HOUSING LAB WORKING PAPER SERIES

2023 | 3

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Linking housing Tobin's Q to land prices*

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December 21, 2023

Abstract

We examine whether the Norwegian housing market produces single-family homes at prices that are aligned with the replacement costs. We start out by using detailed data on construction costs, baseline land costs and markups, and calculate replacement costs as minimum profitable production costs (*mppc*). Inspired by Glaeser and Gyourko (2018) we construct a Tobin's Q for the housing market, defined as the estimated ratio of house prices on *mppc*, between 2010 and 2020. In the short run, the two valuations, house prices and replacement costs, may deviate significantly. In the long run, well-functioning markets should ensure that they converge. If Tobin's Q for the housing market is (considerably) above unity over a period of time, it could indicate boundaries to investments, i.e. the presence of regulations that prevent land development, referred to as a regulatory tax. We observe substantial differences in Tobin's Q of housing over time in a given market and across cities at at given time. To probe deeper into the supply side mechanisms, we use tear-down sales to estimate regional land prices and accounting data to estimate markups for developers. We do this in order to uncover which agents benefit from the gap between house prices and the *mppc*. Finally, we compare the estimated Tobin's Q with a measure of Norwegian cities' efforts to facilitate housing construction.

Keywords: Construction costs, Land prices, Tear down index, Tobin's Q
JEL Codes: R31, R14, R52, D12, D22

*The authors are grateful to Eiendomsverdi for data. Thanks to Vegard Salte Flatval and André K. Anundsen for help compiling data. The paper has been presented at Samfunnsøkonomenes Forskermøtet 2022 and OsloMet Workshop : Norsk bolig- og urbanforskning 2023.

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1 Introduction

In economics, some ideas are so compelling that the mind is immediately drawn to them. Among such ideas, Tobin's Q ranks high (Tobin (1969)). In popular terms it says that when the replacement cost of an investment object is lower than its market value, investors would tend to acquire the object by replacing it. Thus, the ratio of the market value to the replacement cost would point observers in the direction of potentially attractive investment opportunities and encourage behavior that would tend to lead the ratio towards unity.

In this paper, we ask three questions. In Norway, is the housing Tobin's Q high or low? Who benefits from the gap between house prices and construction costs, developers or land-owners? What is the link between housing Tobin's Q and regulation?

Our answers are: Yes, in Oslo; both groups benefit, but especially land owners; and the link works through land prices.

The power of the idea behind Tobin's Q was recognized early (Hayashi (1982)) and it has received much attention (Andrei et al. (2019)). Although Tobin's Q originally was conceived as a measure to gauge valuation of firms, it has also been applied to model housing investments, see Takala et al. (1990), Jud and Winkler (2003) and Haagerup (2009). Schulz and Werwatz (2011) estimate Tobin's Q of housing and Rosenthal (1999) looks at the difference between construction costs and new home prices, both as a way to assess market efficiency and as a metric that signals potential hindrances in the market for land.

Glaeser and Gyourko (2018) take another approach and use the Tobin's Q of housing to illustrate how regulations to housing development may lead to large price premiums on houses. The key difference when estimating the Q is that, instead of using observed land costs, Glaeser and Gyourko (2018) measure a minimum profitable production cost of a new home using "fixed" land costs at 20 percent of total construction costs across all areas studied, assuming this is a realistic share when land is in abundance and/or regulations are lenient. This makes it possible to compare different developments of the housing Tobin's Q's over time and across regions.

A housing Tobin's Q persistently above one, i.e. a positive difference between house prices and production costs, can be indicative of a regulatory tax: If it is profitable for developers to construct new housing, they will tend to do so, and the increase in supply would prevent the ratio from reaching levels much above unity. If developers are prevented from constructing new homes, the ratio would increase when demand is larger than supply, and thus indicate that either regulations or geographical obstacles cause a low elasticity of supply. The implication is that developers will compete over scarce land and bid up land prices.[1]

We find substantial differences in housing Tobin's Q across regions in Norway, and we document what seems to be an association between Tobin Q's and supply side obstacles. It appears that policy plays a major role since restrictive rules on building or zoning are associated with house prices much above the minimum profitable construction cost. We also find evidence that is consistent with land owners using their advantageous position to extract high prices for land in highly regulated areas.

The findings we put forward are useful to economists and policymakers because they illustrate and quantify the role played by housing regulation, a policy branch that makes decisions with societal impact that is not well understood (DiPasquale (1999), Murphy (2018), Hsieh and Moretti (2019)). Oslo, a city with stricter regulation than the median in Norway, has higher Tobin's Q compared to Kristiansand, a city with more lenient regulation. Since Oslo is a capital, and capital cities might be in positions in which they must have stricter regulation, we also compare Kristiansand to cities of similar size and status. We show that regulations are indeed associated with implications for home owners in terms of less construction and higher prices.

The basis for these findings are rich data sets. We use transaction data to obtain price

[1]Benedictow et al. (2022a) show how contracts often contain a list of contingency plans that outline different prices for different regulatory outcomes, i.e. a form of profit sharing between land sellers and builders. The implication is that if we let the denominator in the housing Tobin's Q fully reflect real market prices for lots, the ratio would tend towards unity. Thus, for the housing Tobin's Q to be an indicator of regulatory activity one needs to control for land owners' utilization of market power and settle on an assumption on a land share of costs in absence of regulatory hindrances, as Glaeser and Gyourko (2018) do.

information and to construct hedonic price indices, we access engineering data for construction costs, we employ accounting data to estimate markups, and we identify tear down sales using firm identifiers to estimate land prices. Finally, we use estimates of regional building restrictions based on a large set of indicators.

We start out by constructing a Tobin's Q of the housing market by estimating the ratio between observed house prices of detached homes and replacement cost for six cities in Norway; Oslo, Bergen, Trondheim, Stavanger, Kristiansand and Drammen[2]. We use high-resolution housing transaction data for individual dwellings, and we access detailed data on construction costs to estimate corresponding costs.[3] As Glaeser and Gyourko (2018), we estimate the minimum profitable production cost (*mppc*). The *mppc* includes construction costs, the lot price and a markup. The ratio of the house price to the *mppc* is the Housing Tobin's Q (HTQ).

To investigate the impact on housing prices from the effort of the cities to facilitate the supply side, we use an index that measures and ranks Norwegian cities and municipalities with regard to how well they promote and facilitate housing construction. The Housing construction facilitation index (HCFI) is based on 42 indicators, covering five themes: Facilitation, housing construction, sustainability, renewal and inclusion, see Benedictow et al. (2021)[4]. In Norway, municipalities are responsible for planning and facilitating the construction of housing, and there are substantial differences across regions.

A clear pattern emerges: There is more variation across cities in house price growth than in the development of construction costs across cities in Norway. The population, and thus demand for housing, in urban areas has increased in all the largest cities in the country. However, whether the increased demand has materialized in more housing supply or in higher prices differs between the cities. Thus, Norway has seen a rise in house price disparities. In Oslo, the median price of a detached house in 2020 was almost 18 times

[2]In Norway, the large cities are also municipalities. A city is a geographical area and a municipality is a political and administrative unit

[3]This information is compiled by engineers that know the construction industry well.

[4]available upon request. See Benedictow et al. (2022b) for a version based on 16 indicators

the median income for a household, while it was 8 times the median income in Bergen and Trondheim, the second and third largest cities in Norway[5]. In Kristiansand, the median price of a single-family house was 6 times the median income of a household in 2020.

Geographical heterogeneity in house prices has a variety of sources since house prices are affected by both short-term and long-term factors on both the demand and the supply side. Although some demand side factors are common to all areas in a country, e.g. the interest rate and tax rules, macro variables such as unemployment and income may vary across regions. Moreover, agglomeration effects may have increased demand more in larger cities than in smaller towns. On the supply side, there are substantial regional differences in building restrictions, natural or man-made, and how local authorities facilitate housing construction. In this paper, we focus on the supply side and effects of public building policies in particular.

Gyourko et al. (2021) document heterogeneity in regulatory framework across regions when they report results from a survey of regulation in a large number of areas across the U.S. Gyourko and Krimmel (2021) estimate the impact of the restrictions and are able to put a number on zoning taxes, i.e. the land price premium that is due to limits on the supply side. For example, they find that the gap between the extensive and intensive margin of land values of a quarter acre of land amounts to USD 400,000 in the San Francisco area, which is more than double that of Los Angeles, New York City, and Seattle.

The stricter regulation can have substantial negative impact on the functioning of the economy. As one example, Xiao et al. (2021) use firm office relocation to identify the effect of commuting distance on inventor productivity. They find that every 10 kilometer increase in commuting distance is associated with a 5 percent decrease in patents per inventor-firm pair per year. Thus, economic performance could, potentially, be enhanced by reducing restrictions. Anagol et al. (2021) use spatial regression discontinuity design and find that zoning reform in Sao Paulo is associated with decreases in price and increases in stock. More

[5]Source: Eiendom Norge (median house prices), Statistics Norway (median income for households at county level. Table: 06946)

ambitiously, Hsieh and Moretti (2019) find that easing restrictions in only three U.S. cities can have measurable effects on the U.S. GDP. These are only a few examples of a wide literature (Molloy et al. (2020)) on agglomeration effects.

Duca et al. (2021) study the interplay of demand and supply internationally, and show that mapping supply constraints play a key role in understanding house price increases. Moreover, there are studies on the different facets of the supply side. In one fascinating study, Ahlfeldt and Barr (2022) build a model for the economics of skyscrapers and show that the insights from the monocentric city model, proves us right: vertical growth is a rational response to land shortage. When urbanization forces are strong, rational agents would anticipate future price increases. Thus, holding land until the price of it has increased more, could become an attractive option. Murray (2020) shows how land hoarding affects prices.

The idea of tear down sales was presented by Rosenthal and Helsley (1994) and has later been tested by e.g. Dye and McMillen (2007), Gedal and Ellen (2018) and Munneke and Womack (2020). These authors find that properties bought for redevelopment, i.e. tear-down sales, offer a good approximation of land values in urban areas.

