Master's thesis

NTNU
Norwegian University of Science and Technology
Faculty of Economics and Management
NTNU Business School

Emil André Karlsen

Tobin`s Q-ratio in Real Estate Finance.

An analysis of the development of Tobin`s Q-ratio on first-hand dwellings using repeated sales methodology.

Master's thesis in Economics and Business Administration
Supervisor: Are Oust
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Abstract

For many years, investors have been a huge part of first-hand dwelling projects, investing in a significant share of the dwellings on real-estate projects, often with the sole purpose of reselling them at a future point. The purpose of this paper is to use the framework of Tobin`s Q-ratio by creating a repeated sales model in combination with a hedonic price index to find the development in value through time for first-hand dwellings as they are resold on the market. The model will use first- and second-hand data of 2100 and around 60 000 dwellings respectively. The data will come from Trondheim and will develop a timeline displaying how the value of first-hand dwellings develop compared to the rest of the market. The information derived will be of value for investors that aim for profit when purchasing real-estate contracts to be resold in the market at a future point. Based on the fixed effects model that has been developed from Tobin`s Q-ratio investors can draw excess returns when reselling the contract purchased within the first two years, with a significant decrease in overperformance posterior to these first two years. The results were definite and showed a clear benefit of selling the contract on the dwelling within or around finalization of the project, implicating that the use of Tobin`s Q-ratio discovers underpricing of first-hand dwellings compared to second-hand dwellings.

Sammendrag

I mange år har investorer vært en stor del av førstehånds boligprosjekter ettersom de investerer i en stor andel av leilighetene i boligprosjekter, ofte kun med formål om å selge dem på et fremtidig tidspunkt. Målet med denne oppgaven er å ta i bruk rammeverket til Tobins Q-rate ved å lage en repeated sales-modell i kombinasjon med en hedonisk prisindeks for å finne Tobins Q-ratios utvikling over tid for førstehåndsboliger i det de selges videre på markedet i form av annenhåndsboliger. Modellen vil bruke første- og annenhåndsdata på 2100 og 60 000 boligsalg fra Trondheim for å utvikle en tidslinje som viser hvordan verdiutviklingen er sammenlignet med bevegelsene til resten av boligmarkedet. Informasjonen som hentes ut vil være av stor interesse for investorer som sikter på profitt ved kjøp av kontrakter i førstehånds boligprosjekter, for så å selge disse videre på markedet på et fremtidig tidspunkt. Ved å se på en fixed effects-modell utledet fra Tobins Q-ratio så kan man se at investeringer i førstehånds boligkontrakter vil ha meravkastning ved videresalg av denne kontrakten innen de to første årene sammenlignet med resten av boligmarkedet. Denne overytelsen vil avta signifikant etter de to første årene. Resultatene var klare, og viste en klar fordel ved å selge kontrakten til boligen innen eller rundt ferdigstillelse av prosjektet, noe som betyr at Tobins Q-ratio har funnet at det er en viss underprising av førstehånds boliger sammenlignet med andrehånds boligenheter.

Acknowledgements

This work will mark the end of my studies in Economics and Business Administration with a specialization in Finance and Investments at NTNU Handelshøyskolen. The thesis consists of 30 credits and is a mandatory part of the master's degree at NTNU Handelshøyskolen.

Researching and working on this thesis inside the topic of real-estate finance has been a rewarding and immensely interesting experience. Learning not only about the topic and the methodology utilized, but importantly about work-discipline and structure.

This thesis has been done with the help of my supervisor Are Oust from NTNU and I would like to express my deepest gratitude to him for splendid support and insight on both the topic of real estate as well as the process of structuring and constructing a paper of this format. Additionally, I am extremely grateful to Roar Munkhaugen from Heimdal Bolig, Håkon Lutdal from Eiendomsmegler 1 and Jørn Are Skjelvan from Kvaler for data utilized from this thesis and more than anything great wisdom on the topic.

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1.0 Introduction

Investors all over Norway purchase first-hand dwellings with the intention of reselling the dwelling at some future point to reap profits from the increased value. At the same time, the real-estate market in Norway and in every major city belonging to it has been growing both steadily and rapidly in the previous decades, shown through Krogsveen`s price index, surging almost 100% in Trondheim the last 15 years (Krogsveen, 2022, a). The initially described investments happen systematically on first-hand real-estate projects and many investors resell the dwellings before finalization of the project. The development in value of these dwellings compared to the second-hand market will therefore be an interesting and unique angle, and the idea of taking use of Tobin`s Q-ratio to better understand the development in value of these dwellings through time when they are resold is intriguing.

The aim of this article will be to utilize Tobin`s Q-ratio to analyze the development in value of first-hand dwellings compared to the second-hand market. The perspective will be from a real-estate investors side, to display how an investment in a first-hand dwelling will develop through time in terms of excess returns compared to their second-hand counterparts when reselling the asset. Moreover, the results can possibly detect if there are significant differences for the various dwelling types and size with regards to excess returns for investors. Many investors choose to buy dwellings that they then rent and keep for many years to then see the value appreciate over the years while others buy first-hand contracts to sell when the project is finalized. Results from this article can determine what investors with such strategies can expect in terms of returns compared to the rest of the market.

The literature surrounding the topic of this article will be based on the work of James Tobin (1969) and his work on developing the Q-theory as a model for investment. His work was later developed further by Hayashi (1982) when he studied the relation between the marginal and average Q-ratio. Jacobsen et al (2006) looked at the relation between investment in real-estate and supply and demand through the Q-ratio in Norway. A similar study was completed in Sweden and the UK by Barot and Yang (2002). Other studies have been done on the level of investment in real estate on an aggregate level such as Berger and Berg (2006), and Jud and Winkler (2003) among others. To my knowledge no other study has been conducted on the Q-ratios development through time on first-hand dwellings.

This paper will utilize first-hand data gathered from Heimdal Bolig (developer) and Eiendomsmegler 1 (real-estate agent) and second-hand data collected from Eiendomsverdi. The data consists of 2100 first-hand and around 60 000 second-hand dwellings respectively. To track the development of the Q-ratio of first-hand dwellings, repeated sales methodology will be applied to the data. The methodology was developed by Bailey et al (1963) and fits into the intention and use of Tobin`s Q-ratio. The repeated sales values will show how the value of the first-hand dwelling (replacement cost) develops when resold as second-hand dwellings (market value). The methodology is widely utilized when developing general housing indices such as Standard and Poor`s and the Federal Housing Agency (OECD et al, 2013). Moreover, hedonic methodology will be used in combination with the repeated sales ratio to create an index following the market movement for the timeframe of the data (2005-2021). After correcting the Q-ratio results with the market index they will showcase potential excess returns on first-hand dwellings making it comparable to the general market movement. Lastly, the datasets with both first-hand and second-hand transactions of the dwellings will make up a panel dataset, and to best model the potential effects of the various variables on the Q-ratio, a fixed effects model will be applied.

The results show that purchasing a first-hand dwelling contract as an investor, to be resold at a later point generally will outperform the rest of the market. Reselling within the first two years, or within or upon finalization of the project will be significantly more beneficial compared to the market, than waiting for a longer period. However, there are no definite results in either direction when speaking of type and size of the dwelling, where it will not be possible to conclude which dwelling type an investor should prioritize. The results from this article means that according to data from Trondheim, an investor purchasing a contract for a first-hand dwelling will expect to retrieve excess returns compared to the rest of the market when reselling the same dwelling within two years after the initial transaction.

This thesis is organized as follows, section 2 reviews relevant literature on the topic. Section 3 will present the two real-estate markets, both overall and specifically to Trondheim. Later in section 4 the reader will have the data presented, with relevant descriptive statistics. Section 5 describes the methodology to be utilized, before section 6 showcases the results. Lastly section 7 discusses and analyzes the results and section 8 will give a conclusion.

2.0 Literature review and theory

2.1.0. Tobin`s Q Theory

James Tobin can be described as one of the most important figures of modern financial theory. He proposed his Q-theory in 1969 which was a model he originally designed to replace or to serve as an alternative to the neoclassical model of investment. The neoclassical model of investment was for a long time the standard model for housing investment theory. Dale Jorgenson`s (1963) model used financing, taxes, and depreciation as the fundament for the cost of capital. He then applied Cobb-Douglas production function as a tool to solve for any company`s optimal capital stock. Derivating this into a function that showcases that investment will be determinant for any company`s optimal capital stock (Jorgenson, 1963). Later, Jorgenson found alternative formulations with similar outcomes and importance as the Q-theory. Over to the Q-theory, the ratio is found by taking the ratio of the market value of a new additional investment good to its replacement cost, meaning that the ratio can be applied to almost any asset type as a ratio on the market price above replacement cost (Hayashi, 1982).

The Q-theory has been applied on a wide scale to evaluate the investment in housing on an aggregate level in the respective countries, Berg and Berger (2006), Takala and Tuomala (1990), Jud and Winkler (2003) analyzed this in Sweden, Finland, and USA respectively. Sørensen (2006) applied Tobin`s Q-theory to data across countries to look for international co-movement in the market and found that the housing markets have become synchronized across borders. Schulz and Werwatz (2008) studied the housing investment models at a microlevel utilizing the Q-ratio to analyze the equilibrating relationship between replacement costs and market prices. In Norway, Jacobsen et al (2006) looked at the investment in real estate using Q-theory and the potential co-movement with supply and demand, and a similar study was conducted for Swedish and UK markets by Barot and Yang (2002). To my knowledge, there has not been any previous studies that utilize the Q-ratio to track the development of the Q-ratio through time for first-hand dwellings.

In theory, the norm would be to utilize marginal Q-ratio, which will be the ratio of the market value of adding one additional unit to the replacement cost. The marginal Q will be impossible to observe, therefore empirical research will take advantage of the average Q-ratio. The connection between the aforementioned Q-ratios relation were developed by Hayashi (1982). He stated that four conditions needed to be in place in order to have identical

average and marginal Q-ratio. These are perfect competition, the production function and installation function are linearly homogenous, and have constant scale yield. Lastly the capital market must be perfect.

