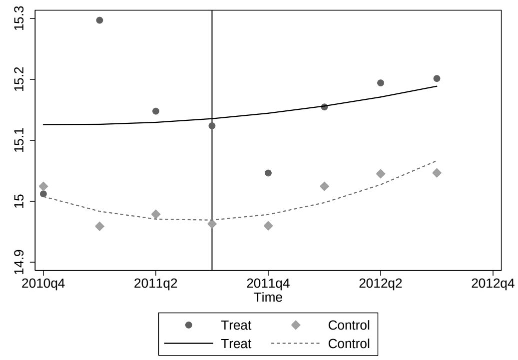
Table B.8: Transactions, Bergen and Fjell and Askøy, 2014

Postcode	Obs	Mean	St. Dev.	Min	Max	Detached (%)	Semi-detached (%)	Row house (%)	Apartment (%)
Bergen									
5179	63	3,442,905	1,185,228	1,700,000	6,700,000	40	16	40	4
Askøy									
5300	43	3,398,597	1,301,662	1,430,000	7,200,000	51	16	28	5
5301	57	3,303,211	946,289.3	575,000	4,440,000	18	26	47	9
5302	35	3,416,143	1,074,986	2,050,000	6,700,000	26	31	23	20
Fjell									
5354	30	3,258,833	945,983.1	1,760,000	5,700,000	40	30	23	7
5355	30	3,867,333	950,498.7	2,390,000	5,850,000	40	13	3	44
5360	35	3,288,571	895,656.7	1,650,000	5,100,000	49	17	17	17
Total	293	3,412,204	1,071,613	575,000	7,200,000	37	21	29	13

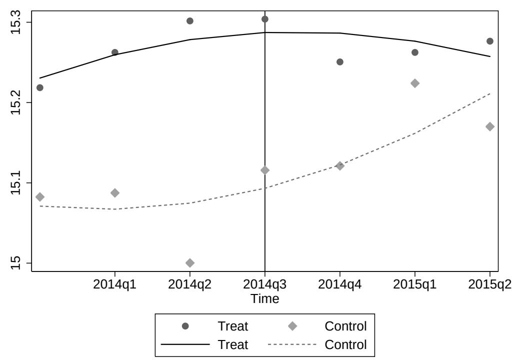
Note: The table presents summary statistics of the transactions in the different postcodes included in the treatment and control groups in the year preceding the treatment. The left side shows price statistics, while the right side shows the percentage of each house type.



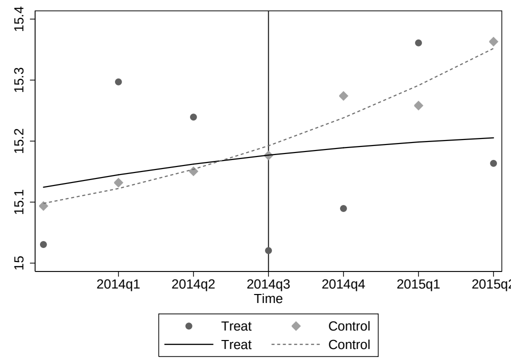
(a) Municipality level, 2011Q4-2013Q3



(b) Postcode level, 2011Q4-2013Q3



(c) Municipality level, 2013Q4-2015Q2



(d) Postcode level, 2013Q4-2015Q2

Figure B.4: Bergen and Fjell and Askøy

Median log prices of detached houses, Bergen and Fjell and Askøy.

The lines are fractional-polynomial prediction plots.

Table B.9: Property taxes, Stavanger, Randaberg and Sandnes

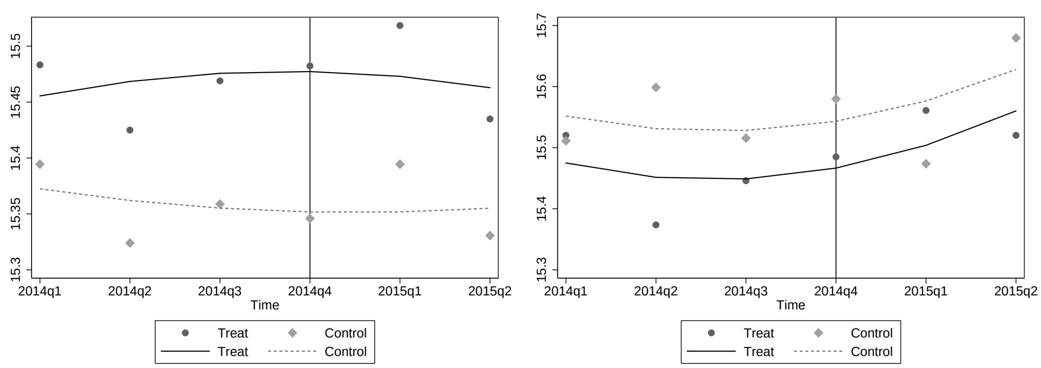
	Stavanger				Sandnes				Randaberg			
	Tax rate	Valuation	Deduction	Income	Tax rate	Valuation	Deduction	Income	Tax rate	Valuation	Deduction	Income
2007	2	2006	360,000	85,437	No tax				7	1989	No	6,700
2009	2	2006	360,000	86,412	No tax				2	2009	400,000	8,480
2015	3	2006	360,000	138,356	No tax				No tax			