We contribute to the literature by first replicating Glaeser and Gyourko (2018) using Norwegian data, then add to their analysis with measures of regional land prices and markups in building industry. We also focus attention on prices on new homes instead of prices on second hand homes. We decompose the residual gap between prices on new homes and *mppc* defined by Glaeser and Gyourko (2018), which is referred to as a regulation tax. We also make an attempt at identifying who benefits from the gap between new-home prices and mppc; land-owners or developers. We measure markups in building projects across the cities studied using accounting data from 2013 to 2021. Furthermore, we construct measures of land values based on tear down sales in the six cities to investigate the extent to which the land-owners profit from the gap between house prices and replacement costs.

This paper is organized as follows. First we present a simple theoretical framework. The subsequent section presents our data and the institutional background for Norway. We go on to describe our empirical findings in Section 4. In Section 5 the role of regulation is discussed. The last section concludes and offers policy implications.

2 Theoretical framework and empirical techniques

In order to construct the HTQ for a city, c, house price is divided on the minimum profitable production cost, *mppc*, for each c.

$$HTQ_c = \frac{House\ price_c}{mppc_c}. \tag{1}$$

The $mppc_c$ includes construction cost, cc_c, land cost, lc_c and an entrepreneurial markup, p_c, and expresses the lowest price developers are willing to build a home for:

$$mppc_c = (cc_c + lc_c) * p_c. \tag{2}$$

We start by replicating Glaeser and Gyourko (2018) and construct a housing Tobin's Q (HTQ) where house prices are second hand home prices and we set a benchmark *mppc* with land costs as 20 percent of total costs in all areas as in Glaeser and Gyourko (2018) and a markup of 15 percent based on a survey among contractors. Second, we construct our benchmark HTQ, in which we use benchmark *mppc* as above, but we use new-home prices in the numerator. We do this because we observe a discrepancy between prices of new and second-hand homes and we assume that developers look to new-home prices when assessing whether developing new houses is profitable or not.

These assumptions facilitate comparison across regions and over time. For a given region, if benchmark Tobin's Q increases over time, it is indicative of land scarcity that may have been caused by changes in regulation. For a given time period, if benchmark Tobin's Q is different across different regions, it signals spatial differences in land scarcity, which is consistent with differences in regulation.

In the short run, the numerator and the denominator, house price and *mppc*, may deviate substantially from each other. When house prices increase there are profit opportunities for developers, which stimulates the construction of new homes. However, construction takes time. In the meantime, excess demand may push up house prices, and thus the value of HTQ. In the long run, well functioning markets should ensure that house prices and replacement costs do not deviate much from each other. If Tobin's Q for the housing market is (well) above 1 over a period of time, it may indicate boundaries to investments, i.e. regulations to land development. Such boundaries to investment will push up the house prices by increasing the price of land.

Third, we estimate a HTQ with new-home prices and estimates of land prices and markups in the *mppc*. The three definitions of the housing Tobin's Q are presented in Table 1.

Table 1: Alternative definitions of HTQ

HTQ	House price measure	Land price measure	Markup measure
Replication	Second hand home prices	Benchmark 20 percent	Benchmark 15 percent
Benchmark	New-home prices	Benchmark 20 percent	Benchmark 15 percent
Observed	New-home prices	Estimated land costs	Estimated markup

To calculate the benchmark HTQ and the observed HTQ, we need estimates of new-home prices and land costs, which are presented in the following two sub sections respectively.

2.1 Estimating new-home prices

We observe substantial differences in prices of new and second-hand homes. As a consequence, developers study the cost of producing new homes and expected sell prices of new homes when they consider a project to be profitable or not. However, there may be substantial differences in quality and construction methods between vintages. Such differences create a potential confounder for econometricians since we would not compare similar units if we use old vintages in the numerator and new homes in the denominator.

Thus, we study two different sets of house prices for two types of Tobin's Q, one with observed, second-hand home prices, akin to Glaeser and Gyourko (2018) and one for a newer vintage model home of a pre-determined size, new-home prices, matching the model home we have construction costs for. We estimate the price of a house sold as if it were of newer vintage, with 150 square meters living area and 300 square meters of land. We compare these estimated new-home prices with estimations of *mppc*, calculated at city level per year.

The calculation of the new-home price for the model home is done in two steps. First, the following hedonic model is estimated for each city (for convenience we suppress the index c for city[6]):

$$sqmprice_i = \alpha + \beta_1(area_i) + \beta_2(area_i)^2 + \gamma(land_i) + \xi agedec_{a,i} + \varphi qy_{t,i} + \mu_i, \tag{3}$$

in which $sqmprice_i$ is the log price per interior square meter for unit i, $area_i$ indicates interior area, and $land_i$ indicates the land size, i.e. the size of the plot. The variable $agedec_a$ is a dummy variable that indicates age decile of the building at the time of the transaction of unit i. The baseline age decile is the lowest 10 percent age group, which comprises of dwellings that are 5 years old or newer in this case [7]. qy_t is a dummy variable for the quarter and year sold, t, for unit i. Second, we compute the predicted price of a model home for each city c in time t by inserting the model home characteristics [8].

$$\widehat{newprsqm}_{ct} = \hat{\alpha}_c + \hat{\beta}_1 * 150 + \hat{\beta}_2 * 150^2 + \hat{\gamma} * 300 + \hat{\varphi} * qy \tag{4}$$

Equation 4 produces the predicted log price of a model home of 150 sqm with 300 sqm

[6]The estimations are done with the command *areg* in Stata, in which zip code is absorbed. *areg* estimates the zip code fixed effects as deviations from the average transaction.

[7]The age groups within each decile is presented in Table 9 in Appendix B.

[8]In practice, we use the predicted price from the regression, then subtract the element for the actual vintage. We also subtract for the excess area above 150 and the excess lot area above 300 (add if area is below 150 and lot below 300). $ln(newsqmprice_i) = ln(\widehat{sqmprice_i}) - \hat{\beta}_1(area_i - 150) - \hat{\beta}_2(area_i - 150)^2 - \hat{\gamma}(land_i - 300) - \hat{\xi} agedec_{a,i}$. This gives the same result as Equation 4.

plot in the average zip code in the respective quarter sold. To convert from log form to level we use the "smearing estimate", multiplying with the average exponentiated residual, see Wooldridge (2020) pg. 206.

We obtain a predicted price per city per quarter for each observation. In the measure of the housing Tobin's Q we use the median price of the model home, $newsqmprice_i$, each year.

2.2 Estimating land costs - tear down sales

In order to evaluate whether observed high house prices reflect strict regional regulations of housing development, we need an estimate of the land cost share for markets that have an abundance of land and/or few regulations as a counterfactual. We then apply this benchmark land cost share to all cities. Thus, the benchmark HTQ may be interpreted as an indicator of the degree of regulation. If HTQ is well above 1 over time in a city, it indicates strict regulation and a regulatory tax or zoning tax, see e.g.Gyourko and Krimmel (2021).

Glaeser and Gyourko (2018) use a rule of thumb for the land cost share of total construction cost of 20 percent. Norsk Prisbok, a database on detailed construction costs, reports that the average land cost was approximately 35 percent in the Eastern part of Norway in 2011. However, these are the estimated actual land costs, which reflect both the scarcity of land and the imposed regulations in that area. In the estimation of Tobin's Q, we test for different levels of the cost share of land. We focus attention on the land cost share in the cities Kristiansand, Stavanger and Bergen, which have relative high rankings on the Housing Construction Facilitation Index, Benedictow et al. (2021). These three cities had estimated average land cost shares of 15, 18 and 29 percent respectively between 2010 and 2020. We use 20 percent land cost in the estimation of benchmark HTQ, which is the average land cost of the cities listed above and consistent with the rule of thumb from Glaeser and Gyourko (2018).

When computing the benchmark HTQ, we attain HTQs both consistently below and consistently above 1, indicating differences in regulatory environment in the different cities. To decompose the gap between house prices and replacement costs, we estimate land prices for each city using tear-down sales. A tear-down sale is defined as a sale in which the property is bought with the intention of tearing down the existing building and constructing new dwellings. The assumption is that the price of the tear-down sale plus demolition costs is the price of the land. If the assumption holds, the price should only reflect location and other attributes to the land, and not the attributes of the building structure upon it.

Our identification plan for identifying properties bought with the purpose of tearing the structure down is to combine buyer characteristics and property types. We define a tear-down sale as one in which i) the buyer is an organization, ii) the plot size is between 300 and 4800 square meters. We also trim the data along several parameters as organization type and property type, described in the Data section, 3.1.

We estimate median price per square meter land for each city based on transaction data for tear-down sales. However, as construction costs and house prices are expressed as prices per square meter interior, we also convert the land prices per square meter land to land price per square meter interior. To do this we need to make assumptions on the floor-to-area ratio, number of stories built, and parking lot requirements which are set in the city's regulation plans. Within the cities there are different regulations for different areas. We have contacted the Agencies for Planning and Building Services in the six cities we study and requested an estimate of the regulations on floor to area ratios in areas that are regulated for detached, semi-detached, and row houses. We then utilize the floor-to-land ratio reported by the cities in our computations. The floor-to-area ratios applied in the different cities are presented in Table 2. The ratio is set to 30 percent in all cities except for Oslo where it is set to 24 percent. We assume that the new construction is 2.5 stories tall on average. We extract 36 square meters for parking (equivalent to 2 parking spaces). The estimation method is presented in Appendix A.

Table 2: Floor to area ratios

	Oslo	Drammen	Kristiansand	Stavanger	Bergen	Trondheim
Percent FAR	24	30	30*	30	30*	30*

Source: Agencies for planning and building services in the respective cities and own calculations.
Notes: *For Kristiansand we have received different estimates of the floor to area ratio and used the average. For Bergen we have used the lower bound of the floor to area ratios obtained. For Trondheim we have looked to the other cities, except for Oslo as Oslo is ranked as the lowest in facilitating new development, and have the strictest regulations on floor to area ratio in the cities where we have received information.

3 Data and institutional arrangements

3.1 Transaction data

We use data from Eiendomsverdi, a firm that specializes in acquiring housing market data and that estimates an Automated Valuation Model (AVM) for Norwegian banks. Eiendomsverdi collaborates with Real Estate Norway (the association of real estate brokerages), Finn.no (an online advertising platform), and other firms that source housing information, and combines these data with public records. Eiendomsverdi has access to Kartverket´s Matrikkel, a public registry that includes all properties in Norway. About 70 percent of all transactions pass through Finn.no and real estate agents. Examples of transactions that do not pass through such market places are within-family transactions and other non-arms-length transactions. We have obtained two data sets from Eiendomsverdi, one with house transactions in the relevant cities to compute price per square meter, and a data set with sales to an organization number to compute land costs based on tear-down sales.