After James Tobin developed the Q-theory, researchers have applied this theory to various asset types, as Tobin`s Q ratio is seen as a highly flexible and gives results that can be easily interpreted (Tobin, 1969). Simultaneously, it showed more satisfactory results compared to Jorgenson`s Neoclassical theory as it includes and accounts for adjustment costs. The same application can be done for the asset type in discussion here and it can be especially useful for this topic and methodology. The intention is to compare the market price of housing, which can be described as the second-hand market, placed on top of the fraction, to the replacement costs which will be seen underneath the fraction, and will be represented in this case by the cost of a newly developed dwelling. This utilization fits into the methodology of repeated sales which will be further developed in section 5.1 and appendix B1. The fraction for the Q-ratio would therefore look like this:

$$Q - ratio = \frac{Market\ value\ of\ dwelling}{Cost\ of\ a\ new\ dwelling} \quad (2.1)$$

Concerning this thesis, one can interpret the Q-ratio as follows. With a Q-ratio > 1, the investor should invest in the asset, as the market price would be higher than the cost of acquiring it (Jud et al, 2003). Meaning specifically that the price improvement of the first-hand dwelling will be higher than the comparative movement for the market. A high Q-ratio will mean that the market has a very high demand of the asset (dwelling) which in return would cause a surge in the value compared to the market, for the investor. On the other hand, a Q-ratio<1 would imply that the price development of the first-hand dwelling will be weaker than that of the market for the investor.

2.2.0. Which characteristics affect the price of a dwelling?

Outside of macroeconomic and political factors that lie outside the importance of this paper there are important characteristics on each individual dwelling. The asset class is heterogeneous, each dwelling will have very different characteristics, something that will appeal to very different people depending on their life situation (Cupal, 2017). Characteristics such as size (square meters), number of rooms, quality, location, balcony, parking, floor, age

and many more will have variating importance for potential buyers. This can lead to an insurmountable number of variables that can make the valuation methodology complicated both in terms of execution and interpretation. When considering the hedonic price method (HPM) that is famously used in real estate, some of the criticism towards it is concerning the high number of variables that can be extremely difficult to observe at times. In this part of the literature review the focus will be on which factors that are included and discuss which will be important on a general basis.

As mentioned previously, and something that will be developed more in appendix part B2, hedonic methodology utilizes numerous independent variables that adds to the dependent variable (price). The variables in a hedonic methodology regression will work in an additive manner to the dependent variable, for example, the variable for balcony will add a certain amount of value to the dwelling (often measured in square meter price). Lutdal and Brenden (2021) did a study on the preferred qualities when buying a first-hand dwelling. These types of assets are certainly of a certain guarantee in terms of quality, but there are other characteristics that matter. There are many qualities here that might not fit in a hedonic model, but characteristics or qualities such as the layout and/or quality of kitchen, balcony, parking, customization possibilities, storage volume, closeness to public transport among others are all given scores above 4 (out of 6) in importance in their questionnaire. These will be more qualitative variables in the eyes of the consumers and in general they can have some impact on the value of an asset in the eyes of the buyer/seller. When looking at it from a modelling perspective, Malpezzi (2003) found that the most common variables in hedonic pricing models were the following: Number of rooms and type (bedrooms and bathrooms), floor area (size), type of dwelling (attached, detached, number of floors, etc), availability and type of heating/cooling, age, structural features and lastly structural material used/quality of finish (Malpezzi, 2003; Herath et al, 2010).

3.0 Background

3.1.0. Real-estate market

The pricing of the housing market work through the basic economic principles of supply and demand as any other market. However, it is important to point out how essential this asset class is for most people, as its value has enormous importance and impact on almost every person. To use Norway as an example, real-estate is by far the biggest component when we calculate the fortune of most people. For more than 70% of the Norwegian citizens, real-estate will be the biggest part of the personal fortune (SSB, 2018). Telling us that it will have a huge impact on the economy of Norwegian citizens if the real-estate prices were to drop significantly, as real-estate traditionally and still has a high rate of leverage. The Financial Supervisory Authority of Norway "Finanstilsynet" has in later years shown alarming numbers regarding this debt ratio on their personal dwellings as a decline in value on these assets then can hurt the personal economy of big parts of the population (Lea, 2021; Lorvik, 2021; Løtveit, 2020). Even with these warnings, the population still make these "risky" investments in something as important as their home and the reasoning behind might be because it is regarded as an extremely sophisticated asset and very diversified. It is described as sophisticated because of its characteristic as an asset to have a long lifetime, and the asset itself is diversified because its usage, location, scale, age, and rights can come in various styles. Again, considering Krogsveen price index (2022, a), the reader can see that there is a clear upwards trend for real-estate with shorter recession periods during crisis times compared to other asset-classes, a reason for this might be the level of diversification in real-estate. This, in addition to its characteristics can lead to a feeling of decreased risk considering that the population has more risk compared to the investments in other assets.

The supply and demand of this asset class come with some specific characteristics. First, the supply will stay at a relatively stable level in the short term. It takes a significant amount of time to go through the process of planning, bureaucracy, and construction of first-hand dwellings, which will be the only method of adding to the housing supply. Ergo, the general price level in the short term will be controlled by the demand. Defining the long-term supply and demand is a very different task, as the level of construction will be adjusted to the demand over time following the increase in prices that a high-level demand will lead to increased supply and vice versa (Jacobsen & Naug, 2004).

3.2.0. First-hand market

First-hand dwellings are mainly sold as contracts prior to construction/during construction through the developer to get investment and liquidity for developing areas further and works to generate sufficient capital for the funding of existing and new projects. When the developers sell these shares in the project as dwellings, they will require proof of funding for the whole sum but will generally only collect 10% at the time of purchasing the contract. The rest will be due on the day of finalization of the dwelling. Different from second-hand dwellings, these assets are sold at a principle of first come first serve at a set price. This gives a sense of security and eliminates price risk for both developer and buyer (Obos, n.d.). The buyers have incentives such as price certainty and possibilities of participating in some customization of their own dwellings.

The process of planning, sale and development of a first-hand dwelling can be a matter of years. The planning starts with the long-term vision of the city from the local authorities as well as development wishes and plans from developers. Regulation can be a time-consuming element and there can be several different plans before a final plan is approved. As mentioned in the previous paragraph, the sales process usually starts before construction and can be up to 2 years before the dwellings will be ready. The remaining two steps has many details such as some customization and inspection opportunities from the customers perspective. Generally, the process follows this timeline, but the duration of each step might vary.

The profitability of projects has a dynamic but quite simple mechanism as they will be more profitable if the prices increase more than the costs (Jacobsen & Naug, 2004). If this development is positive, it is intuitive to think that there is more demand than the current supply the market can provide. The supply will generally be determined on how much construction there is, as this will be the added supply in the housing stock of any city. Consequentially real-estate developers will increase their production and gradually we will see a demand and supply that comes closer to each other.

3.2.1. Second-hand market

Descriptive statistics of this market will be developed in section 3.3.0. and as the reader will come to learn in that part, the second-hand market will be the dominant part of sales in real-estate. The platform that is used almost exclusively for sales on the market is Finn.no, as the owner Schibsted advertise of a near 100% market share in terms of real-estate sales on their webpage (Schibsted, 2013). Moreover, the process of selling a dwelling has been very similar for many years, with some new actors that try to work outside of these traditional methods. The traditional method has been to use a real-estate agent that again uses an appraiser to evaluate the asset as well as to evaluate the conditions of the dwelling. After all these formalities the dwelling is announced on Finn.no in most cases. The dwelling will then showcase for interested parties through a "open house" before an eventual English auction where the bidding starts low and increases as the bidders' "fight" until there is only one left with the highest bid (Khazzal et al, 2020). The dwelling will then be transferred to the buyer at a specific point in time fitting with the terms that buyer and seller agrees to. The process will normally be a matter of months from initiation and planning of sale with a real estate agent until the final sale, contrary to the first-hand process described earlier that can take years until completed.

Jacobsen and Naug (2004) tries to model the pricing mechanisms for second-hand dwellings under general terms. The model was tested using numerous variables and model types and the best one tested was when utilizing variables such as income, interest rate, tax rate, the difference between the expectations from households on their own and the country's economic situation with the explanation that can be explained through interest rate and unemployment. Moreover, they add the supply and unemployment rate as well as seasonal variables.

This model had significant results with good measures on most parameters that evaluate a quantitative model as such. Their own prediction ended up fitting nicely to the actual change in real estate prices (Jacobsen et al, 2004). One interesting factor that is very relevant with the current economic environment is that an increase in interest rate is something that in theory should lead to a decrease in the real-estate prices, but in terms of results show that this effect will only be important in the short term.

3.3.0. Real-estate market in Trondheim

The data used for this paper will come from the city of Trondheim this section will go through the characteristics of Trondheim as well as some statistical background to the real-estate market in the city. It will develop the average prices in both market types to get a better understanding of the magnitude and importance of both markets.

The city of Trondheim can be split into many smaller districts, but Trondheim Kommune grouped the city into 4 main districts. These are called Midtbyen (Center and west), Heimdal (Far west and south), Lerkendal (Center and East) and Østbyen (East). Erik Bolstad has developed lists showing the postal numbers and their belonging district (Bolstad, 2022). The dataset will therefore be split into these four districts in which the geographical categorizations will be based upon.

Trondheim has as the rest of the country had a reasonably stable increase in real-estate prices. As statistics from Krogsveen shows us an increase in average square meter price for dwellings in Trondheim has increased just under 100% the past 15 years (Krogsveen, 2022, a). This follows the increase on a country-wide basis of just above 105% in the same time span (Krogsveen, 2022, b). However, the higher value in this statistic nationwide will be largely driven by Oslo and the extreme development in and around the capital of Norway.

The price increase in Trondheim can come down to two factors, an increase in demand through for example an increase in the general population. Trondheim has for the past decades been one of the most rapid growing cities in Norway (excluding Oslo) increasing from just above 150 000 inhabitants at the beginning of the millennial to 210 000 at the end of 2021 (Trondheim Kommune, 2022). It is important to consider that Klæbu Kommune was added to Trondheim inside this interval, meaning that the number will be boosted marginally. However, this showcases the high demand that the average dwelling will have as without a significant increase in the supply of dwellings (increasing the construction of new projects) the prices will generally tend to increase.

