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Navn:	Mathilde Dobloug og Kristin Egeli

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A thesis about how unintended consequences of financial stability regulations together with a declining interest rate, and urbanization affect equity restricted first-time buyer's ability to buy a dwelling.

Master Thesis

by

Mathilde Dobloug and Kristin Egeli

MSc in Business with Major Finance

Supervisor: Espen Henriksen

Oslo, July 1, 2022

ABSTRACT

House prices in Norway have increased during the last 30 years. This price increase may have several causes, including a secular downward trend in interest rates. Some have argued that "higher house prices have made it harder for young households to buy a dwelling" or similar statements. There have also been arguments about the distributional consequences of higher house prices.

In this thesis we will investigate whether and under what conditions such statements may be true. To the extent house-price increases have been caused by lower interest rates, we show that the distributional consequences to a large degree may be due to unintended consequences of financial-stability measures such as loan-to-income ratios and equity requirements.

We then empirically estimate whether house price changes in different areas have been due to decreasing interest rates or other factors such as urbanization. With these results we will get a better understanding of the distributional consequences of changes in house prices.

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1 Introduction

In this thesis, we study unintended distributional consequences of debt constraints and equity requirements for young individuals. In particular we ask; *May there have been unintended consequences of regulations to ensure financial stability that has, together with declining real interest rates, adversely affected young households' ability to buy a dwelling?* We then ask *to what extent differences in house prices across regions in Norway have been due to declining real interest rates and to what extent it has been due to other factors, such as urbanization?*

Many aspects of the economy are affected by changes in the interest rate, and one of these aspects is how it influences house prices. A lower interest rate is assumed to increase housing prices and reduce interest expenses (Bø, 2010). When prices reach a certain level, first-time buyers will not be able to buy a dwelling if they don't get financial help (Wig, 2017).

The rapid development in the house prices has prompted a number of governmental regulations trying to prevail the price growth and the following debt-level. In 2010 the government implemented equity requirements, followed by a debt capacity regulation in 2016 (Aastveit et al., 2020). These regulations have provoked our question of interest.

We will start our analysis by looking at a parsimonious frictionless model. In this model we make our own assumptions on income, house expenses and the interest rate to illustrate the effect of interest rate changes on equity requirements and maximum loan value for first-time buyers. The purpose of this is to abstract the impact of the effects of financial stability regulations.

We then gradually add "frictions" to our model. By "frictions" we have in mind all regulations put in place to ensure financial stability, such as equity requirements and borrowing limits. Within this framework, we will be able to analyze how secular trends in interest rates may affect first-time buyer's ability to enter the housing market.

In addition to financial-stability regulations, and interest rates, factors such as income, unemployment, and location also affect the house prices. In the second part of our thesis we do an empirical analysis to study how housing prices vary across different regions, such as Hamar and Oslo. One of the motivations to investigate different regions is to distinguish between price changes due to changes in interest rate, and price changes caused by a preference effect.

This will give us an idea of the importance of the mechanism we analyzed in the first part of our thesis. If house prices in metropolitan areas are mainly due to a preference shift, our mechanism may not be that important. However, if the house prices have increased due to lower interest rates, the mechanism we have highlighted may be important.

The rest of the paper will be structured as follows: Chapter 2 presents a literature review of the empirical evidence and theory on the topic. Chapter 3 presents the parsimonious model where we show how frictions make it harder for young householders to buy a dwelling. In Chapter 4 we introduce an empirical model where we show how price changes are caused by relative preferences. Finally, in Chapter 5 we conclude on our research and make future predictions for the housing market based on our models.

2 Literature review

This part provides prior discoveries and research on some of the most important aspects of our research.

2.1 The Norwegian housing market

The high growth in the Norwegian housing market over the last couple of years has spurred a number of articles examining which factors play a significant effect on determining house prices. Larsen and Sommervoll (2004) suggest that demographic factors such as urbanization and centralization, as well as the interest rates, availability to capital, and wages can explain the fluctuations in housing prices.

One of the most important factors stimulating growth in housing prices is the interest rate. The interest rate further affects many aspects of the economy, among them households' financial capability, as the amount of money they are able to pay for a dwelling is decided primarily by their income and housing costs. Moreover, the interest rate is crucial as it will affect households' consumption and savings. A lower interest rate is assumed to increase housing investments and increase individuals' credit, especially for young households. This is because it will lead to a growth in housing prices and reduced interest expenses associated with the loan (Bø, 2010). When the interest level increases, households will have less funds for consumption and investments, which in general reduce demand for housing. This reduction can in turn reduce growth in housing prices (The Bank of Norway, 2019).