Note: The table shows the nominal tax rates, valuation year, the size of the standard deduction and the total income from property taxes on housing (denoted in 1000s of NOK) for 2007 and the following years where one or more of the variable (excluding income) changes.

Table B.10: Transactions, Stavanger and Sandnes

Postcode	Obs	Mean	St. Dev.	Min	Max	Detached (%)	Semi-detached (%)	Row house (%)	Apartment (%)
Stavanger									
4034	56	356,1071	1,315,823	1,900,000	9,000,000	18	20	34	28
Sandnes									
4313	59	3,461,102	1,311,112	1,500,000	7,800,000	14	8	19	59
4314	23	4,286,887	1,645,113	1,790,000	8,423,408	43	17	40	0
4315	18	3,862,369	1,200,457	2,300,000	6,899,000	17	11	0	72
Total	156	3,665,039	1,371,655	1,500,000	9,000,000	20	14	25	41

Note: The table presents summary statistics of the transactions in the different postcodes included in the treatment and control groups in the year preceding the treatment. The left side shows price statistics, while the right side shows the percentage of each house type.



(a) Municipality level

(b) Postcode level

Figure B.5: Stavanger and Sandnes

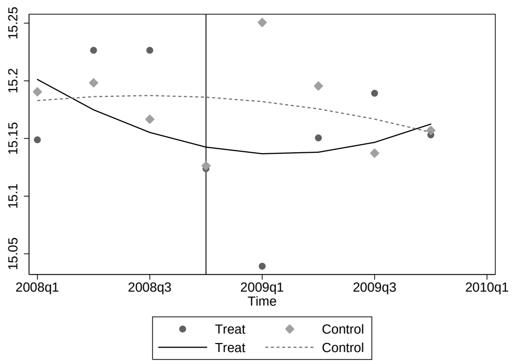
Median log prices of detached houses, Stavanger and Sandnes.

The lines are fractional-polynomial prediction plots.

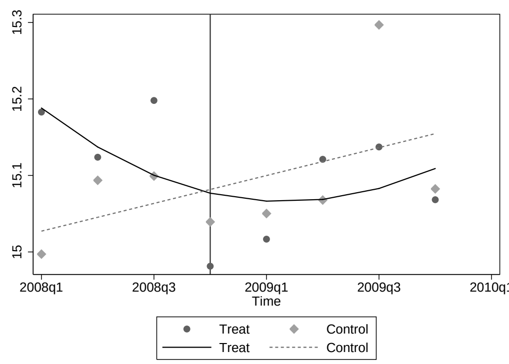
Table B.11: Transactions, Stavanger and Randaberg, 2014

Postcode	Obs	Mean	St. Dev.	Min	Max	Detached (%)	Semi-detached (%)	Row house (%)	Apartment (%)
Stavanger									
4027	148	4,176,331	1,306,337	800,000	7,400,000	13	5	20	62
4028	62	3,442,097	1,152,399	1,600,000	7,250,000	23	16	23	38
4029	36	3,866,806	1,239,706	1,250,000	6,990,000	53	25	22	0
Randaberg									
4048	28	3,650,357	926,889.4	2,350,000	6,200,000	25	11	46	17
4049	15	4,684,667	975,945.5	2,950,000	6,400,000	60	20	20	0
4070	165	3,961,186	1,603,915	720,000	7,020,000	38	16	17	29
Total	454	3,957,682	1,392,597	720,000	7,400,000	29	13	21	37

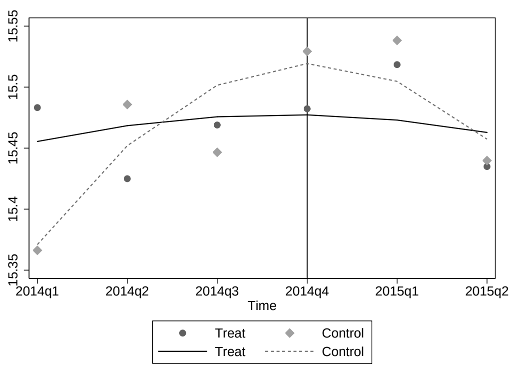
Note: The table presents summary statistics of the transactions in the different postcodes included in the treatment and control groups in the year preceding the treatment. The left side shows price statistics, while the right side shows the percentage of each house type.