The data set for house prices comprises transaction data with high temporal resolution. Since Norwegian law states that all bids are legally binding and all acceptances of bids are legally binding, the date on which a bid is accepted, the transfer of ownership is essentially locked in. Thus, this data set allows us to use a daily granularity. We have data from 2010 to 2020, and we have information on date of sale, sell price (transaction value plus common debt), square meter interior, square meter land, type of building and district.[9] We add the

[9]When the variable interior area is missing, we impute values based on reported gross interior area. We

transaction value and common debt to obtain the sell price. Summary statistics is presented in Table 3. Over our time period the median price for a single-family home spans from 3.4 million in Kristiansand to 8.6 million in Oslo. Trondheim, Bergen and Stavanger have quite similar patterns throughout the distribution for prices and price per square meter. Drammen and Kristiansand have the lowest prices and Oslo the highest throughout the distribution.

Table 3: Summary statistics. Transaction data single-family homes

City	variable	min	pct 10	pct 50	average	pct 90	max
Bergen	Interior sqm	55	113	167	173	240	348
	Price NOK per sqm	12,739	19,926	28,926	30,155	42,050	67,308
	sell price NOK	1,750,000	3,000,000	4,800,000	5,099,212	7,600,000	13,700,000
	Share of obs.				20.0 pct.		
Drammen	Interior sqm	55	103	156	162	228	344
	Price NOK per sqm	9,267	15,979	24,390	25,445	36,343	55,859
	sell price NOK	1,350,000	2,350,000	3,700,000	3,995,919	6,100,000	11,100,000
	Share of obs.				14.4 pct.		
Kristiansand	Interior sqm	79	117	165	169	228	323
	Price NOK per sqm	9,211	15,164	21,421	22,294	30,637	50,588
	sell price NOK	1,500,000	2,350,000	3,435,000	3,712,814	5,500,000	10,000,000
	Share of obs.				14.3 pct.		
Oslo	Interior sqm	68	130	183	192	266	455
	Price NOK per sqm	18,506	28,155	46,407	49,500	74,731	120,192
	sell price NOK	2,885,000	4,700,000	8,600,000	9,411,483	15,100,000	30,000,000
	Share of obs.				20.1 pct.		
Stavanger	Interior sqm	62	123	183	186	255	368
	Price NOK per sqm	13,320	21,985	29,808	31,033	41,257	62,500
	sell price NOK	1,950,000	3,750,000	5,350,000	5,608,570	7,900,000	13,200,000
	Share of obs.				14.6 pct.		
Trondheim	Interior sqm	60	122	175	180	250	378
	Price NOK per sqm	11,214	19,034	28,058	29,347	41,685	66,116
	sell price NOK	1,980,000	3,150,000	4,800,000	5,152,597	7,500,000	13,700,000
	Share of obs.				16.4 pct.		
Total	Number of observations				18,068		

Source: Eiendomsverdi, own calculations.
Notes: The prices are expressed in Norwegian kroner, NOK. The exchange rate between NOK and USD was 1 USD=9.6 NOK in 2022. The average exchange rate between 2013-2022 was 1 USD=8.1 NOK.

The second data set consists of observations in which the buyer has an organization number.[10] We use this dataset to construct a measure of the price of land and it covers the period 2010-2020. The data set contains sell price, sell date, plot size, primary area, utility floor space, type of existing building on the plot if there is any, postal code, which

remove observations in which there is no information on either net or gross interior area. We also remove observations in which the building year or square meter land is missing. We remove the 1 percent oldest buildings in the data set, with building year before 1865. We trim the data by excluding observations in the 0.5^{th} and 99.5^{th} percentile of sell price, price per square meter, and interior area. We then run the hedonic regression $sqmprice_i = \alpha + \beta area_i + \beta_2 area_i^2 + \gamma land_i + \xi agedec_{a,i} + \psi zip_{d,i} + \varphi qy_{\tau,i} + \varrho_i$ and exclude observations where $\frac{p_i}{\hat{p}_i}$ is in the 1^{st} and 99^{th} percentile.

[10] When the buyer is an individual the buyer is registered with a social security number.

Table 4: Summary statistics tear-down sales

City	variable	min	pct 10	pct 50	average	pct 90	max
Bergen	Land area sqm	300	419	950	1,180	2,322	4,732
	Price NOK per sqm	10	727	3,704	5,907	13,405	58,544
	sell prices NOK	15,000	787,000	4,000,000	5,153,677	10,250,000	58,500,000
	Share of obs.				25.5 pct.		
Drammen	Land area sqm	301	428	809	1,034	1,972	4,530
	Price NOK per sqm	85	932	3,462	5,555	10,929	56,549
	sell prices NOK	103,000	800,000	3,180,000	4,436,396	8,750,000	40,000,000
	Share of obs.				13.4 pct.		
Kristiansand	Land area sqm	301	388	929	1,247	2,756	4,624
	Price NOK per sqm	25	548	3,135	5,296	12,286	56,628
	sell prices NOK	25,150	600,000	3,000,000	4,214,610	9,000,000	28,393,300
	Share of obs.				12.3 pct.		
Oslo	Land area sqm	304	670	1,172	1,318	2,075	4,080
	Price NOK per sqm	743	3,580	8,419	9,785	16,615	39,882
	sell prices NOK	1,000,000	4,400,000	10,000,000	11,787,754	22,000,000	45,000,000
	Share of obs.				15.4 pct.		
Stavanger	Land area sqm	304	376	651	906	1,820	3,993
	Price NOK per sqm	70	1,549	6,899	8,726	16,571	47,750
	sell prices NOK	88,032	1,500,000	4,900,000	5,891,687	10,700,000	35,000,000
	Share of obs.				11.9 pct.		
Trondheim	Land area sqm	301	373	846	1,057	2,080	4,383
	Price NOK per sqm	42	1,430	5,371	7,729	16,283	61,917
	sell prices NOK	35,000	1,250,000	5,100,000	6,301,071	10,900,000	63,000,000
	Share of obs.				21.5 pct.		
Total	Number of observations				6,395		

Source: Eiendomsverdi and own calculations.
Notes: The prices are expressed in Norwegian kroner, NOK. The exchange rate between NOK and USD was 1 USD=9.6 NOK in 2022. The average exchange rate between 2013 and 2022 was 1 USD=8.1 NOK.

organization that bought the property, number of new dwellings developed on the plot after the sale, and the number of existing buildings torn down.

We remove observations where the buyer of the property is registered as a public agency, a municipality or city, or state highway authority. We also exclude electricity providers, kindergartens, churches, and other organizations that we assume do not develop housing units. We exclude property types as garages, schools and buildings with cultural status if there are no new dwellings developed on the land. In Oslo, we drop observations in central districts where there are few single-family houses[11].

A common type of regulation is a minimum size requirement on plot sizes in order to allow housing development. We remove observations that have plot size below 300 square meters. [12]

[11] In Oslo we drop the districts Sentrum, Gamle Oslo, Sagene, St. Hanshaugen, Frogner, Grunerløkka, Marka, Alna and Bjerke as these districts have a low share of single-family houses.

[12] We also trim the data by excluding observations in the 1^st and 99^th percentiles for price and price per square meter, and on the 99^th percentile for square meter plot.

Summary statistics of the trimmed data set is presented in Table 4. As in the data set over transactions of single-family homes, Oslo has the most expensive land prices and Kristiansand and Drammen have the lowest prices. The median sell price for land throughout the time period lies between NOK 3 million in Kristiansand and NOK 10 million in Oslo. The median price per square meter land is between NOK 3,135 in Kristiandsand and NOK 8,419 in Oslo, with price per square meter in the other cities within this range.

After the data cleaning described above, we assume for the remainder of the observations that the property is bought for development purposes. We perform multiple checks to inspect the validity of the assumption. We have access to information on how many new units were built on the property after the sale and how many were torn down. These variables are obtained by Eiendomsverdi from Matrikkelen, the public registry of all properties in Norway. There may be some lags in the reporting of these variables, and in some cases this information is missing. We construct a subset of the data that includes only observations in which at least one of the variables indicates a new building on the property or a torn down building, or in which the name of the organization that bought the property includes either of the words "development", "property", "dwelling" or "plot". The results are presented in Section 5.2.

3.2 Construction costs

Constructions costs are obtained from Norsk Prisbok, a database on detailed construction costs delivered by Bygganalyse AS and Norconsult Informasjonssystemer. Bygganalyse AS is a consulting firm that monitors construction prices for various types of buildings and assists in a number of private and public building and construction projects. The data span from 2010 and are updated semi-annually. The database provides prices on three levels: unit price register, input prices, and model building projects. The model building projects are based on totals of the the costs of the inputs used in the construction, which again is based on the unit price register.

Norsk prisbok contains construction costs for various types of houses and buildings. The houses are categorized into standards and with or without basement. The model home used for estimating construction costs in this paper is a normal standard detached house of 150 square meters without basement. Costs attached to work processing and completion of the outside area of the dwellings are added to the construction costs[13]. The construction costs applied are expressed per square meter.

The data set's baseline costs are obtained from Oslo and the Eastern part of Norway. To differentiate the construction costs between the cities in our sample, we use regional wage levels for the construction industry from Statistics Norway and regional cost weights of materials from Norsk Prisbok. An industry rule of thumb is that 50 percent of construction costs are labor (wage) costs. This is also in line with the weight used in Statistics Norway's construction cost indices, in which the weight is 44 percent for single-family houses made of wood and 48 percent for apartment buildings, Høiby (2020).

Accordingly, we adjust 50 percent of the construction costs with regional wage levels and the other half with the regional cost weights from Norsk Prisbok. Earnings and material costs are normalized to 1 in Oslo. Both the wage level and material costs are higher in Oslo compared to the other cities.