Based on the paper from Iversen, the Norwegian economy has experienced blossoming with a relatively high-income growth and positive development in the labor market during the past decades (Iversen, 2016). This economic growth has increased the availability for credit and in turn increased demand for housing. Because housing supply is limited in the short term, the increased demand has led to higher prices (Bø, 2010). In 1993, an average dwelling cost

about three times annual income, while in 2012 it had increased to about six times income (Sættem et al., 2012). When prices continue to rise over a longer period of time, households aim to enter the market as soon as possible, driving higher demand and pushing prices further upward (Hammernes, 2006).

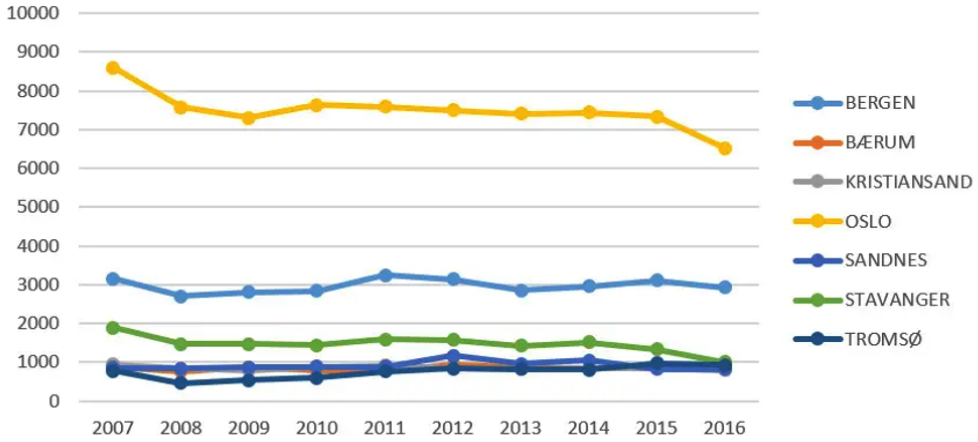
Even though the housing prices have risen sharply across the country based on a ten-year period, Oslo has outperformed the rest of the country with an increase of 90 percent in price per square meter (Statistics Norway, 2022). The areas in Oslo differ in prices, population, and demand and most often, wealthy households tend to live in the western part of the city, while less wealthy tend to live in the eastern part of the city (Oslo Municipality, 2019). These social differences are further reflected in the housing prices, as the prices are higher in the west compared to the eastern parts of Oslo (Oslo Municipality, 2022).

2.2 First-time buyers

The increasing housing prices makes it more difficult for first-time-buyers to enter the market, particularly in metropolitan regions. An article by Mamre (2021) analyzes the housing affordability of Norwegian local first-time buyers. The findings of the study show that while a typical first-time buyer would be able to afford 29 percent of homes sold in the six largest Norwegian cities in 2010, the corresponding figure is 7 percent of homes sold in 2019. Nevertheless, it's more common to own a home in Norway compared to other European countries, and also more usual for young households to buy their own dwelling (Statistics Norway, 2019). However, over the past years there have been observed a reduction in the amount of households owning a home in Norway. From 2008 to 2017 the number of households in their twenties owning a home shrunk from 54 to 48 percent. Statistics Norway (SSB) points out several potential reasons for this reduction of owners. Firstly, the housing prices are increasing at a high pace, which is stated as a greater disadvantage for younger buyers nowadays. Moreover, increased requirements for equity as well as more strict evaluation of the borrower's ability to serve the loan, have also made it more difficult to enter the housing market. The Norwegian Real Estate Association (NEF) and

Ambita did a mapping of the market over a ten year period showing that the average age in 2016 for a first-time-buyer was 32.3 years, a small reduction from the average of 32.5 years (Wig, 2017). The age range of 20 to 25 represents the biggest group of first-time-buyers nationally. However, in Oslo there is also a large group of first-time buyers in their thirties. This indicates that, on average, first-time buyers in Oslo are older compared to other places, which is assumed to be correlated with the high price level there.