The other factor will be the supply of dwellings, which was previously stated as steady and will change following the long-term demand. Looking at statistics from Trondheim Kommune in table A1 in the appendix, it will be possible to detect a long-term trend when speaking of the level of planned construction. At the same time, through table A2 in the

appendix the pattern of construction since 2006 is clearly visible (first-hand dwellings sold), following the socio-economic situation at the time. During the financial recession from 2008 to 2012, significantly fewer dwellings were developed in Trondheim, a fact that almost certainly will be accurate for almost any place in the world. Trondheim saw an increase up to around 1600 and 2000 dwellings developed yearly, compared to post-recession years of 2008-2011, which averaged about 700 per year. The period after the financial crisis has had extraordinarily high levels of construction compared to previous cycles in Trondheim and looking at the projections for the necessities in the decade of the 20`s the administration of the city predict that the level will decline to a more "normal" level. Again, through table A1 in the appendix, the suggested level following the increase in population will be around 1200 dwellings developed yearly (Trondheim Kommune, 2020).

Moving on to describe the market, the total number of dwellings sold throughout a year will consist of both first-hand and second-hand sales. The latter will make up the largest part of sales as it has been established that in the past years the city has developed between 1600 and 2000 dwellings per year. When looking at figure 1 underneath, the graph will indicate that apartments make up most the dwelling sales in Trondheim, as a majority of the population in Trondheim live in dwellings with such characteristics. As seen in table A3 in the appendix, apartments counts for 53 000 of Trondheim`s 108 000 inhabited dwellings (SSB, 2021). Lastly, throughout the last 15 years there has been an average of 6614 dwellings sold, ranging from below 5000 during the financial recession up to 7900 in 2020. The variation in the total number of sales look to be following the same socio-economic situation as mentioned above concerning the level of construction of first-hand dwellings.

Figure 1: Dwellings sold for the various dwelling types

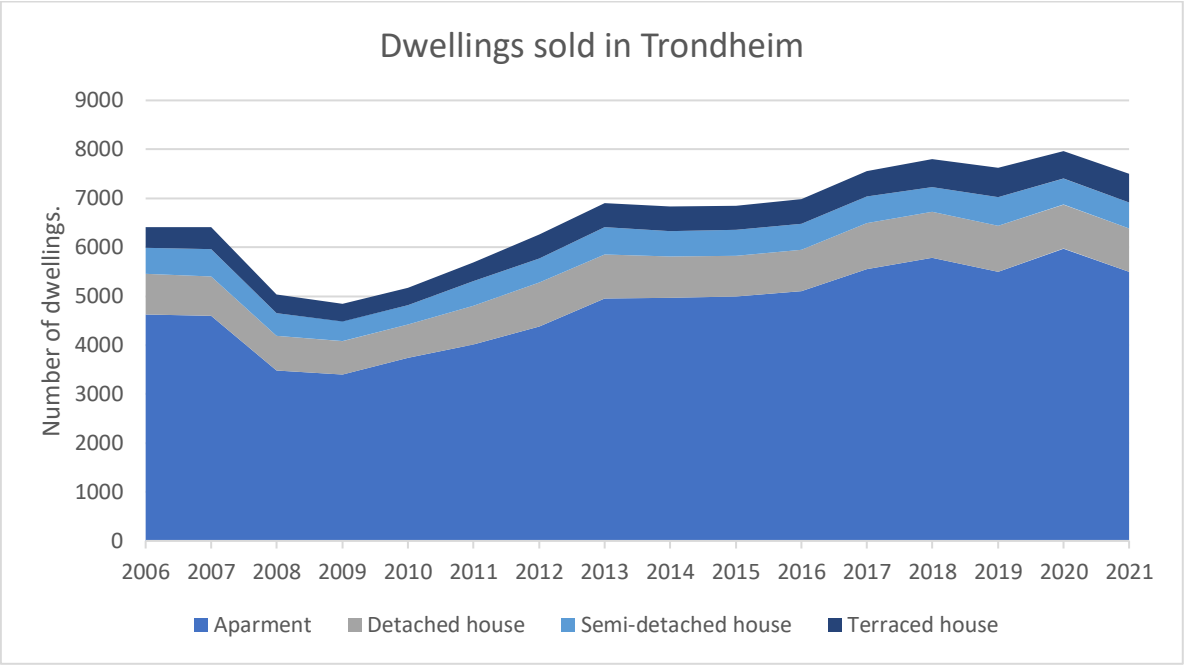

Figure 1: Total dwellings sold in Trondheim per year between 2006-2021 sorted by type of dwelling, data gathered from Eiendomsverdi.

As previously stated, second-hand sales will make up most of the total number of sales, which is effectively illustrated below in figure 2. Using the same data from Eiendomsverdi seen in table A2 of the appendix we can see a "normal" range in the share of new dwellings in total sales from 17% up to 25%. There are some extreme years on both ends with numbers as low as 9% and high as 33% but these have come under extreme circumstances, as we have established that the construction level takes time to adjust to the economic situation compared to second-hand sales which is a more flexible market. Likely to affect here is the fact that 30% of sales were first-hand dwellings in 2007, as second-hand markets quickly adjusted to the financial crisis. Because of this high number, it is likely that construction halted for many projects, as it hit an all-time low in this period of only 9% in 2009.

Figure 2: Dwellings sold for first-hand and second-hand dwellings.

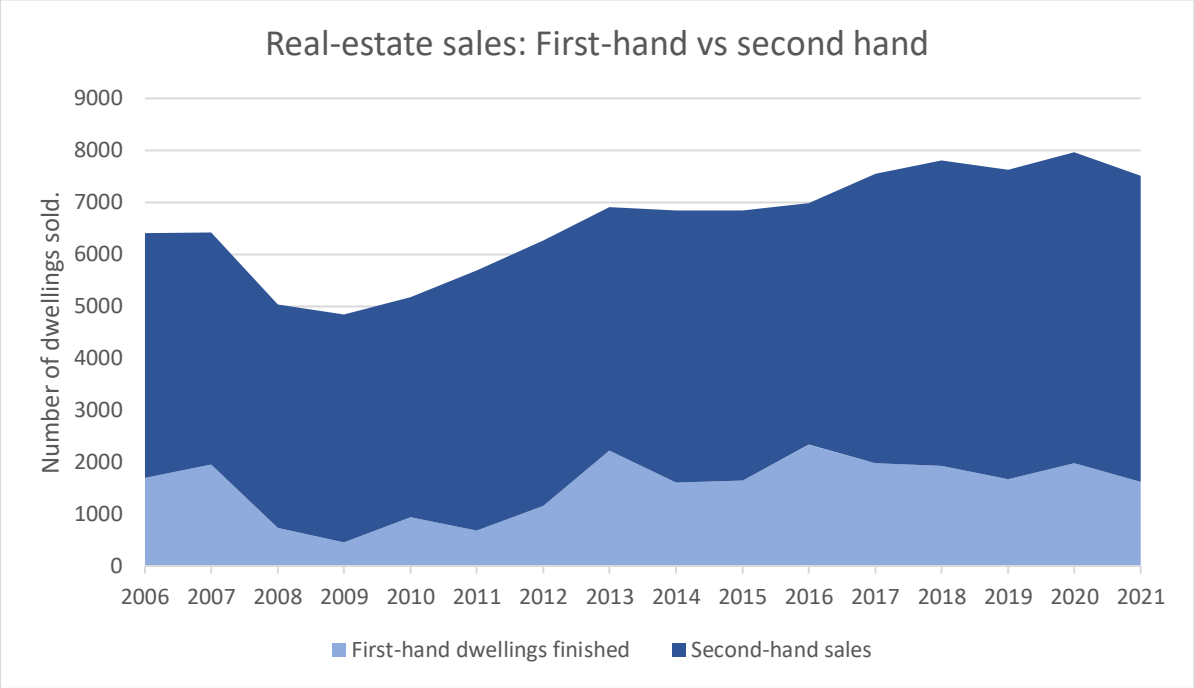

Figure 2: Dwellings sold in Trondheim per year between 2006-2021 divided between first-hand and second-hand sales. Data from Eiendomsverdi and Trondheim Kommune.

4.0 Data

One of the main issues when conducting analysis on the real-estate market, especially the first-hand market, will be the ability to gather data on dwelling contracts sold on first-hand basis at a unit level. The data will only have origin from the city of Trondheim. The main dataset (second-hand data) has been gathered from Eiendomsverdi with characteristics such as size, number of rooms, price, common debt, parking, balcony as well as time of sale. For the other datatype, first-hand dwellings, it was necessary to gather data straight from the developers or real-estate agents. The data was supplied by Heimdal Bolig (a developer) and Eiendomsmegler 1 (real estate agents). This led to a first-hand dataset consisting of more than 2100 dwellings and a second-hand dataset of around 60 000 dwellings after data cleaning. With data ranging from 2005 to 2021 the data will have robustness in terms of timespan. The first-hand dataset consists of projects from various neighborhoods of the city, from Ranheim (Østbyen) in the east to Heimdal (Heimdal) in the southwestern part of the city. A distinction of the various city districts was developed previously in chapter 3.3.0.

Cleaning the dataset from transactions that were missing information on price, size and sales date was the first step. Furthermore, observations with extremely low/high price and size will be removed, this will include any transaction above 20 000 000 NOK as well as above 200 square meters. On the other side datapoints with a price below 1 000 000 NOK and characterized with less than 15 square meters will be excluded from the analysis. This makes it possible to exclude unrealistic or mistaken datapoints, as well as private transaction with artificially low prices.

When combining the two datasets, they will have the initial transactions, the sale of the first-hand dwelling, as well as the repeated sales of the same dwellings through the second-hand data. This part of the data will establish a panel data set from the period 2005 to 2021. These will be the most important datapoints for this analysis, although the whole dataset will be utilized when applying the hedonic modelling.

Categorization of dwellings has been done through a collaboration with Kvaler and inspired from their service Boligmiks.no (Boligmiks, n.d.). They categorize dwellings in terms of the number of livable rooms and size in square meters (BRA or Prom both work in this context). The categorization of dwellings can be seen in appendix part A4.

4.1.0. Descriptive Analysis

Some statistics on the real estate market in Trondheim were presented in an earlier part (figure 1 and 2), the focus now will be on descriptive data derived from the datasets utilized for this thesis. The descriptive statistics will display how some of the important characteristics look for this data.

Table 1: Descriptive statistics for both datasets.