From 2016 the wage data used are average monthly basic earnings for the aggregate of the construction industry allocated by county. We assign to each city the wage level in the county. During the period some counties have been merged for administrative and political reasons. For the years of the merging, the development in earnings for construction in the whole of Norway have been used for the development in earnings for the relevant city. The statistical agency Statistics Norway does not have data on earnings in the construction industry allocated by county for the years prior to 2016. For these years we have assumed the same relative wage weights as 2016.

[13]Outdoor work includes processing land, outdoor construction, outdoor electricity, outdoor heat, water, sanitation, roads, parks and gardens attached to the building. Norsk prisbok also reports costs for outside area for detached houses. Total costs for outside work are divided by inside area, 150 sqm., to obtain estimates per square meter.

A potential problem concerning the wage data is that the composition of firms is different in Oslo compared to other counties. For larger firms, headquarters are more often situated in Oslo and the earnings for the industry allocated by county may be affected by higher earnings for the administration in Oslo. Another issue is that the construction aggregate consists of the three industries: construction of buildings, specialized construction activities, and civil engineering. The first two industries are involved in housing construction. The latter sub-industry includes building of roads, infrastructure etc. This industry has a higher wage level and may thus exaggerate the estimate of the average wage level in the Oslo region. However, we still believe that the wage levels for the aggregate industry at county level offer a good approximation for the wage disparities between the cities at hand. The wage weights are illustrated in table 6 in Appendix B.

Bygganalyse provides an assessment of geographical differences in construction costs in the form of geographical weights on the total of construction costs. The firm takes into consideration material and transport costs, climate, and building customs. The over-all judgement is that with well-organized and implemented projects, there are small differences in construction costs across the country, as illustrated in table 7 in Appendix B. Bygganalyse reports that it bases the wage costs on the levels of central Eastern Norway, in which Oslo is situated. Thus, we interpret the regional weights as mainly reflecting differences in material costs and adjust the other half of the construction costs with these weights.

3.3 Accounting data

We have obtained access to an accounting database (SAFE) provided by the consultancy Samfunnsøkonomisk analyse (SØA). The data are collected from public records and comprise annual accounts for all companies subject to accounting in the period 2011-2020. The database includes characteristics such as firm address, firm name, and geographical location as well as business affiliation. SAFE allows us to perform detailed analyses of the firms operations including profitability. We focus attention on companies classified in NACE code

41.1, i.e. development of building projects.

We emphasize that we cannot identify the profitability of individual building projects in a specific city. As a proxy for profitability in a specific city, we calculate a measure of the markup for of the 15 largest developers that are (also) active in the city. We calculate the markup as a ratio of operating income for all companies on operating costs for all companies.

To identify the developers that have been operating in the cities in our study, we use the data base Econ Nye Boliger, also provided by SØA, covering all house building projects in Norway including 15 units or more.

We include companies with a 2020 three-year moving average revenue of more than NOK 85 million. By using three-year moving averages for markups, the profitability assessments are less sensitive to factors such as timing of individual projects. The companies are weighted by their revenue.

These numbers must be interpreted with caution. The markups are estimated among the largest firms operating in the cities. These firms are most likely also building large apartment projects, while we are studying the market for single-family homes.

3.4 The housing construction facilitation index

To investigate the impact of land-use restrictions and efforts made by cities to facilitate the supply side on housing prices, we use The housing construction facilitation index (HCFI), Benedictow et al. (2021). See Albouy and Ehrlich (2018) for a similar approach on US data. The latter finds that strict regulatory and geographical restrictions increase housing prices significantly.

HCFI ranks Norwegian cities and municipalities according to how well they promote and facilitate housing construction. It maps a large number of data sources and includes 42 indicators grouped into five themes: Facilitation, housing construction, sustainability, renewal and inclusion:

- Facilitation measures how the cities and municipalities arrange for housing to be built.

- Housing construction measures the actual progress of homes building.
- Sustainability sheds light on the extent to which housing facilitation and construction are in line with key values for people and laws and regulations related to the environment (nature and wildlife), climate and life and health.
- Renewal measures to what extent the existing stock of buildings is utilized.
- Inclusion measures whether housing construction covers the population's actual needs and ensures everyone a safe and suitable home.

The proportion of indicators that a municipality has not responded to is included in each theme index as a separate indicator. A higher number of non-responses reduces the overall score on housing facilitation. The rationale is that a housing-friendly municipality or city should care about measuring its performance.

Cities may have different preconditions. To increase comparability, several steps are taken. First, in many cases numbers are expressed as shares, for example housing reserves in relation to population growth in each city. Second, regressions are carried out on a number of indicators in which important differences between the cities may be present. This includes controlling for factors such as centrality, population size, land area, non-buildable land area, median income.

To reduce the sensitivity of the ranking of the theme indices and the main index to random variation in individual indicators, a ranking test is employed to eliminate such indicators.

The HCFI can be calculated for all Norwegian cities. In this paper, we focus attention on the largest 20, and in particular on the cities of Oslo, Drammen, Kristiansand, Stavanger, Bergen and Trondheim.

3.5 The role of the municipalities

Norwegian housing supply policy can generally be described by the tripartite cooperation between the federal government, the municipalities, and private developers. The government determines the housing policy objectives and the legal framework. It assists municipalities and developers to meet these objectives.

The government is responsible for the Planning and Building Act and the technical regulations. The municipalities are responsible for planning and facilitating the construction and improvement of housing. They make the overall plans and process private proposals for e.g. zoning plans, which in turn determine how the local house building actually turns out.

Finally, there are private companies. The companies finance, build, and manage the housing stock. The interaction between the municipalities and these companies is central for the ability of housing construction to adapt to changing conditions in the municipalities, such as population growth, changed preferences in the population and new regulations.

3.6 Institutional arrangements

The Norwegian housing market is largely liquid and transparent. The sales process typically begins with a seller hiring a realtor, but the realtor is also required to look after the interests of potential buyers.

The realtor sets the ask price in consultation with the seller, normally supported by price estimates from Eiendomsverdi, a data analytics firm that estimates the market value of individual homes based on a detailed data set including a large number of characteristics (AVM). Sellers will also hire an appraiser to prepare a technical report for the home.

Subsequently, the home is put up for sale, usually on the online advertising platform Finn.no. Earlier, sellers also advertized in national and local newspapers. The ad contains price information, photos, a detailed description of the home, and a technical report.

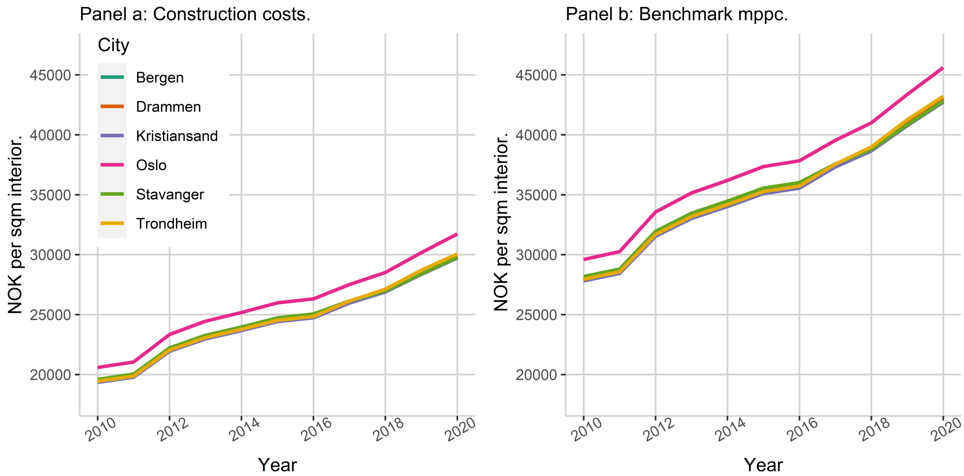
Open houses are generally open to anyone. On these showings, potential buyers may inspect the home while the realtor and/or seller are present to answer questions about the home, the neighborhood etc. Stakeholders may also bring professional assistance.

Homes are usually sold through English auctions. Bids are submitted via a digital platform, and the realtor informs participants and other stakeholders about the progress. All bids are legally binding, within a time horizon specified by the seller, which can vary from minutes to days. However, the seller may reject any bid. Acceptance is legally binding.

4 Empirical findings

First, we compute regional construction costs and benchmark *mppc*. The results are displayed in Figure 1, panel a and b, respectively. The benchmark *mppc* is calculated with 20 percent land share of total costs and 15 percent markup. The construction costs obtained from Norsk Prisbok are adjusted with regional weights for materials and wages displayed in Table 7 and Table 6. There are small differences in both wage levels and material costs between the regions. Between 2010 and 2020 construction costs increased with 54 percent, from NOK 20,600 per square meter to approximately NOK 31,700, before adjustments with regional weights. Benchmark *mppc* increased similarly in percentage terms, from NOK 29,600 to NOK 45,600 in the same period.

Figure 1: Construction costs and benchmark minimum profitable production cost (*mppc*). NOK per sqm. Detached houses

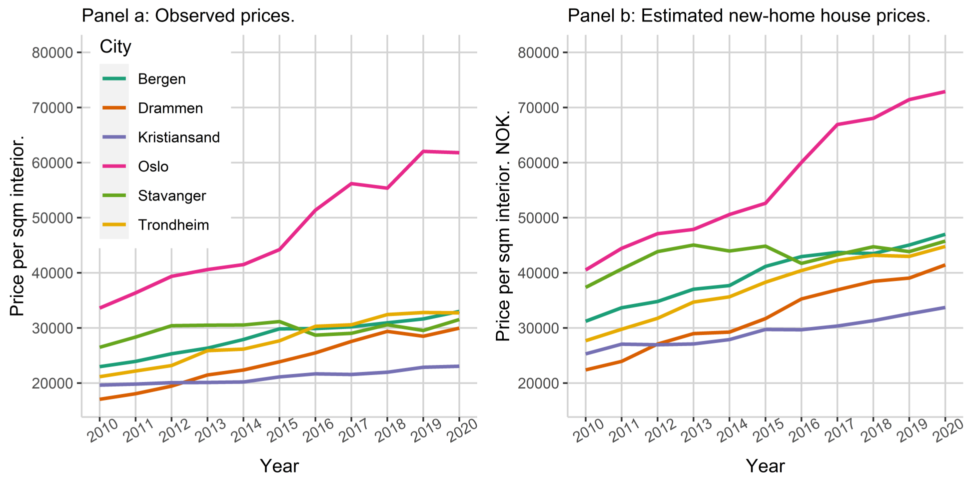


Source: Norsk Prisbok, own calculations.