Figure 2.1: Number of first-time buyers in the age group 20-40



Source: The Norwegian Real Estate Association (NEF)

We can observe from the graph that the number of first-time-buyers in Oslo have reduced over the given ten-year period. Carl O. Geving, the director of NEF, states that when prices reach a certain level, some individuals will not be able to buy a home if they don't get financial help from their family. A recent mapping from Samfunnsøkonomisk Analyse (The Norwegian Real Estate Association, 2021) shows that 59 percent of all Norwegian first-time buyers in 2020 bought their home together with someone else.

2.3 Financial stability regulations

Concerns about financial stability rose to the top of the global agenda in the aftermath of the 2008 financial crisis and the subsequent Eurozone debt crisis. High levels of credit obligations expose the economy to higher interest rates, higher unemployment, and lower real wages (The Bank of Norway, 2008). In order to ensure financial stability and to protect private consumers, countries have set limits on the size of loans that banks can offer their customers. The regulations include limiting individuals loan-to-value (LTV) ratios and implementing loan-to-income (LTI) based on the consumers' income to further reduce household indebtedness (The Bank of Norway, 2016).

In Norway, the Financial Supervisory Authority (FSA) has imposed the LTV restriction, which puts an upper bound on mortgage debt. In March 2010, they issued national guidelines stating that mortgages should not exceed 90 percent of the home's market value (Aastveit, et al., 2020) . The guidelines were already updated in December 2011, when the maximum LTV-level was reduced from 90 to 85 percent, which is equivalent to saying that the equity requirement rose from 10 to 15 percent. Løyning examines the debate that arose following the implementation of the new equity requirement in his paper. Opponents of the regulations appear to dominate the debate, arguing that they create social divides, general injustices, and housing market imbalances. However, this opposition has not resulted in any changes to the regulation, and it is now barely discussed. Løyning discusses potential explanations for this fading topic in his article from 2020, with one argument being that eliminating regulations will not necessarily substitute social goals. This is because a removal will encourage excessive risk-taking and higher prices, primarily affecting first-time homebuyers and the less fortunate. In December 2016 the FSA additionally implemented the LTI requirement of 500 percent, stating that loans shall not be granted if the customer's total debt exceeded five times gross annual income (Aastveit et al., 2020).

Larsen and Sommervoll (2004) discuss how most houses are debt financed which makes the housing market sensitive to credit institutions' lending policies. They underscore that access to credit is connected to the economic situation. In an economic boom, it will be easier to get credit financing, while in a burst, it will be more difficult. The housing prices are also assumed to correlate with the economic situation, which aligns with research done by Adelino, Scholar, and Severino's from 2012. They discovered that easier access to credit led to a considerable increase in housing prices. Furthermore, stricter lending policies makes it more difficult to get a mortgage, meaning housing prices should be declining. Mamre's paper from 2021 also agrees with the findings in Larsen and Somervoll's article when discussing how the economic situation impacts the lending regulations. She underscores that the number of homeowners reduces as credit constraints get tighter and discusses how this development leads to an excluding housing market that is too expensive for the younger generations. Haurin, Hendershott and Watcher did research in 1996 which is in line with Mamre's paper. They found that ownership tendencies are sensitive to various economic variables such as borrowing constraints, and that these constraints reduce the probability for ownership to a third to a half depending on the characteristics of the household.

As a result of credit institutions lending policies, most households will be unable to borrow the total market value when purchasing a dwelling. According to Borgersen and Greibrokk (2012), the amount that the bank will lend households will be determined by the amount of risk the bank is willing to take on. Borgersen and Greibokk argue that a higher LTV ratio increases the risk for both parties and might lead to bubbles in the long run due to households borrowing more than what they are able to repay.

3 Parsimonious model

In order to analyze and illustrate how prices of long-term duration assets such as dwellings are sensitive to interest-rate changes, and how financial-stability regulations may asymmetrically affect the purchasing power of first-time-buyers, we introduce a simple, parsimonious model. The model gives an indication on, to what extent, financial stability regulations and a changing interest rate lead to unintended consequences affecting first-time-buyers ability to enter the housing market. This analysis will be done in three different situations; in a frictionless market, with equity requirements, and with equity requirements along with credit constraints.