	First-hand sale			Second-hand sale		
	Number of dwellings	**Square meter price**	**Share**	**Number of dwellings**	**Square meter price**	**Share**
Location						
Midtbyen	372	33 813	18%	16 262	39 362	28%
Lerkendal	290	53 685	14%	10 949	33 303	19%
Østbyen	1 300	51 489	62%	22 156	41 905	38%
Heimdal	146	53 778	7%	7 250	29 157	12%
Outskirts	0	0	0%	1 640	27 057	3%
Total	2 108	50 039	100%	58 257	37 574	100%
Number of rooms						
1	134	63 625	6%	705	64 647	1%
2	665	50 041	32%	10 691	46 664	18%
3	978	48 568	46%	20 082	41 783	34%
4	329	48 917	16%	16 622	31 779	29%
5	2	43 624	0%	8 535	27 832	15%
6	0	0	0%	1 622	24 435	3%
Total	2 108	50 039	100%	58 257	37 574	100%
Size						
Very small (0-40)	412	51 378	20%	4 720	52 243	8%
Small (40-60)	655	53 735	31%	12 173	46 972	21%
Medium (60-80)	495	46 533	23%	13 599	40 253	23%
Medium L (80-100)	356	47 453	17%	7 858	36 071	13%
Large (100-120)	118	47 159	6%	5 583	31 474	10%
Very large (>120)	72	50 370	3%	14 324	25 414	25%
Total	2 108	50 039	100%	58 257	37 574	100%

Table 1: Descriptive statistics of the two datasets with the first-hand dataset being shown on the left-hand side with frequency, square meter price and share of observations on location, number of rooms and size being shown. On the right-hand side, the same statistics are shown for the second-hand sales.

Table 1 above describes many characteristics of these two datasets. One key takeaway from this table that will be logical both in terms of city development and economic theory, is that the new first-hand dwellings are both smaller and more expensive in terms of square meter

price than their second-hand counterparts. The housing needs has changed a lot, and more people move into smaller apartments compared to past decades (Trondheim Fylkeskommune, 2021). The tendency on size is confirmed in table 2 underneath, where first-hand dwellings have an average size around 60 square meters, compared to around 90 square meters for second-hand dwellings. Lastly, a lot of the data from the first-hand part will be from apartments in the district of Østbyen as prominent projects from Heimdal Bolig the past 15 years has been in the areas of Lade, Ranheim and Ringve which are areas inside Østbyen.

Table 2: Descriptive table on first-hand and second-hand sales.

	First-hand sale		**Second-hand sale**	
	Number of dwellings	Square meters	Number of dwellings	Square meters
2005-2008	360	57,12	6 564	98,08
2009-2011	50	64,40	7 800	97,94
2012-2014	454	75,23	10 892	97,72
2015-2017	417	62,56	12 577	92,41
2018-2021	827	58,30	20 424	88,78
Total	2 108	62,71	58 257	93,51

Table 2: Table showing size of dwellings divided between first-hand sale and second-hand throughout time passed of these datasets.

5.0 Methodology

5.1.0. Tobin`s Q-ratio

For this part of the methodology, it is important to consider what was written in the theory chapter, in section 2.1.0. Tobin`s Q-ratio will be found applying formula 2.1 from the literature review, which will consist of the market value of the dwelling, represented by the repeated sale (second-hand sale) at the top of the fraction. At the bottom the replacement value, which will be the price of the first-hand dwelling represented by the initial transaction of the dwelling. One can also describe formula 2.1 as below for the dataset in discussion here.

$$Q - ratio = \frac{Price\ of\ dwelling\ when\ resold\ on\ the\ market}{First{-}hand\ dwelling\ price} \qquad (2.1)$$

This showcases an application of the methodology repeated sales coming from Bailey et al in 1963, which is thoroughly explained in appendix part B1.[1] To find the data for the Q-ratio the two separate datasets described in the data chapter will be utilized, one contains second-hand data, and the other first-hand data. The data will be grouped up to see which first-hand transactions has one or more repeated sales within the specified timeframe of until six years after the initial transaction. For the data at hand for this paper a total of 689 repeated sales were found inside the six-year timeframe specified. The Q-ratio will then be calculated by using the repeated sales transaction price and dividing it by the initial sales price of that dwelling. The ratio will display the development in value in that sales interval.

To make the Q-ratio applicable to the research questions at hand, they need to be comparable to the market movement inside the same periods. The ratio will therefore be corrected towards the market movement by applying a hedonic price index. The hedonic model will take use of various characteristics on second-hand dwellings to replicate the market movement in the same timeframe as each individual Q-ratio results.[2] The Q-ratio at hand will be divided by the belonging market movement, meaning that it will showcase the development in value compared to the market inside the same timeframe. This is seen below in formula 5.1.

[1] $R_{iit} = \frac{B_{t`}}{B_t} * U_{itt`} \quad OR \quad r_{iit} = -b_t + b_{t`} + u_{itt`}$. Repeated sales formula found in appendix B1.

[2] $(P_{i,t}) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_n X_n + e$. The formula for a hedonic model found in appendix B2.

$$Adjusted\ Q-ratio = \frac{Q-ratio\ for\ X\ dwelling}{Market\ development\ for\ X\ dwelling\ in\ sales\ interval} \quad (5.1)$$

The process briefly outlined is explained more in depth in appendix part B2. The results will show how the Q-ratio develops through a sales interval variable, and by utilizing this variable it will be possible to see how an investment in first-hand dwellings will develop when reselling the asset on the market. As previously established in the literature review the market-corrected Q-ratio can be used as a guide to whether a first-hand dwellings investment will beat the market or not. A Q-ratio above 1 will indicate that the repeated sale of a first-hand dwelling will have an improved price development compared to the market, and vice versa.

5.2.0. Panel data modelling

The datasets for first-hand and second-hand dwellings respectively will in the end make up one dataset with several transactions for the same dwellings. This makes it a set of panel data, a combination of time series and cross-sectional data for which surveys a group, which in this case will be dwellings with repeated sales over period (Studenmund, 2020, p. 491; Okeke et al, 2016). To model panel data a fixed effects model and a random effects model can be applied.

Firstly, fixed effects model ensures that the panel data equations has enough dummy variables to be able to map each of the different intercepts of these cross-sectional entities which in this case will be the various dwellings with more than one sale (Studenmund, 2020, p. 493). When applying fixed effects modelling the variables in discussion will be time-demeaned for every unit, something that will make the estimator analyze the relationship between the Q-ratio and variables such as years between transactions, dwelling type, and sales year (Nesset et al, 2020). This will give us information on how these factors affect the ratio from a perspective of each individual variable.

If we assume that the unobserved effects will be correlated to our dependent variables, a fixed effects model will be preferable. However, if this is not the case, a random effects transformation will be preferred. The random effects model will have intercepts that are

based around a mean of intercepts, these will each form a random draw for the distribution. Therefore, each intercept will be independent for the error term of the observations (Studenmund, 2020, p. 501). To distinguish and determine which model to utilize, a Hausman test will be applied (Hausman, 1978).

The previously mentioned variables will form both a fixed and random effects model as described below:

$$Q - ratio = \alpha_i + \beta_1 X_{iy} + .. + \beta_k X_{iyk} + \beta_2 X_{ic} + .. + \beta_k X_{ick} + \beta_3 X_{isy} + .. + \beta_k X_{isyk} + U_{ik} \quad (5.2)$$

For the equation above, α_i represents the constant of the regression, while X_{iy} will show the dummies for the variable years, consisting of time between the sales. X_{ic} will form the dummy variable for the eight dwelling categories. Lastly, X_{isy} represents sales year of transactions which then will showcase the evolution of the Q-ratio for the various sales years. β_k represents the k-number of dummy variables that will be a part of each variable ranging from years to dwelling categories.

6.0 Results

This segment will start off with the Q-ratio results describing the timeline, types and the development of the ratio throughout the timeframe of this data. Moreover, it will show the regression results for the fixed effects model and random effects models. The results for the hedonic regression model can be found in the appendix part C3.

6.1.0. Tobin`s Q-Ratio results

To start off for the results, the overall Q-ratio throughout the timespan of the datasets is displayed below in figure 3. The Q-ratio below shows that the average level of the Q-ratio will vary between years, varying from below 1 for some years such as 2008 and 2014, to above 1.10 in 2005 and 2009 among others.

Figure 3: Overall Tobin`s Q-ratio

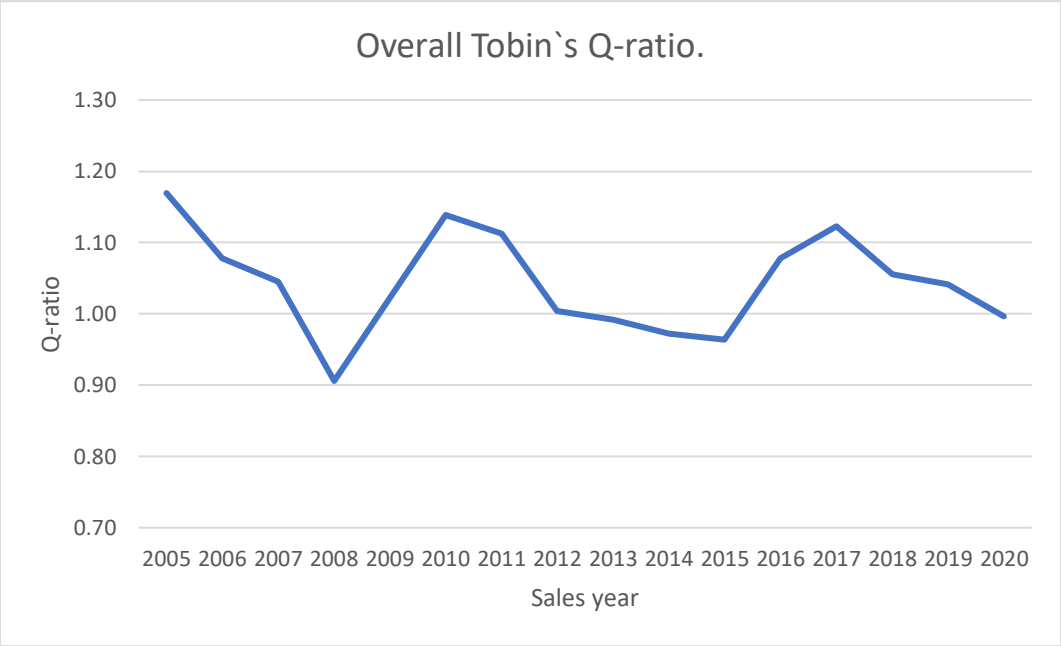

Figure 3:The average Tobin`s Q-ratio adjusted for the market index through time from the beginning of the dataset (2005) until the last year with Q-ratio results (2020). The graph displays the average ratio through all sales intervals. Tobin`s Q-ratio is found by applying formula 2.1 and 5.1.