Notes: To construct regional costs, we weigh labor and material costs. In our estimation, 50 percent of the construction costs are regional wages and 50 percent are weight regional material costs. In the estimation of benchmark minimum profitable production cost, land cost is set to 20 per cent. of total construction cost, and markup is set to 15 per cent.

House prices per square meter are shown in Figure 2. Panel a shows median observed prices for detached dwellings in the respective regions, while panel b shows the estimated price per square meter for a new house.

Figure 2: Median house prices detached houses. Price per sqm. NOK



Source: Eiendomsverdi, own calculations.

Notes: The estimated new-home prices are estimated using equation 4 in Section 2.1.

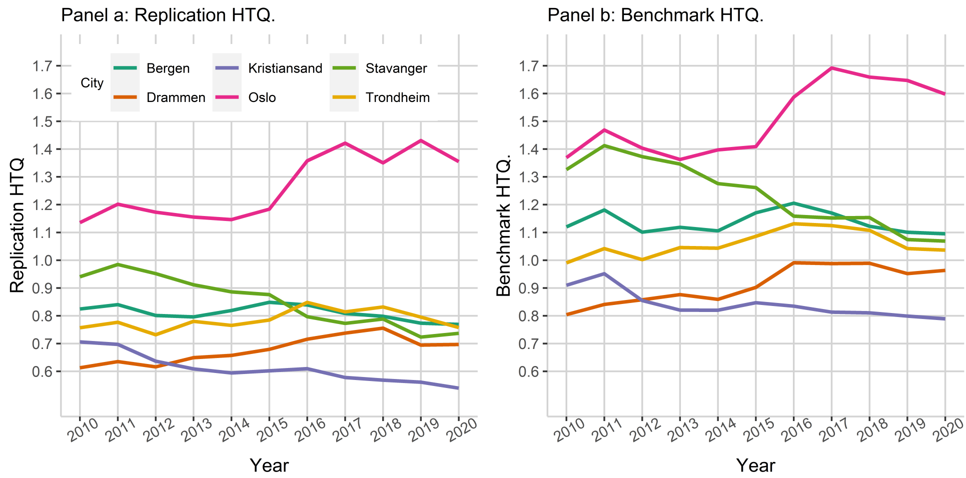
We see in Figure 2 that the median observed prices of second-hand homes in panel a is well below the estimated new-home prices in panel b. This is attributed to adjustments for size, vintage, and zip code.

In the hedonic model in Equation 3, we find that the discount for older vintages of homes, *agedec*, is larger in all cities compared to Oslo. The regression results for the *agedec* coefficient is presented in Table 8 in Appendix B. The base group comprises houses that are 0-5 years old at the time of sale. In inelastic markets with high demand, there tends to be a relatively small price premium on new homes compared to older homes, as the land value represents the largest part of the overall value of the home.

Land value does not depreciate in the same way as the building upon it. In areas in which land is a large share of the total value of a home, as in Oslo, the total value will not depreciate at the same rate as in areas in which land is a small share of total value. Rather, an increase in the land value may offset the depreciation of the building; thus, the total value increases. The city of Kristiansand is an example of the opposite. Efficient regulation/deregulation of land and few restrictions on residential construction have provided lower land costs, and led to a significant premium on new houses.

4.1 Tobin's Q

Figure 3: Replication HTQ (panel a) and Benchmark HTQ (panel b)



Sources: Eiendomsverdi, Norsk Prisbok, own calculations.

Notes: Replication HTQ is measured as observed house prices on second-hand homes per sqm over *mppc*. Benchmark HTQ is new-home prices per sqm over *mppc*. In the calculation of *mppc*, land cost is set to 20 percent of total building costs and markup is set to 15 percent in both measures of HTQ.

The results for the replication HTQ, using median second hand home prices, and benchmark HTQ using new-home prices, both with benchmark mppc with 20 percent land cost share and 15 percent markup, is presented in Figure 3. The replication HTQ is depicted in panel a, while the benchmark HTQ is depicted in panel b. When we use the benchmark mppc with equal land cost share and markup across the cities, we can interpret the deviations between the cities and changes over time as indications of differences and changes in how well supply of houses matches demand.

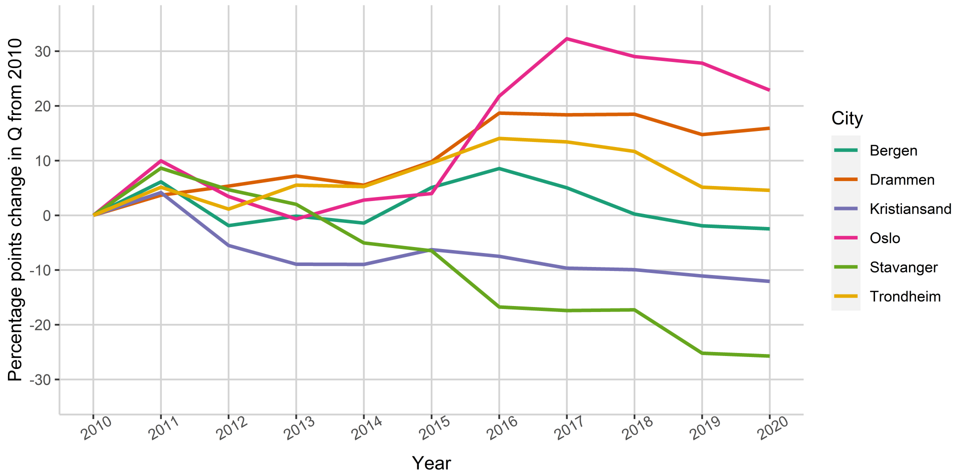
We find that when using observed prices to calculate the HTQ, HTQ is well below 1 over the time period for all cities except for Oslo, as can be seen in panel a in Figure 3. For all cities, except Oslo, replication HTQ lies below 0.8 for multiple years. This should indicate that it is not profitable to develop new housing and we should see little or no new construction in these cities. This observation supports our assumption that new-home prices is the relevant price measure to use.

The benchmark HTQs, using new-home prices, shown in panel b, score at higher levels for all cities, and are more centered around 1. We find the more accentuated pattern when we compare the benchmark HTQ across cities and over time. Glaeser and Gyourko (2018) define an interval of 0.8 to 1.2 approximately equal to 1. For all the cities, except for Oslo, the benchmark HTQ lies within this interval. For Oslo, the benchmark HTQ is well above 1.2 for the whole time period. This finding suggests that regulations on housing development puts a limit on supply in Oslo, which contributes to put an upward pressure on prices. It represents an implicit regulation tax.

Figure 4 shows the change in benchmark HTQ relative to 2010. We see that Oslo, Drammen and Trondheim had an increase in the HTQ between 2010 and 2020 while Oslo experienced a sharp increase between 2015 and 2017, and then a decrease. Kristiansand and Stavanger has seen falling levels of housing Tobin's Q in the time period.

For Oslo in particular, we find that benchmark HTQ is well above 1 over time. We would like to probe into the underlying causes and seek to decompose which agents stand to benefit.

Figure 4: Change in benchmark HTQ relative to 2010



Source: Eiendomsverdi, own calculations.

Notes: Benchmark HTQ is measured with new-home prices per sqm over *mppc*. In the calculation of *mppc*, land cost is set to 20 percent of total building costs and markup is set to 15 percent in both measures of HTQ.

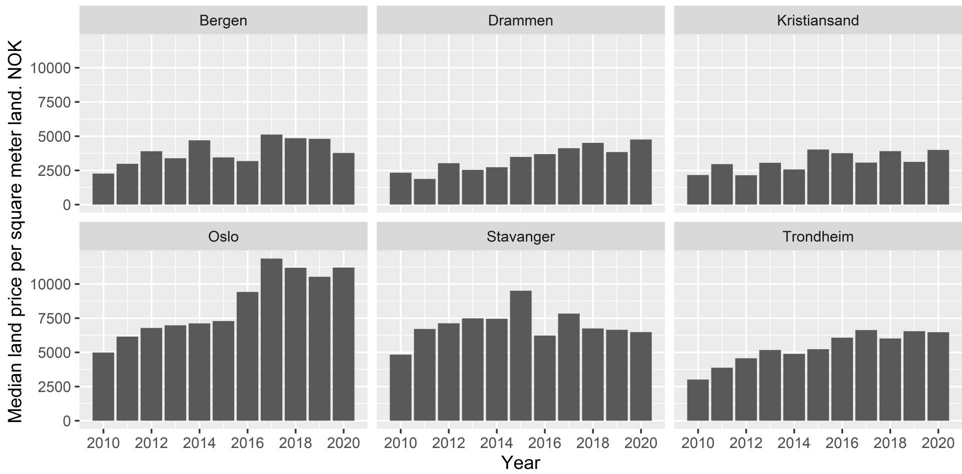
4.2 Estimated land costs

The idea of tear-down sales was presented by Rosenthal and Helsley (1994). Dye and McMillen (2007) use tear-down sales in Chicago and some suburbs around Chicago to calculate the price of land between 1993 and 2004. They use the two-step Heckman procedure, proposed by Rosenthal and Helsley (1994) to control for selection bias. The authors conclude that data from tear-down sales allow researchers to construct measures that approximate land values in urban areas that are developed. Gedal and Ellen (2018) compare land values in tear-down sales and vacant land sales in New York between 2003 and 2009. They find that there is greater price dispersion in vacant land sales than in tear-down sales, when controlling for characteristics of the property.