3.1 Illustrating case in a frictionless Market

In the first case we investigate the situation of a parsimonious model in a hypothetical, frictionless market[1]. In such a market, the only parameters affecting long-term duration assets such as housing, are the interest rate and individuals personal value. The monthly personal value is referred to as the household's average housing expenditures. It is assumed to be a fixed amount on a monthly basis, similar to a potential rental expense for a given apartment. This fixed amount gives an indication on how much individuals are willing to pay for a dwelling.

$$PV = \frac{Monthly\ PV \times 12}{SQM} \tag{3.1}$$

By converting the monthly personal value into annual terms per square meter (SQM), we find the component needed to prove the findings in equation (3.2) and (3.4) below, namely PV. We do not consider any additional costs accruing from regular use as the PV is assumed to be adjusted for depreciation.

[1] This is eg. similar to the starting point when deriving the Miller-Modigliani theorem.

Housing is a long-term duration asset, and our model illustrates that the market value of the asset is a function of mainly two factors; how much households, on average, would like to spend on housing services, and the interest rate level.

$$Market\,value = \frac{PV \times SQM}{r} \tag{3.2}$$

The price of this asset is driven by the personal value in annual terms, which is equivalent to how much it would cost to rent a dwelling for a year. Further, the market value is sensitive to changes in the interest. A lower interest rate will increase the market value, and vice versa. The asset is assumed to live forever, making it similar to a perpetuity. Its value can therefore be derived based on a Gordon Growth model, by dividing the annual personal value, multiplied by square meter, on the interest rate to get the present market value of the apartment.

The second equation illustrates the relationship between the interest expenses and the personal value. The expression is obtained by inserting the market value, (3.2), into the equation for interest expenses, (3.4).

$$Interest\,expenses = Market\,value \times r = \frac{PV \times SQM}{r} \times r \tag{3.3}$$

$$Interest\,expenses = PV \times SQM \tag{3.4}$$

Interest expenses do not include repayments, meaning it only incorporates interest payments on the loan. If the interest rate increases, this will not affect the interest expenses for i.e. a potential entrant to the housing market, as house prices also adjust to higher interest rates. The interest expenses are solely affected by the personal value and the size of the apartment.

By simple calculations, we have demonstrated that interest expenses are independent of the interest rate level, meaning that, interest expenses are equal to the personal value in annual terms multiplied by SQM. This finding suggests that the market value of an apartment is determined by how much households are willing to spend on housing services.

The proof gets more comprehensible when we use a numeric example. We are interested in investigating the effect of interest rate changes on the market value and assume that the buyer is an outsider, trying to enter the market. In this case, we do not consider any equity requirements or other financial stability regulations. Even though it is reasonable to believe most first-time buyers have some equity, we assume that in this case, all first-time buyers have zero equity and debt for simplicity. We do not consider any additional costs that occur when buying an apartment other than the actual market value. This helps us isolate the relationship between changes in the interest-rate and prices of long-term duration assets such as dwellings.

Since the monthly personal value is a fixed amount, we assume it to be 10,000 NOK for a 50 SQM apartment. This is equivalent to saying that the annual personal value is 120,000 NOK and the PV is 2,400 NOK. From Appendix 1, we see that a 50 SQM apartment has a market value of 6,000,000 NOK. We get the following result for interest expenses with a 2 percent annual interest rate:

$$Interest\,expenses = \frac{2,400 \times 50}{2\%} \times 2\% = 6,000,000 \times 2\% = 120,000 \quad (3.5)$$

We do the same calculations with an interest rate equal 5 percent:

$$Interest\,expenses = \frac{2,400 \times 50}{5\%} \times 5\% = 2,400,000 \times 5\% = 120,000 \quad (3.6)$$

Since we assume all first-time buyers to be equity constrained, they would have to borrow the entire market value from the bank. Changes in the interest rates do not impact the monthly personal value, meaning we keep the amount spent on housing fixed. This means that interest expenses are held constant, assuming everything else, but the interest rate, equal. If the interest rate increases to 5 percent, the market value will drop to 2,400,000 NOK, and the apartment will be cheaper. A first-time buyer will then only need to borrow 2,400,000 NOK as opposed to 6,000,000 NOK when the interest was 2 percent. However, when the interest rate increases, the yearly interest expenses remain constant at 120,000. The result demonstrates that, changes in the interest rate will not lead to changes in interest expenses for a potential entrant, as house prices adjust to the interest rate.