The results for the average Tobin`s Q-ratio will show the ratio from years 0 to 6 from the initial transaction which will show the general trend for the data utilized. The results will consider all transactions in this timeframe, including repeated sales beyond the second sale if it occurs inside the first six years after the initial transaction. As described previously, the second-hand sale represents the market value of the asset which will be the numerator, also referred to as the market value in Tobin`s Q. The first-hand sale will at the same time

represent the replacement and will be in the denominator. First, the overall movement of Tobin`s Q-ratio is illustrated below in figure 4, derived from table C1 in the appendix and it is possible to detect a clear trend where the asset has the highest index value compared to the market one year after the asset or contract is purchased.

Figure 4: Tobin`s Q-ratio through time.

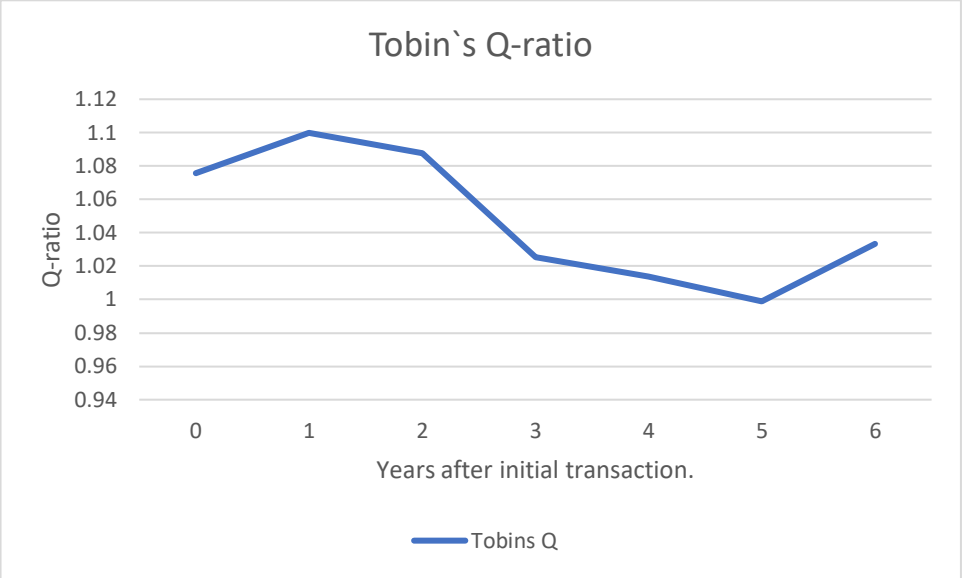

Figure 4: Q-ratio adjusted for the market movement for all dwellings from year 0 to 6 after first-hand sale. Year 0 indicates a sale inside the first year after the contract purchase, the following years follow the same methodology. The numbers are derived from table C1 in the appendix.

Subsequently, below in table 3, the Q-ratios for the different types and years are presented for the first six years after the initial transaction. Moreover, the total number of dwellings associated with each characteristic presented is featuring and there is also a table for the ratio for the various districts of Trondheim in appendix table C2. These ratios have been "corrected" by using the market development in the same way as described before, therefore the values seen will be in relation to the market.

Table 3: Tobin`s Q-ratio for dwellings characteristics.

Q-ratio for dwelling type								
Type - Years	**0**	**1**	**2**	**3**	**4**	**5**	**6**	Number of dwellings
1 room	1.1356	1.2106	1.1164	1.0643	1.0412	1.0853	1.0179	46
2 room <50 Sqm	1.1089	1.1229	1.0896	1.0595	1.0684	1.1112	1.1398	198
2 room >50 Sqm	1.0601	1.0267	1.0592	0.9325	0.9454	0.8842	0.9854	53
3 room <70 Sqm	1.0745	1.0892	1.1140	1.0522	1.0629	1.0225	0.9810	179
3 room >70 Sqm	1.0478	1.0453	1.0536	0.9728	0.9800	0.9373	0.9912	147
4 room <90 Sqm	1.0840	1.1130	1.0293	1.0662	0.9410	1.0382	0.9980	26
4 room >90 Sqm	1.0556	1.0256	1.0155	0.9715	0.9240	0.8827	1.0747	39
5+ rooms							1.1501	1
Q-ratio throughout time								
Year - Time	**0**	**1**	**2**	**3**	**4**	**5**	**6**	Number of dwellings
2005	1.1185	1.2005	1.1927	1.1491	1.1266	1.1957	1.1834	107
2006	1.1187	1.1322	1.0948	1.0069	1.0008	1.0753	1.1197	28
2007	1.0702	1.1369	1.1441	0.9686	1.0156	0.9792	1.0048	52
2008				0.9059				1
2009	1.0543	1.0145	0.9693	1.1074	1.0079	1.0687	0.9282	20
2010		1.1655	1.0915	1.0002	1.0499	1.1781	1.3466	16
2011		1.2012	1.1195	1.0577	1.0736			12
2012	1.1579	1.0561	1.0620	0.9868	0.8890	0.9060	0.9677	87
2013		1.1325	1.0562	0.9985	0.9182	0.9456	0.9006	55
2014	1.0839	0.9834	0.9415	0.9433	0.9585	0.9467	0.9488	37
2015	1.0714	1.0274	0.9637	0.9672	0.9758	0.8834	0.8608	23
2016	1.1678	1.0903	1.0930	1.0446	1.0521	1.0211	-	65
2017	1.1255	1.1490	1.1214	1.1413	1.0762	-	-	50
2018	1.0459	1.0783	1.0646	1.0316	-	-	-	98
2019	1.0312	1.0402	1.0543	-	-	-	-	30
2020	1.0274	0.9658	-	-	-	-	-	9

Table 3: Q-ratio adjusted for the market movement for different dwelling types from year 0 to 6 after first-hand sale. Year 0 indicates a sale inside the first year after the contract purchase, the following years follow the same methodology. The table also shows the Q-ratio for the timeframe inside these two datasets as well as the N of the characteristics.

Taking a closer look at the numbers above in table 3, there are definitely very interesting results. Starting at the top, on a general basis the trend shows that smaller dwellings with fewer rooms perform better in comparison to the market than their larger counterparts. The trend seen in figure 4 and 5 is replicated at some level through all types and years, showing a

clear dip posterior to year 2 specifically. When looking at the data for the various sales years, it is possible to detect that the ratio has large intervals as the ratio has some degree of variation across years. Below in figure 5 the variation is illustrated graphically, and overall, the trend earlier described, with a Q-ratio peaking inside the first two years is still at place, with a few outliers like 2010 and 2006.

Figure 5: Tobin`s Q-ratio from 2005-2019

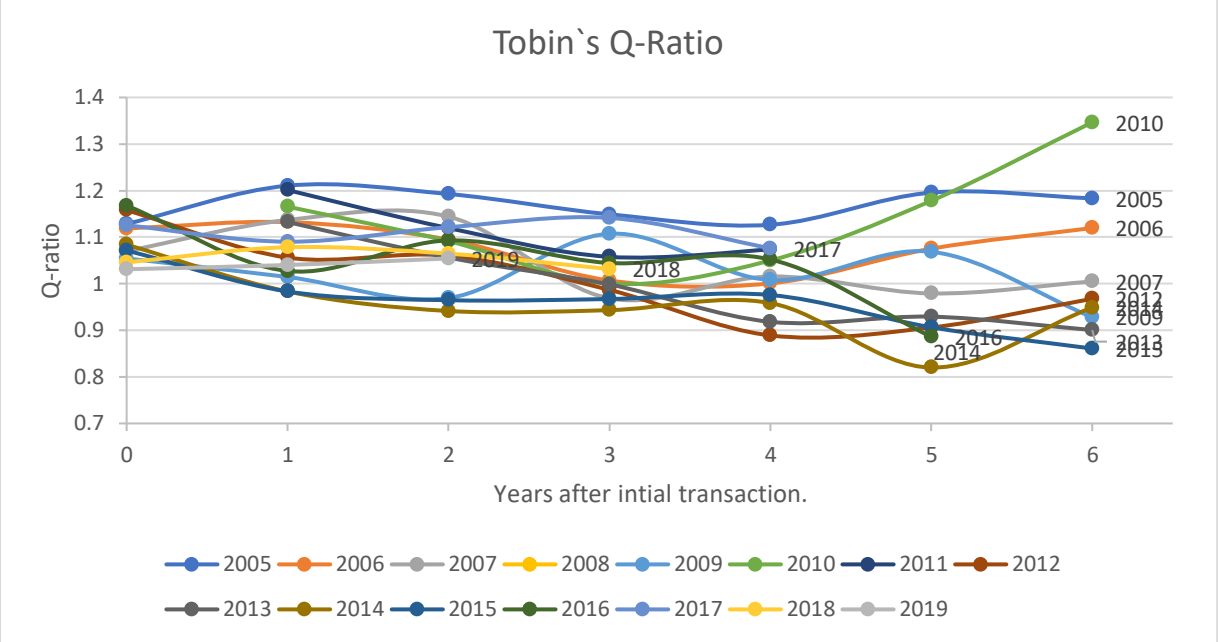

Figure 5: Graphical illustration of the development of the Tobin`s Q-ratio adjusted for market movement throughout time during the span of these datasets (2005-2019). The year 2020 was dropped for this graph as the year gave little illustrative purpose. Year 0 indicates a sale inside the first year after the contract purchase, the following years follow the same methodology.

6.2.0. Tobin`s Q Ratio - Fixed effect results

The results from the fixed and random effects can be seen in table 4 below. The model has been applied as described in the methodology chapter, while trying the model both with and without the variable for sales year. In addition, a robust fixed effects model was run as issues with heteroscedasticity was present in the model.