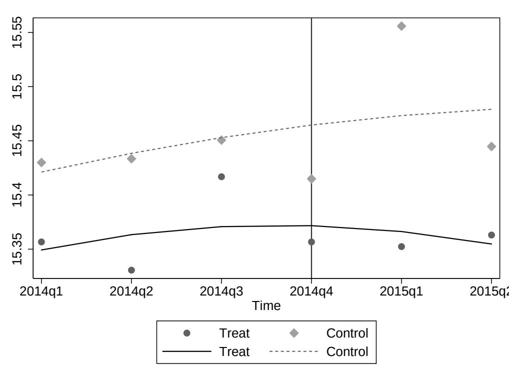
(a) Municipality level, 2008-2009



(b) Municipality level, 2008-2009



(c) Municipality level, 2014-2015



(d) Municipality level, 2014-2015

Figure B.6: Stavanger and Randaberg

Median log prices of detached houses, Stavanger and Randaberg.

The lines are fractional-polynomial prediction plots.

Table B.12: Property taxes, Nes et cetera

	Nes				Aurskog-Høland, Eidsvoll and Ullensaker				Sørum			
	Tax rate	Valuation	Deduction	Income	Tax rate	Valuation	Deduction	Income	Tax rate	Valuation	Deduction	Income
2007	No tax				No tax				2	2006	500,000	11,034
2009	2	2009	No	15,789	No tax				2	2006	500,000	12,530

Note: The table shows the nominal tax rates, valuation year, the size of the standard deduction and the total income from property taxes on housing (denoted in 1000s of NOK) for 2007 and the following years where one or more of the variable (excluding income) changes.

Table B.13: Transactions, Nes et cetera

Postcode	Obs	Mean	St. Dev.	Min	Max	Detached (%)	Semi-detached (%)	Row house (%)	Apartment (%)
Nes	294	1,771,071	655,499	590,000	4,500,000	37	10	39	14
Aurskog-Høland	123	1,805,840	745,610.3	750,000	5,471,975	41	11	25	23
Sørum	268	2,358,628	878,748.6	690,000	5,500,000	55	12	22	11
Ullensaker	911	2,055,995	777,518	574,000	6,300,000	24	11	14	51
Eidsvoll	207	1,803,223	663,848.9	445,000	6,600,000	28	27	14	31
Total	1,803	2,008,433	783,452.5	445,000	6,600,000	32	13	20	35

Note: The table presents summary statistics of the transactions in the different postcodes included in the treatment and control groups in the year preceding the treatment. The left side shows price statistics, while the right side shows the percentage of each house type.

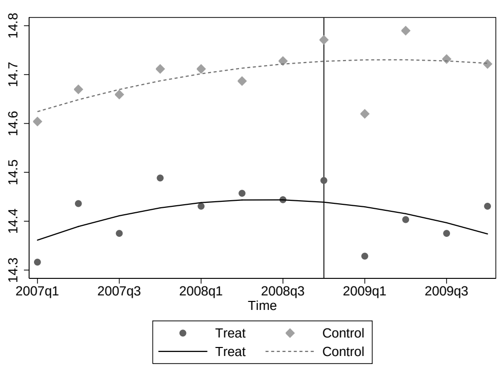


Figure B.7: Nes et cetera

Median log prices of detached houses, Nes and Aurskog-Høland, Eidsvoll, Sørum and Ullensaker.

The lines are fractional-polynomial prediction plots.

Table B.14: Property taxes, Gjesdal, Time and Klepp

	Gjesdal				Time and Klepp			
	Tax rate	Valuation	Deduction	Income	Tax rate	Valuation	Deduction	Income
2007	No tax				No tax			
2011	2	2011	100,000	8,628	No tax			

Note: The table shows the nominal tax rates, valuation year, the size of the standard deduction and the total income from property taxes on housing (denoted in 1000s of NOK) for 2007 and the following years where one or more of the variables (excluding income) changes.

Table B.15: Transactions, Gjesdal, Time and Klepp

Postcode	Obs	Mean	St. Dev.	Min	Max	Detached (%)	Semi-detached (%)	Row house (%)	Apartment (%)
Gjesdal	203	2,496,596	850,676	990,000	4,725,000	47	11	14	28
Klepp	193	2,632,128	804,497.1	800,000	4,420,000	28	13	26	33
Time	267	2,537,043	969,623.9	490,000	6,150,000	22	6	31	41
Total	663	2,552,338	888,368.9	490,000	6,150,000	31	10	26	33

Note: The table presents summary statistics of the transactions in the different postcodes included in the treatment and control groups in the year preceding the treatment. The left side shows price statistics, while the right side shows the percentage of each house type.