We compute median land prices per square meter land based on tear-down sales, depicted in Figure 5. We find substantial differences in land prices across the cities. Land prices are lowest in Kristiansand, followed by Drammen and Bergen. Land prices were highest in

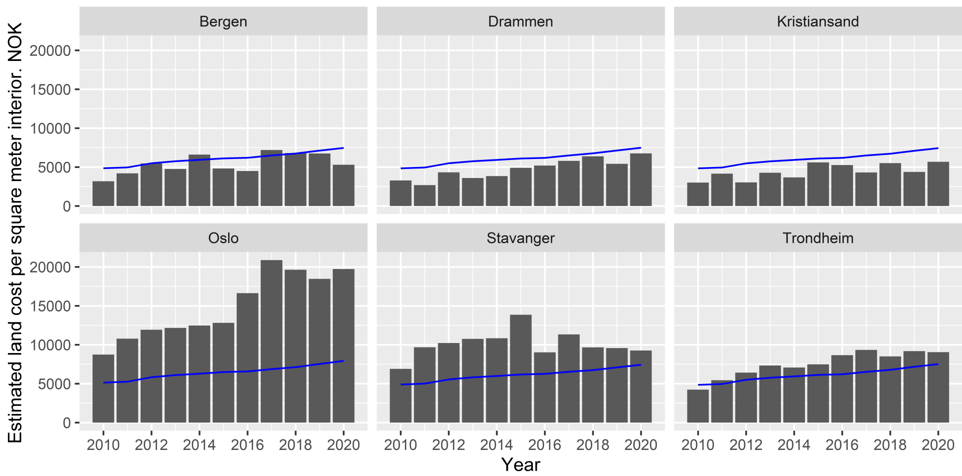
Stavanger until 2016 when they started decreasing, at the same time as land prices grew substantially in Oslo.

Figure 5: Estimated land price. Median price per sqm plot



Source: Eiendomsverdi, own calculations

Figure 6: Land cost per square meter interior. Detached houses



Source: Eiendomsverdi, own calculations.
Notes: Median price per square meter land is converted to price per square meter interior as described in Section 2.2. The blue line indicates the land price per square meter interior given by the assumption of land costs being 20 percent of total construction costs.

Figure 6 shows the price of land per square meter interior. The conversion from land price per square meter of the plot to land price per square meter of the interior is explained in Appendix A. The blue line indicates the land price per square meter interior given by the benchmark assumption of land costs being 20 percent of total construction costs. As can be seen, the assumption of 20 percent land share of total cost is in line with what we observe in Bergen, while the observed land price has been somewhat lower in Drammen and Kristiansand and somewhat higher in Trondheim and clearly higher in Stavanger and particularly in Oslo.

The assumption of 20 percent land share, proposed by Glaeser and Gyourko (2018) was thought of as applicable for areas with abundance of land or lenient regulations. A land cost share of total costs above a reasonable threshold over time can be interpreted as a regulatory tax. Following this line of reasoning, the regulatory tax on land can be estimated as the observed land cost, less the hypothetical land cost of 20 percent, which in the case of Oslo translates into a regulatory tax of about 11 800 NOK per square meter interior in 2020.

The land share of total costs is depicted in Figure 7. There is a great difference between the cities. In Oslo the land cost share varies between 30 and 43 percent, with an average of 36 percent. In Kristiansand, Bergen and Drammen the average over the time period was 15, 18 and 16 percent respectively. In Trondheim, the average over time was 23 percent. In Stavanger, the land cost share started out at 26 percent in 2010, peaked in 2015 at 36 percent and fell to 24 percent in 2020.

Thus our finding that land cost in Oslo is very high is consistent with the notion that the high Tobin's Q in Oslo is a result of supply side limitations.

Figure 7: Land share of total cost. Detached houses

Sources: Norsk Prisbok, own calculations.

Notes: The estimations of land share of total costs are based on median prices per square meter land and median square meter area sold from the tear-down sales dataset. To convert the price of land to prices per square meter interior, we have used footprint as in Table 2, 2.5 stories built and extracted 36 square meters for parking. The interior area is then divided by median square meters of land to calculate floor to area ratio. Finally, the median price per square meter of land is divided by the floor-to-area ratio to obtain price per square meter interior. The share of total cost is then calculated as

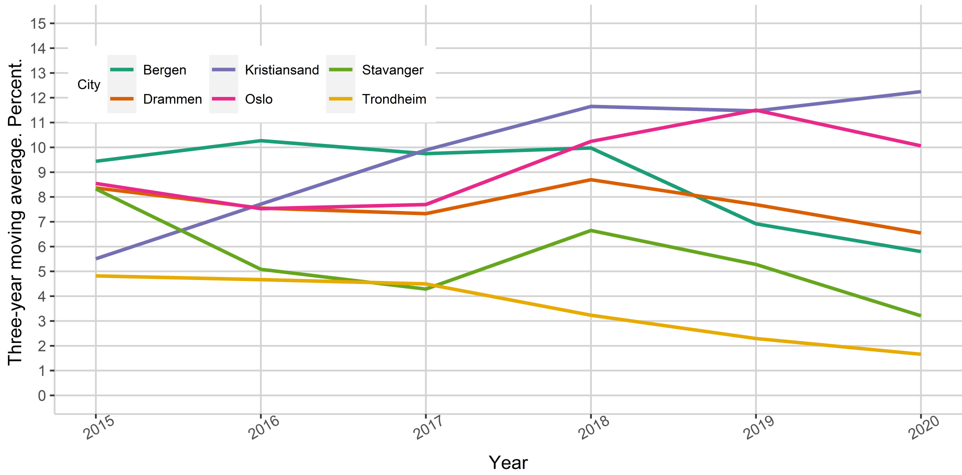
$share = \frac{\text{land cost}}{\text{land cost + construction cost}}$

4.3 Estimated Markups

We have used data on revenues and costs to obtain an estimate the entrepreneurial markup. We compute the markup as p=operating revenue/operating costs, as explained in Section 3.3. Three-year moving averages of the markup is depicted in Figure 8. We see that there is substantial variation across the cities and over time. The realized markup is below the ex ante requirement benchmark of 15 percent based on an informal survey among large developers. It is also below what we find in the data for the industry in total from Statistics Norway in all cities, which is 17 percent on average over the whole time period. The measured markup in percent in Oslo and Kristiansand display an upward trend, with a three-year moving average of 8.5 percent in 2015 and 10 percent in 2020 for Oslo. For Kristiansand, the three-year moving average was 5.5 percent in 2015 and ended at 12.2 percent in 2020. The other cities have the opposite development, starting the time period with a higher three-year moving average in 2015 than in 2020. Trondheim has the lowest measured markup with an average of 3.6 percent from 2013 to 2020.

Figure 8 indicates that the high Tobin's Q is not due to high markup for the developers. Oslo and Kristiansand have substantially different HTQs but relatively similar markups.

Figure 8: Markup in percent. Three-year moving average. 2015-2020

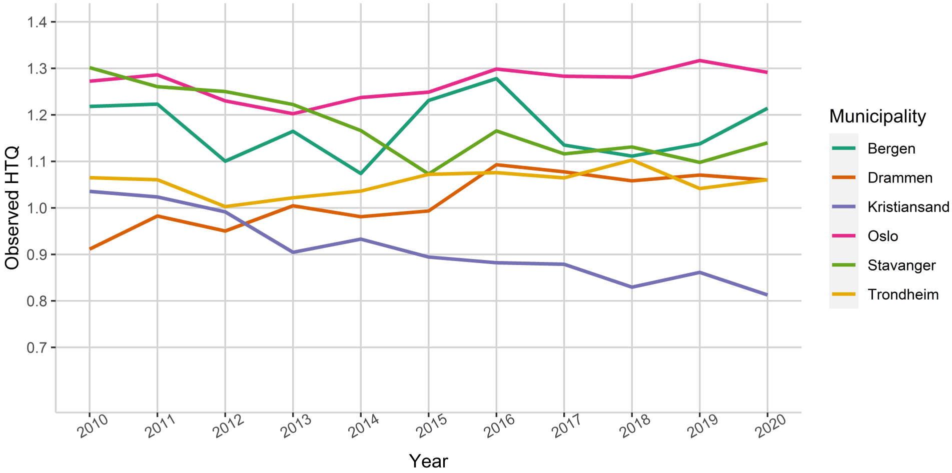


Source: Samfunnsøkonomisk analyse, own calculations.

Notes: The percent markup is calculated as $\frac{revenue-costs}{costs} * 100$ for the 15 largest firms operating in each city from 2013 to 2020.

We substitute the benchmark markup of 15 percent and benchmark land cost of 20 percent with observed markup and land costs.

Figure 9: Observed HTQ

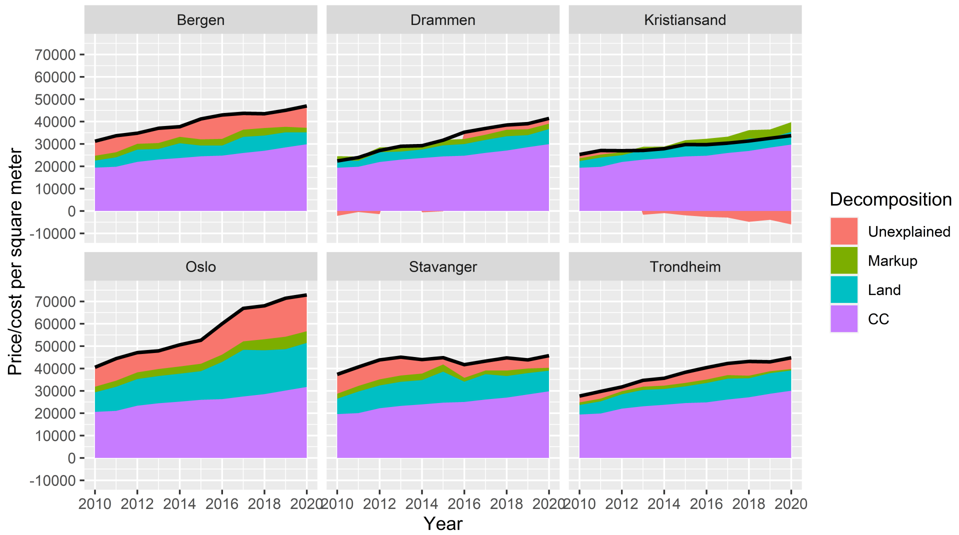


Source: Eiendomsverdi, Norsk Prisbok, own calculations.

Notes: Observed HTQ is estimated using new-home prices in the numerator and estimates of observed land costs and markups in the *mppc* in the denominator.

In Figure 9, observed HTQ is depicted with predicted new-prices and estimated land prices from the tear-down sales are depicted. In Figure 10, an alternative representation of the data is depicted; new-home prices are decomposed into construction costs, estimated land costs, and estimated entrepreneurial markups.