Table 4: Fixed and random effects models.

	Reg 1 - FE	Reg 2 - RE	Reg 3 - FE	Reg 4 - RE
Constant	1.0076	1.2605	0.9740	1.2457
	(29.16)***	(34.28)***	(7.65)***	(39.97)***
Years				
1	0.0449	0.0028	0.0997	0.0019
	(0.69)	(0.09)	(0.95)	(0.07)
2	-0.1239	-0.0218	-0.0538	-0.0162
	(-2.83)***	(-0.78)	(-0.75)	(-0.65)
3	-0.1614	-0.0501	-0.1414	-0.0539
	(-2.91)***	(-1.79)*	(-1.97)**	(-2.19)**
4	-0.1351	-0.0567	-0.1553	-0.0656
	(-1.77)*	(-1.84)*	(-2.10)**	(-2.48)**
5	-0.1851	-0.0851	-0.1930	-0.1008
	(-3.58)***	(-2.62)***	(-3.10)***	(-3.53)***
6	-0.2416	-0.0717	-0.2216	-0.0789
	(-3.74)***	(-2.14)**	(-3.54)***	(-2.74)***
Year				
2006	-0.1616	-0.0726	-	-
	(-2.45)**	(-2.81)***		
2007	0.1540	-0.1181	-	-
	(3.83)***	(-4.28)***		
2008	Omitted	-0.2137	-	-
		(-4.26)***		
2009	-0.2010	-0.2077	-	-
	(-3.75)***	(-6.04)***		
2010	-0.1468	-0.0090	-	-
	(-3.94)***	(-0.13)		
2011	-0.0677	-0.1600	-	-
	(-1.88)*	(-2.61)***		
2012	0.0421	-0.1912	-	-
	(0.58)	(-3.52)***		
2013	0.1405	-0.1550	-	-
	(1.52)	(-2.71)***		
2014	-0.0072	-0.1655	-	-
	(-0.07)	(-2.64)***		
2015	0.0813	-0.1155	-	-
	(0.76)	(-1.71)*		
2016	0.1282	-0.1046	-	-
	(1.35)	(-1.79)*		
2017	0.0293	-0.0616	-	-
	(0.23)	(-1.11)		
2018	0.5183	-0.1402	-	-
	(3.99)***	(-2.49)**		
2019	0.1894	-0.1434	-	-

	(1.99)**	(-2.58)**		
Dwelling type				
2 rooms < 50 sqm	0.0262 (0.44)	0.0073 (0.47)	0.0262 (0.44)	-0.0218 (-1.37)
2 rooms > 50 sqm	0.5291 (6.13)*	-0.0829 (-4.25)***	0.5291 (6.13)*	-0.1425 (-8.02)***
3 rooms < 70 sqm	-0.0449 (-1.48)	-0.0158 (-1.09)	-0.0449 (-1.48)	-0.0410 (-2.63)***
3 rooms > 70 sqm	0.3713 (4.42)*	--0.0548 (-3.55)***	0.3713 (4.42)*	-0.1011 (-6.57)***
4 rooms < 90 sqm	Omitted.	-0.04934 (-1.64)	Omitted.	-0.0834 (-2.51)**
4 rooms > 90 sqm	Omitted.	-0.0434 (-1.06)	Omitted.	-0.0805 (-1.73)*
R-squared:				
Within	0.8805	0.3088	0.4616	0.1161
Between	0.0518	0.3799	0.0198	0.2689
Overall	0.0441	0.3757	0.0157	0.2615
Rho	0.9604	0.6832	0.7947	0.4447

*Table 4: *** P< 0.01. ** P < 0.05. * P < 0.10. Shows the results for the fixed effects model (represented by FE) and random effects model (RE). Shows how the models performs with the variable's interval between sales, sales year, and dwelling type. The variable for city district was omitted because of collinearity and will not be present for these results, the same can be said about year 2008 as well as 4- and 5-room dwellings for the fixed effects models.*

A Hausman test was run on the data to find which of the two model types were most fitting, and this test rejects the random effects model, preferring the fixed effects modelling.[3] Accordingly, the focus will be on the fixed effects model from table 4. Based on the previous results, and the belonging hypothesis derived from them, the ratio should have significantly higher numbers for the first two years as well as for smaller dwellings with fewer rooms. The results from this model show few significant results in terms of dwelling type and has positive coefficients with just one exception, showing that results from the fixed effects model will be insignificant for dwelling type. The coefficients belonging to the sales intervals are negative for all years in comparison with year 0 with one exception which is in year 1 which is fairly similar to previous results. The overall R-squared is low for the model with only 0.0441 overall. Rho gives a value of 0.9604 which tells us that the correlation among observations on the dwellings is at 96%.

[3] Hausman specification test statistics: $X^{2(23)} = 69.03$. Prob. > $X^2 = 0.0000$.

7.0 Discussion and analysis

The results presented in the previous chapter gives inspiration to some interesting discussions for the research questions established in the introduction. Specifically, the intention was to look at first-hand dwellings price development as they become second-hand assets through Tobin`s Q-ratio, analyzing how the value develops compared to that of the market from an investor's perspective.

Firstly, the results display a clear development with higher ratios the first two years compared to the successive period, this is reflected all the way through the hedonic model in appendix table C3 as well as the fixed effects model with significantly higher ratios in the beginning. The results in figure 4 is further supported by the panel regressions in table 4 as well as the hedonic model presented in appendix table C3. However, when analyzing the trend from a yearly perspective, one can identify some years that have a deviation from the trend. Seen in figure 3 and 5, 2014 and 2015 respectively has a downward trend from the beginning, including ratios below 1 in this period. The same analysis can be drawn from figure 3, showing that even on average numbers, the Q-ratio will vary significantly on a yearly basis. Reiterating, Q-ratios above 1 on a general level signifies that the first-hand dwelling value development will exceed that of the market, while ratios below 1 will indicate that the dwellings` value developed worse than the market.

The result has significant impact to what an investor, or another interested party would consider when purchasing and eventually selling first-hand contracts in terms of timing. As mentioned in the introduction, many investors sell their first-hand dwellings before or at finalization of the project. Selvaag Bolig projects this to be around half of all investors and it would be quite safe to assume that this is the case for other developers as well (Akerbæk, 2017). One of the reasons for investors selling the dwellings before finalization will be that the investor will have an exception to a documentation fee that only will be applicable if the dwelling has been inhabited (Norges Eiendomsmeglerforbund, 2015). According to the data gathered for this paper and the models developed I can say that these investments will have excess returns, and on a general basis will perform better than the rest of the real estate market inside this timeframe. The fact that the Q-ratio is high upon finalization suggests that customization and the eligibility of upgrades in certain parts of the dwelling might not be considered of very high value for dwelling buyers as many will pay a considerably more when purchasing the asset around finalization. An additional explanation to the high initial

ratios can be the fact that investors knowledge and experience might be of a significant factor. As these are likely to be overrepresented for the initial sales (as they often sell within project finalization) the results of investors having better knowledge on which dwellings that are exceptional investment objects compared to the "normal" buyer. A buyer that purchases a dwelling with the intention of living there will be more likely to be represented in the later years, meaning that there is a possibility of high representation of these buyers in later years compared to investors. Looking at the intention behind the purchase of a first-hand dwelling and its belonging Q-ratio might be of interest for a future study.

Posterior to the initial period of high ratios in comparison to the market, it would be natural that the ratios have a reversion towards 1, as the dwelling will gain more of the characteristics of a second-hand dwelling. The results seem to concur with the previous statement, with negative significant variables as well as average values for sales intervals of two to six years much closer to 1. There are several plausible justifications to the downward trend, as it is plausible to believe that this comes from reverting towards the rest of the market movement, while still retaining some excess returns comparable to second-hand dwellings. Moreover, a potential "key-effect" might be in place, as dwelling-buyers will perceive the dwelling as used once the dwelling has been finished and utilized by another party. Although much smaller, and less significant than for goods such as cars, it is possible to argue that there is an effect on this ratio, shrinking the excess returns when another individual has utilized the dwelling. Causing that the Q-ratio reverts closer to 1, meaning that the excess returns comparative to the market will be lower or even non-existent.

Next, one can argue that there are many more possible explanations as to why buying first-hand dwellings to then resell them can give excess returns. Primarily, first-hand dwelling contracts are usually first sold at a set price, meaning that one would avoid any potential high stake bidding round for the dwelling. When resold this would not be the case. Levin et al (2007) found that the sales price will increase in an English auction as the numbers of bidders on a dwelling increase, a similar conclusion can be derived from Easley et al (2004). This could indicate that the absence of an English auction for first-hand dwellings could be one of the factors that leads the price to be lower than when the contract or dwelling is resold. One last factor to consider when discussing this element will be the time factor, as buyers of a first-hand dwelling will be recognizing the time between purchase and finalization. It is plausible that buyers of second-hand dwelling will be in a different need in terms of time

when purchasing a dwelling. Causing that the willingness to pay increases significantly as the buyers will have a risk of either continuing to live at their current dwelling or potentially not having a dwelling to live in. Many potential bidders with this sense of risk can lead to a high stake bidding war, pushing the price upwards. Furthermore, it should be recognized that there probably should be a benefit in terms of reduced price when investing or buying a dwelling with such a long interval between purchase and finalization. Consequentially, there should be a discount for buyers of contracts, incentivizing the fact that they are placing and guaranteeing capital equal to the price of the dwelling. Many might have assumed up until now that this discount has been countered by the "exclusiveness" and customization possibilities a buyer draws from purchasing a first-hand dwelling. Nevertheless, results from this thesis indicate that there are clear benefits to retrieve from purchasing a contract to later resell the asset upon finalization, meaning that the discount discussed will be of a significant nature when reselling the asset.

One cannot say that the results are as uniform when speaking of type and size of the dwelling. Melser et al (2014) discovered that on a general basis the smallest and largest dwellings would give the highest excess returns. These results are partially in line with Carson (1990), who discovered that returns were stronger for large and expensive dwellings. The early results from the Q-ratio average numbers and hedonic modelling in appendix C3 indicated that smaller dwellings with fewer rooms gave significantly higher ratios. However, given the results from the fixed effects model it is not possible to conclude with the same result, as there are both insignificant differences between reference point (1 room) to most of the other types (small 2- and 3-room) and the large counterpart for the same types has significant and positive coefficients. The results do not fall in direct line with the aforementioned studies and one cannot conclude with significant differences between dwellings types and sizes in this paper.