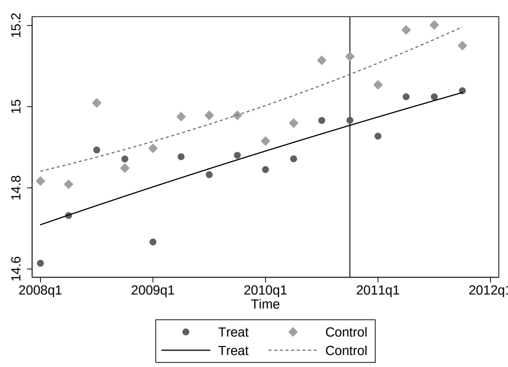


Figure B.8: Gjesdal and Time and Klepp
Median log prices of detached houses, Gjesdal and Time and Klepp.
The lines are fractional-polynomial prediction plots.

Table B.16: Commuter overview, pre-treatment year

	Working in municipality	Working in the treatment/control	Total inhabitants working
Nes	4,082	1,828	10,014
Aurskog	3,972	56	7,525
Eidsvoll	4,847	103	10,818
Ullensaker	7,583	178	15,238
Sørum	2,217	131	8,168
Gjesdal	2,252	387	5,927
Time	3,724	134	9,173
Klepp	3,464	82	9,599
Ålesund	19,903	621	24,808
Sula	2,046	1,921	4,663
Skien	17,286	4,870	25,895
Porsgrunn	10,012	3,987	17,244
Skedsmo	9,311	2,303	26,694
Lørenskog	5,793	1,759	18,063
Bergen	122,789	2,745	139,687
Fjell	5,529	4,815	11,781
Askøy	5,758	6,184	13,543
Stavanger	48,789	7,487	71,881
Sandnes	18,369	11,892	40,057
Randaberg	1,650	2,448	5,691

Table B.17: Commuter inflows

	Inhabitants working in municipality	From control area working in municipality	Total working in municipality
Nes (2008)	4,082	468	5,453
Gjesdal (2008)	2,252	216	3,279
Ålesund (2014)	19,903	1,921	28,389
Skien (2008)	17,286	3,987	25,104
Skedsmo (2014)	9,311	1,759	28,653
Bergen (2011)	122,789	10,999	158,780
Stavanger (2014)	48,789	14,340	83,477

Appendix C

Miscellaneous

Table C.1: KOSTRA

Question	Options
Does the municipality charge property tax?	Yes=1, No=0
Property tax in the municipality as a whole.	Yes=1, No=0
Property tax in the municipality as a whole, excepting areas used for mills and factories.	Yes=1, No=0
Property tax in both areas build in a townish manner and in industrial areas, including mills and factories.	Yes=1, No=0
Property tax in both areas used for mills and factories and in areas build in a townish manner.	Yes=1, No=0
Property tax only in areas build in a townish manner.	Yes=1, No=0
Property tax only in industrial areas, including mills and factories.	Yes=1, No=0
Property tax only on mills and factories.	Yes=1, No=0
The general tax rate	Number
If the municipality apply differentiated tax rates for homes and vacational properties, what is the tax rate	Number
Which year did the last general assessment take effect?	Year
Has the municipality imposed basic deduction that counts only for homes and vacational properties	Yes=1, No=0
If yes, what is the amount on basic deduction?	Sum
Does the municipality give property tax exemption on new homes of upto 20 years from the time of completion?	Yes=1, No=0
If yes, for how many years?	Number
Does the municipality give property tax exemption for historical buildings?	Yes=1, No=0
Does the municipallity use the alternativ taxvalue-method given in the property law § 8 C-1	Yes=1, No=0
Property tax on a detached house measuring 120 square meters	Sum
Property tax in total	Sum in 1000s
Property tax from other properties	Sum in 1000s
Property tax from residential homes and vacational properties	Sum in 1000s

Table C.2: Regions

	Counties
Region 1	Oslo and Bærum
Region 2	Østfold and Akershus (ex. Bærum)
Region 3	Oppland and Hedmark
Region 4	Buskerud, Vestfold and Telemark
Region 5	Vest-Agder and Aust-Agder
Region 6	Rogaland and Hordaland
Region 7	Sogn og Fjordane and Møre og Romsdal
Region 8	Sør-Trøndelag and Nord-Trøndelag
Region 9	Nordland, Troms and Finmark