Figure 10: New-home prices decomposed



Source: Eiendomsverdi, Norsk Prisbok, own calculations.

Notes: The new-home price is depicted with the black line. The land price is median price per square meter interior, converted from price per square meter plot by the method described in Section 2.2. The entrepreneurial markup is calculated as $revenue/costs$ for the 15 largest firms operating in each city from 2013. For the years 2010-2014 three-year average 2013-2015 is used.

Construction costs account for the largest share of the house price for all cities. Land cost accounts for the second largest part of the price in all cities. Oslo and Kristiansand are at the opposite ends of the range of the land cost share, consistent with the hypothesis that local policies affect new supply. The estimated markup vary both across cities and over time, but represents a relatively small share for all cities. We note that there is a positive association between the share of unexplained and Tobin's Q. The high prices in Oslo are consistent with the centrality gradient hypothesis from the monocentric urban theory, but we are not able to fully decompose the high prices.

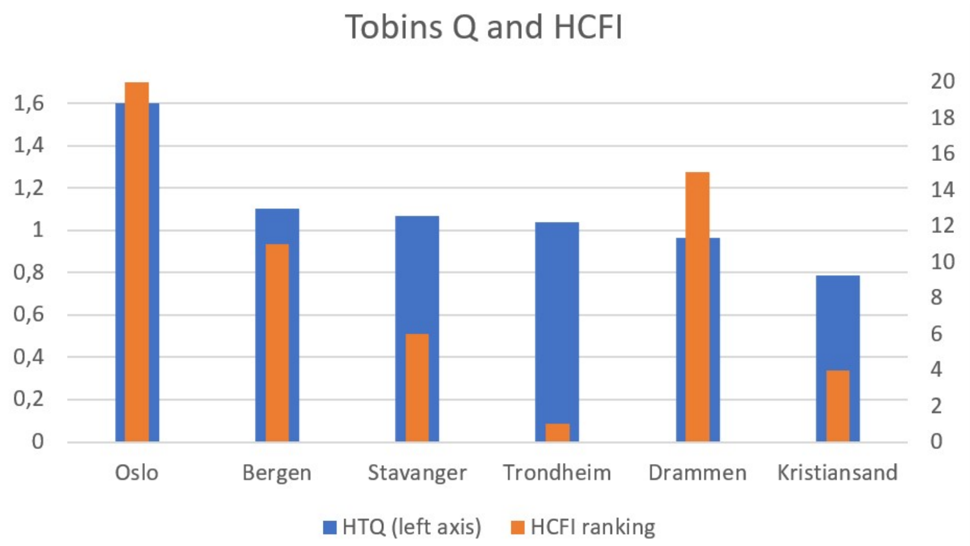
5 Discussion of findings

5.1 Facilitation for housing construction and Tobins's Q

To investigate the impact of supply side efforts made by city authorities on housing prices, we use the housing construction facilitation index (HCFI), which ranks Norwegian municipalities and cities according to scores of promotion and facilitation of housing construction.

Figure 11 shows that Oslo has the highest HTQ and ranks last among the 20 largest cities on the HFCI in 2020. Conversely, Kristiansand has the lowest HTQ and ranks as number 4 on the HFCI. In between, Bergen, Stavanger, and Trondheim have a HTQ of around 1 and medium to top ranking, respectively, by the HCFI. Drammen stands out with a HTQ just below 1 in spite of a weak performance on the HCFI. However, the HTQ has been rising in Drammen in recent years.

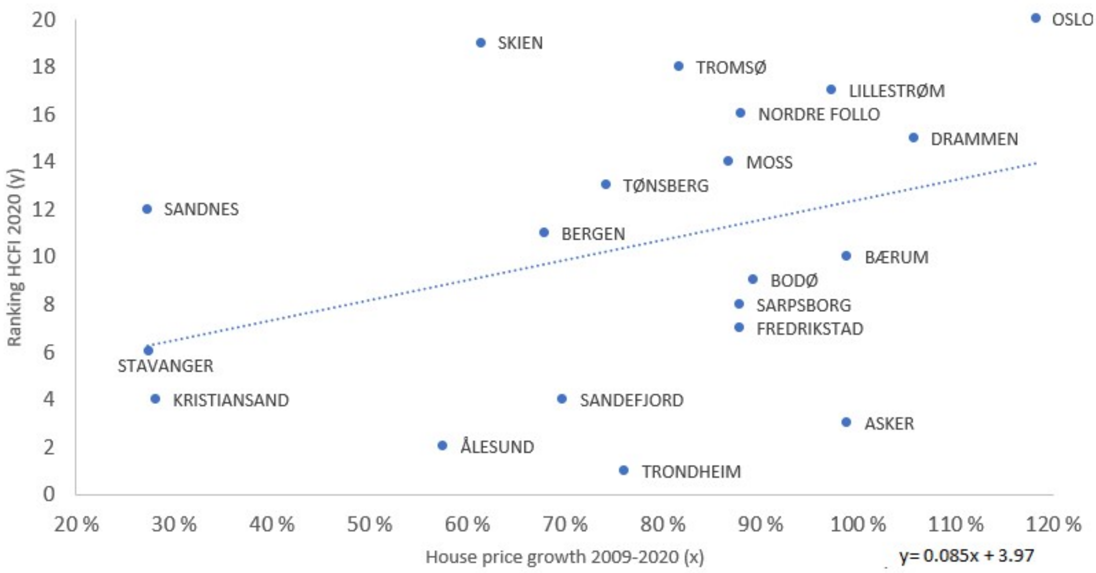
Figure 11: Housing Tobin's Q (HTQ) and ranking on the Housing Construction Facilitation Index (HCFI). 2020



Source: Benedictow et al. (2021), own calculations.

Notes: HTQ on left axis, rank , from 1 (best) to 20 (worst) on HCFI among the 20 largest municipalities and cities in Norway in 2020 on right axis

Figure 12: House price growth 2009-2020 and ranking on the Housing Construction Facilitation Index (HCFI) 2020



Source: Samfunnsøkonomisk analyse, Eiendomsverdi, own calculations.

Notes: Accumulated house price changes for all types of dwellings, from 2009 to 2020 on the horisontal axis and ranking on the HCFI from 1 (best) to 20 (worst) on the vertical axis. The 20 largest cities/municipalities in Norway in 2020.

Figure 12 shows the negative relationship between house price growth and ranking on the HCFI (low number means high ranking, which is associated with low price growth). Cities with a low ranking on the HCFI, as Oslo and surrounding municipalities Asker and Bærum, have high house price growth. Cities with a high ranking on the HCFI, as Kristiansand and Bergen, have lower house price growth.

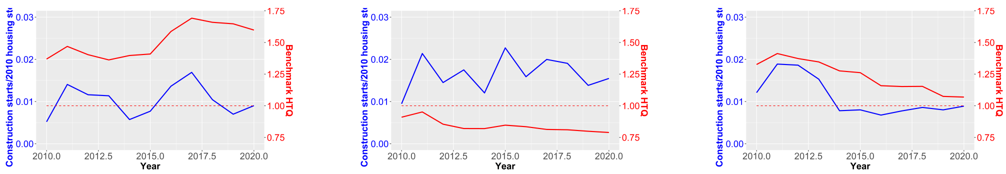
We interpret the association between a higher (lower) ranking on the HCFI and lower (higher) house price growth as supporting evidence of the hypothesis that Tobin's Q indicate a regulatory tax. The notion is that cities that allow policies that encourage new supply see lower house price growth, lower land price growth, and lower scores on Tobin's Q.

Glaeser and Gyourko (2018) distinguish between three types of markets: increasing market with inelastic supply, increasing market with elastic supply and a decreasing market.

Figure 13 shows the time-line of the benchmark Tobin's Q and construction starts over housing stock for Oslo, Kristiansand, and Stavanger, three cities with different characteristics: Oslo is an example of an increasing market with inelastic supply. Even though prices have been increasing more than the benchmark mppc, and benchmark Tobin's Q is well above 1 over the whole period, new housing supply, although volatile, does not seem to increase over time. Again, this is indicative of a regulatory tax. Kristiansand on the other hand, is an example of an elastic market. The city has a higher level of construction starts over housing stock than Oslo throughout the period and a decreasing benchmark Tobin's Q. Stavanger is an example of a market in which prices has fallen over a period of time. Stavanger has, initially, a high benchmark Tobin's Q and relatively high ratio of construction starts. Then, both measures decrease after the oil price decline in 2014.

Figure 13: Construction starts/2010 housing stock (lhs. blue), Tobin's Q housing (rhs. red)

(a) Oslo (b) Kristiansand (c) Stavanger

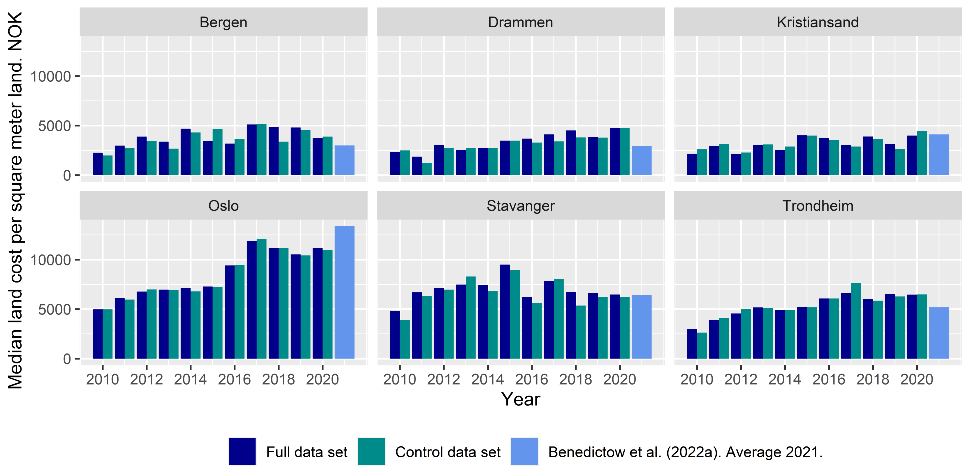


Sources: Eiendomsverdi, Statistics Norway, Norsk Prisbok, own calculations.
Notes: Housing stock contains all existing dwellings except residence and service residence for the elderly, student homes, other residential buildings for communities and non-residential buildings in 2010. Construction starts comparise the number of starts for the same types of dwellings; when building is started within the respective year. Benchmark HTQ is new-home prices over *mppc* for a detached house. In the calculation of benchmark *mppc*, land cost is set to 20 percent of total building costs and profit margin is set to 15 percent.