8.0 Conclusion

The results discussed in this paper should be applicable to other cities in Norway, as there has been an almost uniform movement in the real-estate market across major cities. Tracking back to the intended findings, the paper aimed to investigate the first-hand dwelling prices and how they developed as they were resold on the market. In this case I wanted to look at the results from an investor's perspective, to see how investors in first-hand dwelling contracts returns would compare to the market through the first six years as well as concerning the various dwelling types.

The fixed effects model on Tobin`s Q-ratio did not find significant differences on the various dwelling types, meaning that according to this data one cannot differentiate the development in price of first-hand dwellings on the types and sizes specified in this thesis. In terms of development through time, the modelling has found a significantly higher Q-ratio, above 1, the first two years after contract purchase, with a significant reversion towards 1 posterior to these initial years. Meaning that an investor can purchase a first-hand dwelling contract at sales start, to then resell it within the first two years and derive excess return compared to the market development in real-estate. This indicates that the investor should resell the dwelling upon or within project finalization in order to reap the highest increase in value compared to the market. These findings are to my knowledge unique, as the Q-ratio has not been utilized for this purpose in any previous study. This investment strategy has been common among investors for a long time, understandably so, as this thesis detects significantly better performance than the market.

A suggestion for further investigation on this topic would be to research the various buyers of the dwellings and who resell their dwellings at what time. This would potentially detect if investors performed better than others, buying the dwellings that are more underpriced compared to the market as well as potentially discovering these specifically underpriced dwelling-types.

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Appendices

Appendix A:

Table A1: Projections for population growth and Housing need in Trondheim according to Trondheim Kommune. (Trondheim Kommune, 2020)

	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	Average	Sum
Population growth	2293	2082	2055	1986	1890	1882	1887	1884	1881	1884	1871	2059	24 713
Housing need	1320	1173	1167	1145	1117	1125	1126	1129	1129	1131	1124	1189	14 270

Table A2. Dwellings sold in Trondheim the last 15 years. Data from Eiendomsverdi.

Year	First-hand dwellings finished	Second-hand sales	Total	% First-Hand	% Second-Hand
2006	1 690	4 717	6 407	26,38%	73,62%
2007	1 949	4 467	6 416	30,38%	69,62%
2008	734	4 298	5 032	14,59%	85,41%
2009	453	4 385	4 838	9,36%	90,64%
2010	934	4 242	5 176	18,04%	81,96%
2011	681	5 010	5 691	11,97%	88,03%
2012	1 153	5 110	6 263	18,41%	81,59%
2013	2 219	4 682	6 901	32,15%	67,85%
2014	1 606	5 232	6 838	23,49%	76,51%
2015	1 640	5 204	6 844	23,96%	76,04%
2016	2 332	4 651	6 983	33,40%	66,60%
2017	1 973	5 581	7 554	26,12%	73,88%
2018	1 928	5 872	7 800	24,72%	75,28%
2019	1 669	5 956	7 625	21,89%	78,11%
2020	1 972	5 992	7 964	24,76%	75,24%
2021	1 624	5 883	7 507	21,63%	78,37%
Total	24 557	81 282	105 839	23,20%	76,80%

Table A3: Housing type for the population of Trondheim, data from SSB.

Dwelling type	2021
Detached house	24 967
Semi-detached house	11 405
Terraced house	17 403
Apartment	53 052
Other	1 476

Table A4: Categorization of dwellings. Inspired from Boligmiks.no. Prom is referring to the net usable area for daily activities. (Boligmiks, n.d.).

Rooms	Size (square meters applied)
1 Room	Any
2 rooms	Prom < 50
2 rooms	Prom => 50
3 rooms	Prom < 70
3 rooms	Prom => 70
4 rooms	Prom < 90
4 rooms	Prom => 90
5+ rooms	Any

Appendix part B:

B1 Repeated sales

The concept of repeated sales method is quite simple, and its effect and outcome follow the same intuitive thought process. It will calculate the price change of a specific prospect over the timespan from one sale to another. This will provide a price index that can show the price changes over a specified amount of time. This index will be extremely useful for this thesis as the analysis will be done for the development of first-hand dwellings as they proceed into second-hand sales. This methodology was first developed by Bailey, Muth and Nourse (1963). Beneficially compared to other methodologies used for real estate it does not need the same amounts of information on characteristics on the dwelling. The only requirements for a repeated sales model are price, sales dates, and the exact location of the dwelling. As many say when speaking about real estate, "location is king", and a repeated sales model controls for location at a very fine level (OECD et al, 2013). It does place one key assumption as a basis of the whole methodology, which is that quality will stay still or not change significantly between the sales (Bailey et al, 1963). Repeated sales has been used to develop indexes such as the Case-Shiller U.S. National Home Price Index as well as the FHFA House Price Index. (FHFA, n.d.; OECD et al, 2013; St. Louis FED, n.d.).

Most of the models derived from the BMN model from 1963 are built around the same principles. It will be based around this model:

$$R_{iit} = \frac{B_{t`}}{B_t} * U_{itt`} \quad OR \quad r_{iit} = -b_t + b_{t`} + u_{itt`} \text{ (B.1)}$$

Lower case letters will represent the logarithmic versions of the first formula. The letters can be explained as following, R_{iit} will be the ratio of the final sales price in period t` to an initial sales price in period t for the i-th transactions with two different sales prices. $B_t$ and $B_{t`}$ will represent the unknown but true indices for the previously mentioned periods t and t`. T = 0,1,…, t-1, and t`=1,…, T. Bailey et al assumes that the residuals in logarithmic form ($u_{itt`}$) have zero means, identical variance σ^2, and are uncorrelated with each other. To find our values for B we can deal with it by using regression (Bailey et al, 1963).

The main idiosyncratic weakness of repeated sales will be the fact that any given dwelling will be sold at different timespans (Bailey et al., 1963). Moreover, there will not be a(n) repeated sale for all first-hand transactions, meaning that the dataset will lose a huge part of the total N as we only consider data that is sold more than once (Sønstebø et al, 2021). However, when using a long enough time-period to construct a sufficient N, the data can be representable/of a large enough caliber. Another key point against repeated sales is that the methodology has the assumption of no quality change over time, something that has been subject to criticism as both depreciation and renovation is key in the real-estate market. Case and Quigley (1991) argues that the aging and the depreciation of the value will mean that the results will be biased. This argument can be very important as asset value will change and depreciate over time, but at the same time it will be of less significant importance for first-hand assets. These assets will be of "high quality" and have sufficient perceived quality from a buyer or investors perspective for a long time. As timespan between sales increase, it might be possible to see a significant impact in terms of depreciation and need of rehabilitation, to counter this there has been an evaluation on the timeframe to be used for the repeated sales, and this thesis will only use transaction in the period from year zero after the contract purchase until year six.

Besides these problems with the methodology, many researchers have seen or predicted problems of overrepresentation of certain types of dwellings meaning that the findings might not represent the whole market. A regular assumption is that some smaller sized dwellings will have more turnover, meaning they will be resold more often than the larger ones. Case, Pollowski and Wachter (1991), Meese and Wallace (1997) and Clapp, Giacotto and Tirtiroglu (1991) among others looked at this. The different studies had mixed results when speaking of

sample bias, however, there have been examples posterior to these where smoothing models has been introduced to counter the issue. This is an issue to be observant of when completing the analysis, however considering the types of dwellings that are built and that have been built in the period of interest are largely apartments or attached housing it is safe to assume the types will be relatively equally represented.

To develop a repeated sales index, a variable for the transactions that had a repeated sale from the first-hand dataset to the second-hand data was created. This variable indicated the repeated sales ratio from first-hand to second-hand, at the same time a variable indicating the time between the sales was created. The repeated sales ratio will be pictured through what we have previously explained to be named Tobin`s Q-ratio from the literature review and methodology chapter. After developing the general index, the next step will then be to correct this repeated sales index through the market index which will be developed through a hedonic model (Olaussen et al, 2017). The process for correcting the index will be developed in the next part, appendix B2. Henceforth, the new ratio will show how the ratio for the first-hand dwellings to second-hand performs in relation to the market development inside the same interval as happened between the various sales.

B2: Hedonic methodology.

Hedonic methodology surged from Kelvin Lancaster`s work in 1966, although it originated from Court in 1939 when he used it for automobiles. Hedonic methodology explains the assets value and the fact that it will be composed from the value of each of its characteristics. Lancaster's essence could be summarized by three points. First, the discussed good will not give any value or utility by itself, but each characteristic will give higher utility. Moreover, each good will have more than one characteristic and these characteristics will not be exclusive to that good. Lastly, a combination of goods can give a different sum of characteristics than the assets on its own (Lancaster, 1966). Lancaster developed on the idea that this could be applied to any type of good with different characteristics, and for real estate this became a prominent methodology. Sherwin Rosen brought it further looking at the goods as a package of characteristics that will decide the market prices which then can be comparable (Rosen, 1974).

Charles Noland brought this to the specific asset class of housing and real estate, where each characteristic will not be bought by themselves, but the hedonic methodology will form a regression that will show the dwellings estimated value as a sum of the characteristics (Noland, 1979). A hedonic model for real estate would look like this, with X representing the various characteristics:

$$(P_{i,t}) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_n X_n + e \quad \text{(B.2)}$$

A hedonic model regression model as indicated above will give a clear picture and values on how the selected explanatory variables affect the square meter prices. Which is precisely what is needed to create the price index that will be utilized for correcting Tobin`s Q-ratio for the market movement. The created index will show the movement coming from the market on each dwelling type and year. Categorization of these follows the framework from the table in appendix A4, while also considering the same years that are inside the sales interval of the repeated sale. Meaning that each Q-ratio will have an associated market movement that it will be divided by, thereby correcting it for the market movement. Moreover, the variables can be used to create an understanding on how the various characteristics affect the ratio itself. The characteristics that can influence the valuation of a dwelling can be many, as mentioned in chapter (2.2.0). Variables such as size, number of rooms, sales year, and location (district) will be in focus when developing the hedonic model.

One weakness with hedonic methodology is that some of the large number of variables can be very difficult to both observe (for each dwelling) and ranking them might be even more challenging (Sønstebø et al, 2021). However, the intention for the hedonic model is to use it in combination with Tobin`s Q-ratio, which will avoid and control for idiosyncratic characteristics by itself.

Appendix part C:

Table C1: Tobin`s Q-ratio from years 0-6. Represented in figure 4 from the text.

Year	Tobins Q	Index
0	1.0756	1
1	1.09987	1
2	1.08778	1
3	1.02518	1
4	1.0136	1
5	0.99892	1
6	1.0334	1

Table C2: Tobin`s Q-ratio from years 0-6 showing the values for the various districts of Trondheim.

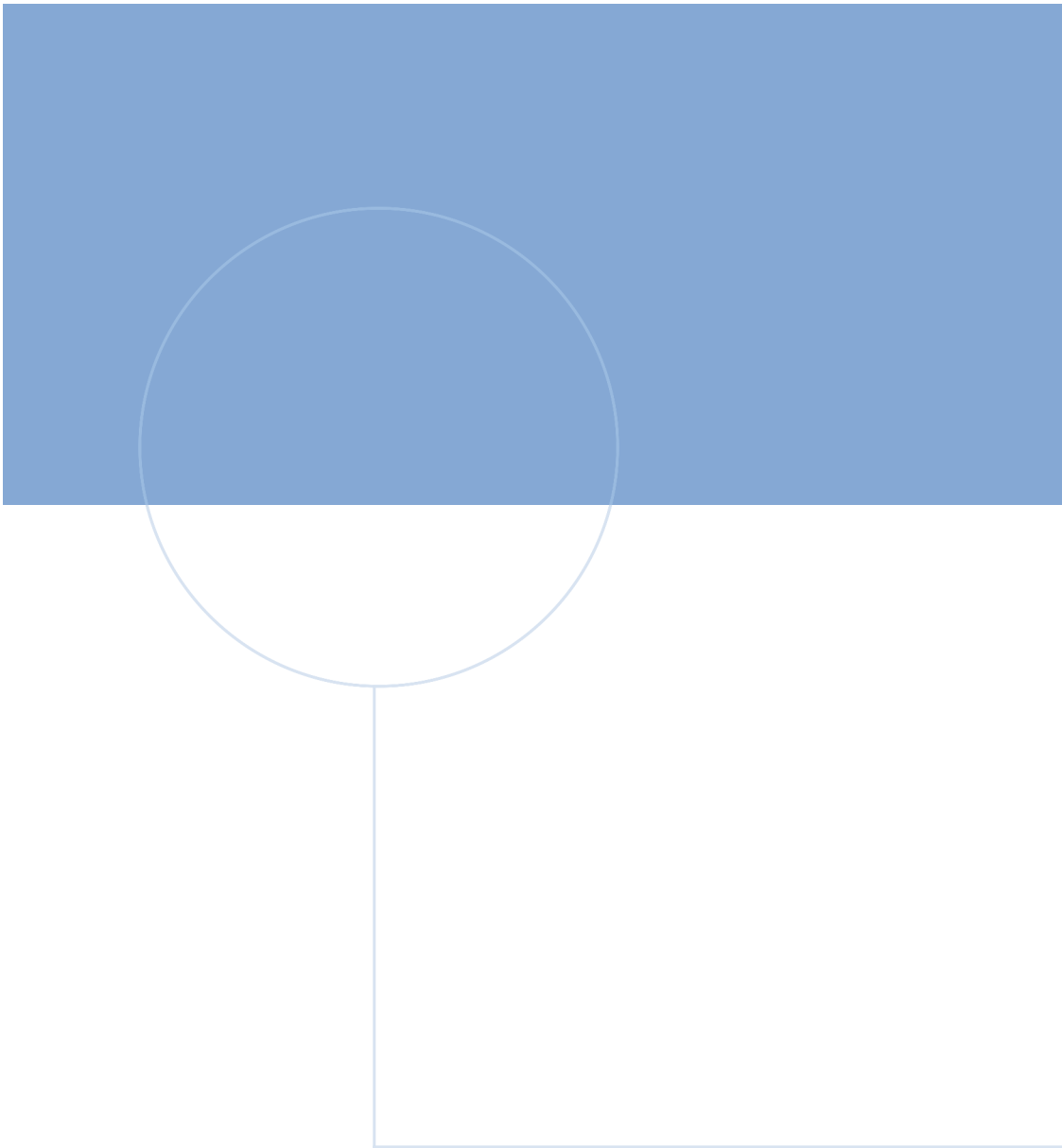
	Q-ratio for the different districts							
Year - Time	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**Number of dwellings**
Midtbyen	1.2345	1.1935	1.1623	1.0479	1.0449	1.0928	1.1191	204
Lerkendal	1.0765	1.0862	1.0674	0.9653	1.0087	0.8998	1.0265	67
Østbyen	1.0693	1.0672	1.0757	1.0426	1.005	0.9642	0.9428	381
Heimdal	1.0778	1.0264	0.9504	0.9276	0.9758	0.8829	0.8468	36

Table C3: Hedonic models for Tobin`s Q-ratio.

	Reg 1	**Reg 2**	**Reg 3**	**Reg 4 (Ln)**
Constant	1.2736	1.2586	1.2964	0.2431
	(35.40)***	(28.74)***	(31.85)***	(8.83)***
Years:				
1	-0.0210	-0.0211	-0.0182	-0.0171
	(-0.75)	(-0.75)	(-0.64)	(-0.78)
2	-0.0308	-0.0306	-0.0305	-0.0248
	(-1.18)	(-1.17)	(-1.15)	(-1.23)
3	-0.0624	-0.0615	-0.0645	-0.0547
	(-2.40)**	(-2.35)**	(-2.42)**	(-2.66)***
4	-0.0817	-0.0809	-0.0887	-0.0734
	(2.90)***	(-2.86)***	(-3.08)***	(-3.29)***
5	-0.0997	-0.0991	-0.0999	-0.0952
	(-3.22)***	(-3.19)***	(-3.16)***	(-3.81)***
6	-0.0854	-0.0851	-0.0859	-0.0829
	(-2.69)***	(-2.67)***	(-2.69)***	(-3.40)***
Year				
2006	-0.0753	-0.0769	-0.0787	-0.0581
	(-3.08)***	(-3.15)***	(-3.32)***	(-2.70)***
2007	-0.1341	-0.1352	-0.1419	-0.1139
	(-5.46)***	(-5.47)***	(-5.55)***	(-5.68)***
2008	-0.2301	-0.2311	-0.2509	-0.2052
	(-4.989)***	(-4.88)***	(-5.03)***	(-5.28)***
2009	-0.1793	-0.1816	-0.1921	-0.1632
	(-6.51)***	(-6.57)***	(-7.23)***	(-6.11)***
2010	-0.0092	-0.0095	-0.0095	-0.0210
	(-0.11)	(-0.12)	(-0.11)	(-0.39)
2011	-0.1632	-0.1653	-0.1612	-0.1436
	(-2.45)**	(-2.45)**	(-2.43)**	(-2.10)**
2012	-0.2117	-0.2130	-0.2154	-0.1876
	(-4.13)***	(-4.10)***	(-4.27)***	(-4.36)***
2013	-0.1724	-0.1746	-0.1767	-0.1465
	(-3.25)***	(-3.23)***	(-3.40)***	(-3.26)***
2014	-0.2078	-0.2097	-0.1995	-0.1824
	(-3.76)***	(-3.74)***	(-3.65)***	(-2.72)**
2015	-0.1537	-0.1559	-0.1516	-0.1246
	(-2.52)***	(-2.53)***	(-2.55)**	(-2.24)**
2016	-0.1246	-0.1242	-0.1167	-0.0959
	(-2.32)***	(-2.31)***	(-2.77)**	(-1.44)
2017	-0.0873	-0.0858	-0.0793	-0.0641
	(-1.72)*	(-1.69)*	(-1.64)	(-1.44)
2018	-0.1711	-0.1697	-0.1621	-0.1405
	(-3.31)***	(-3.29)***	(-3.28)***	(-3.14)***
2019	-0.1753	-0.1745	-0.1696	-0.1427
	(-3.42)***	(-3.41)***	(3.51)***	(-3.29)***
2020	-0.2494	-0.2463	-0.2873	-0.2154
	(-4.56)***	(-4.55)***	(-4.77)***	(-4.47)***

Dwelling type				
2 rooms < 50 sqm	0.0093 (0.61)	0.0058 (0.35)	-	0.0112 (0.83)
2 rooms > 50 sqm	-0.0885 (-5.46)***	-0.0994 (-4.36)***	-	-0.0817 (-4.73)***
3 rooms < 70 sqm	-0.0125 (-0.87)	-0.0261 (-1.12)	-	-0.0109 (-0.84)
3 rooms > 70 sqm	-0.0547 (-3.59)***	-0.0788 (-2.19)**	-	-0.0489 (-3.52)***
4 rooms < 90 sqm	-0.0397 (-1.32)	-0.0615 (-1.38)	-	-0.0419 (-1.71)*
4 rooms > 90 sqm	-0.0397 (-1.12)	-0.0794 (-1.78)**	-	-0.0543 (-1.91)*
5 rooms	0.0372 (1.52)	-0.0118 (-0.16)	-	0.0378 (1.69)*
Location				
Lerkendal	-0.0205 (-0.44)	-0.0199 (-0.43)	-0.0155 (-0.35)	-0.0332 (-0.92)
Østbyen	-0.0047 (0.10)	-0.0043 (-0.09)	-0.0098 (-0.21)	-0.0153 (-0.37)
Heimdal	-0.0750 (-1.34)	-0.0730 (-1.29)	-0.0858 (-1.59)	-0.0853 (-1.67)*
Size (Square meters)	-	0.0005 (0.77)	-0.0008 (-2.41)**	
Adj R-squared	0.3808	0.3814	0.3548	0.4341

*Table C3: *** P< 0.01. ** P < 0.05. * P < 0.10. Table describing regression 1 through 4. Showing the degree of significancy of the different variables or lack of. The regression handles dummy variables such as interval between sales, sales year, dwelling type, and location. Lastly a variable for size is added to some regressions.*



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