5.2 Sensitivity and Robustness

We test the robustness of our results, i.e. land cost per square meter plot, from the tear-down sales with a control data set and with data on land prices obtained from Benedictow et al. (2022a). We create a control data set in which we cross-check with land prices for observations that have registered new buildings on the property or a registered tear-down after the sale, or have any of the words development, building, dwelling, property in their firm name. Figure 14 shows the median price per square meter land from the full sample and the control data set. As shown, the full data set does not systematically under- or overestimate the price per square meter.

Figure 14: Land cost in NOK per square meter plot. Detached houses



Source: Eiendomsverdi, Benedictow et al. (2022a), own calculations.
Notes: The control data set includes observations that have registered new buildings on the property or a registered tear-down after the sale, or have any of the words development, building, dwelling, property in their firm name.

We also cross check our land price estimates with land price data from Benedictow et al. (2022a) for 2021, presented in Table 5 and included in Figure 14. Benedictow et al. (2022a) use data from the land registry obtained from Statistics Norway to measure land prices. On the first transfer of a newly constructed building that has not been put into use, a fee is paid on the land value, not the building. The land registry data includes the average plot size

Table 5: Plot data from the land registry. 2021

	Oslo	Kristiansand	Stavanger	Bergen	Trondheim	Drammen
Transactions	36	54	19	56	38	9
Plot price per sqm	13.375	4.113	6.416	3.002	5.188	2.951
Plot size sqm	340	462	462	583	397	689
Total plot price	4.550.175	1.898.972	2.962.267	1.750.766	2.059.117	2.031.766

Source: Benedictow et al. (2022a).
Notes: Average plot price per sqm and total plot price in NOK

and average plot price, both per square meter where a new detached house has been built, as shown for our six cities in Table 5.

It is fathomable that there exists an incentive for firms to understate the land value in order to reduce the tax basis. However, the land registry does not perceive this to be a major problem in practice: Professional developers and/or estate agents seem to comply with the regulations and appear to enter a correct land value in the deeds that are submitted for land registration. This practice is due to tax surveillance and enforcement: If the tax basis stated in a deed is exceptionally low, the deed will be returned with a request for a more detailed explanation of the tax basis.

Figure 14 shows that the land price estimates from Benedictow et al. (2022a) are quite in line with what we find using tear down sales.

6 Concluding remarks and policy implications

We calculate a Tobin's Q for the Norwegian housing market. The housing Tobin's Q is defined as the ratio of house price on minimum profitable construction cost. We find substantial differences in Tobin's Q across regions in Norway, and demonstrate that there is a positive association between Tobin Q's and hindrances on the supply side. Notably, Oslo, a city with stricter regulation than the median in Norway, has far higher Tobin's Q compared to Kristiansand, a city with more lenient regulation.

Our findings are based on rich data sets. We use transaction data to construct hedonic price indices, detailed data for construction costs, accounting data to estimate markups and estimates of regional building restrictions based on a large set of indicators.

Our finding that land cost in Oslo is very high is consistent with the notion that the high Tobin's Q in Oslo is a result of supply side limitations.

Our evidence does not support a claim that the high Tobin's Q in Oslo is due to a high markup for the developers. Oslo and Kristiansand have substantially different HTQs but relatively similar markups. We find evidence that land owners use an advantageous position to extract high prices for land in areas with high degree of regulations. Market reports indicate that contracts often contain a list of contingency plans that outlines different prices for different regulatory outcomes, i.e. a form of profit sharing between land sellers and builders.

We interpret the association between a higher (lower) ranking on the Housing Construction Facilitiation Index and lower (higher) house price growth as supporting evidence of the hypothesis that Tobin's Q indicate a regulatory tax. The notion is that cities that allow policies that encourage new supply see lower house price growth, lower land price growth, and lower scores on Tobin's Q.

These findings may come with policy implications. First, a stricter regulatory framework hinders new construction and implies higher house prices. In turn, higher house prices may prevent areas from realizing agglomeration benefits since some talented individuals may move elsewhere. Authorities may encourage and stimulate new construction by allowing more applications to be approved. Second, there are distributional ramifications. In areas with regulatory hindrances, land owners benefit from higher values of land. Again, allowing a more elastic supply side would dampen these distributional effects.

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A Appendix A. Estimating land cost per square meter interior.

To convert the land prices per square meter plot to land price per square meter interior we need to make assumptions on the floor-to-area ratio, number of stories built, and parking lot requirements which are set in the city's regulation plans. The floor-to-area ratios applied in the different cities are presented in Table 2. The ratio is set to 30 percent in all cities except for Oslo where it is set to 24 percent. We assume that the new construction is 2.5 stories tall on average. We extract 36 square meters for parking (equivalent to 2 parking spaces). First, we estimate the square meters interior that is possible to build on the median lot size sold in the respective year and city given our assumptions listed above:

$$int_{ct} = (sqml_{ct} * flr_c * st) - pa \tag{5}$$

in which int is the square meters interior, $sqml$ is the median lot size sold in city c in year t, flr is the reported floor-to-land ratio, i.e. the building's footprint as share of plot size, st, the number of stories built and pa, the square meters extracted for parking. The subtraction for parking space is done after the interior area is estimated because we assume that the parking lot is part of the construction, not an outside parking space. Second, we compute the rate between the total square meter interior and the square meter of land, $rate$:

$$rate_{ct} = int_{ct}/sqml_{ct} \tag{6}$$

Finally, we compute the price of land per square meter interior, $pint$, by dividing the median price per square meter land, $psqml_{ct}$, by the $rate$ obtained above:

$$pint_{ct} = psqml_{ct}/rate_{ct} \tag{7}$$

B Appendix B. Tables and Figures.

Table 6: Wage weights

Year	Oslo	Drammen	Kristiansand	Stavanger	Bergen	Trondheim
2010	1	0.88	0.91	0.92	0.89	0.90
2011	1	0.88	0.91	0.92	0.89	0.90
2012	1	0.88	0.91	0.92	0.89	0.90
2013	1	0.88	0.91	0.92	0.89	0.90
2014	1	0.88	0.91	0.92	0.89	0.90
2015	1	0.88	0.91	0.92	0.89	0.90
2016	1	0.88	0.91	0.92	0.89	0.90
2017	1	0.89	0.92	0.92	0.90	0.91
2018	1	0.90	0.92	0.91	0.90	0.91
2019	1	0.89	0.91	0.90	0.90	0.91
2020	1	0.89	0.90	0.90	0.89	0.90

Source: Statistics Norway
The wage weights are based on average monthly earnings for the aggregate of the construction industry by county. The cities are assigned their counties' wage level. Prior to 2016 we have assumed the same relative weights as in 2016. Oslo is normalized to 1.

Table 7: Material costs weights

Oslo	Drammen	Kristiansand	Stavanger	Bergen	Trondheim
1	1	0.97	0.98	0.99	0.99

Source: Norsk Prisbok
Notes: Norsk prisbok discloses regional weights annually in their report. However, apart from a shift in the weights between 2013 and 2014 the weights are constant over the years. We have contacted Norsk prisbok and consulted with their experts. As a result, we interpret the shift in 2014 as an update of information and use constant weights as they are presented after 2014.

Table 8: Estimation results, hedonic model in Equation 3

	Oslo		Bergen		Stavanger		Kristiansand		Trondheim		Drammen	
sqm interior	-0.005	**	-0.005	**	-0.005	**	-0.004	**	-0.004	**	-0.006	**
sqm interior squared	0.000	**	0.000	**	0.000	**	0.000	**	0.000	**	0.000	**
sqm land	0.000		0.000	*	0.000	**	0.000		0.000	**	0.000	**
agedec												
10	-0.083	**	-0.324	**	-0.356	**	-0.240	**	-0.231	**	-0.327	**
2	-0.040	**	-0.074	**	-0.114	**	-0.095	**	-0.053	**	-0.026	
3	-0.078	**	-0.175	**	-0.183	**	-0.146	**	-0.115	**	-0.138	**
4	-0.130	**	-0.240	**	-0.254	**	-0.233	**	-0.195	**	-0.229	**
5	-0.160	**	-0.291	**	-0.334	**	-0.319	**	-0.246	**	-0.289	**
6	-0.136	**	-0.315	**	-0.305	**	-0.359	**	-0.257	**	-0.313	**
7	-0.123	**	-0.340	**	-0.321	**	-0.365	**	-0.281	**	-0.326	**
8	-0.123	**	-0.343	**	-0.357	**	-0.379	**	-0.286	**	-0.366	**
9	-0.067	**	-0.308	**	-0.338	**	-0.201	**	-0.232	**	-0.287	**
Intercept	11.167	**	10.901	**	11.106	**	10.572	**	10.701	**	10.647	**
Number of observations	3638		3633		2637		2588		2963		2609	
Adjusted R-squared	0.85		0.65		0.58		0.65		0.75		0.75	

Notes: ** p<.01, * p<.05. The estimation results are from the hedonic model, Equation 3 described in Section 2.1. The estimation are done with the command areg in Stata, where zip code is absorbed. The age deciles are constructed using the full data set on transactions.

Table 9: Age deciles

Decile	Age
1	0 - 5 years
2	6 - 11 years
3	12 - 19 years
4	20 - 29 years
5	30 - 39 years
6	40 - 49 years
7	50 - 59 years
8	60 - 77years
9	78 - 106 years
10	107 - 149 years

Notes: The age of houses at the time of sale grouped by deciles that are used in Equation 3 and presented in Table 8. The age deciles are constructed using the full data set on transactions.

Acknowledgements:
Housing Lab is partly funded by the Norwegian Ministry of Finance and the Norwegian Ministry of Modernisation and Municipalities. Housing Lab also receives financial support from OBOS, Krogsveen and Sparebank1-Gruppen. We are greatful for the financial support. All views expressed in our papers are the sole responsibility of Housing Lab, and do not necessarily represent the views of our sponsors.

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ISSN: 2703-786X (Online)

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HOUSING LAB
Nasjonalt senter for boligmarkedsforskning