3.2 Introducing equity restrictions (LTV)

In this part, we consider the case when including equity requirements, and focus on how LTV affects entrants with limited equity. The regulation requires households to finance 15 percent in equity when granting loans to purchase a dwelling. We investigate how this requirement, along with changes in the interest rate, affect equity constrained first-time buyers entrance to the house market.

The table in Appendix 2 shows that an apartment with market value equal to 6,000,000 NOK would require 900,000 NOK in equity given an interest rate of 2 percent. First-time buyers that are equity constrained must therefore find other ways to achieve the sufficient equity required. We consider two potential ways to save in order to accumulate the required equity.

1. Reduce private consumption.
2. Reduce the rent (i.e. move to a smaller apartment).

We assume an income of 600,000 NOK and a tax rate of 30 percent, resulting

in an annual net income of 420,000 NOK. After subtracting the annual interest expenses of 120,000 NOK, monthly consumption amounts to 25,000 NOK at an 2 percent interest rate, as displayed in Appendix 3. In the first option, households must be willing to reduce their private consumption in order to save enough money to pay the required equity. Assuming everything else remains constant, reducing consumption to 10,000 NOK per month will lead to savings of 180,000 NOK per year. The sufficient equity to buy a 50 SQM dwelling will then be accomplished within 5 years. If consumption is further reduced, i.e. to 6,000 NOK, the equity will be acquired within approximately 4 years. Table 3.1 illustrates that cutting back on consumption reduces the number of years needed to save until sufficient equity.

This model shows that, when the interest rate changes, this impacts the housing prices which again affect the equity requirement, since equity is a percentage of housing prices. When the interest rate decreases from 2 to 1.5 percent, the equity requirement increases from 900,000 NOK to 1,125,000 NOK. By reducing consumption to 10,000 NOK, the time of saving required to achieve sufficient equity to initiate the same investment in the long-term duration asset increases from 5 to 6 years. However, if the interest rate increases from 2 to 2.5 percent, the equity requirement decreases from 900,000 to 675,000. The number of years saving reduces to approximately 4 years.

Monthly Consumption	2% interest rate	1.5% interest rate	2.5% interest rate
10,000 NOK	5.0 years	6.3 years	3.8 years
8,000 NOK	4.4 years	5.5 years	3.3 years
6,000 NOK	3.9 years	4.9 years	3.0 years
4,000 NOK	3.6 years	4.5 years	2.7 years
2,000 NOK	3.3 years	4.1 years	2.4 years

Table 3.1: *Summarized results from Appendix 3 "Saving to fund own equity with LTV"*

A second option is to rent a cheaper apartment and save the excess cash. Given a 2 percent interest rate, reducing the rent from 10,000 NOK to 8,000 NOK will give yearly savings of 24,000 NOK, and it will take approximately 38 years to acquire sufficient equity. Reducing the rent further, to i.e. 2,000 NOK per

month will require 9 years of saving. Nevertheless, renting for 2,000 NOK in Oslo would indicate a 5 SQM dwelling. Therefore, renting for 2,000 NOK is unrealistic.

If the interest rate decreases, it requires a longer period of time with saving before sufficient equity is obtained. Considering the monthly rent is reduced from 10,000 NOK to 8,000 NOK and the interest rate goes from 2 percent to 1.5 percent, the amount of years saving will increase from 38 to 47, observed from table 3.2. However, if the interest rate increases to 2.5 percent, saving for 28 years will be sufficient.

Monthly Rent	2% interest rate	1.5% interest rate	2.5% interest rate
8,000 NOK	38 years	47 years	28 years
6,000 NOK	19 years	23 years	14 years
4,000 NOK	13 years	16 years	9 years
2,000 NOK	9 years	12 years	7 years

Table 3.2: *Summarized results from Appendix 3 "Saving to fund own equity with LTV"*

The model demonstrates how equity constrained first-time buyers' ability to enter the housing market is sensitive to movements in the interest rate. The amount of years before sufficient equity is obtained increases or decreases with approximately 10 years when the interest rate experiences a 0.5 percentage point change. Entrants will experience a higher interest rate as beneficial, since it reduces house prices, again reducing the equity requirement. Conversely, a lower interest rate has unintended consequences of increasing the equity requirement, making it more difficult to enter the housing market for first-time buyers with no initial equity.

3.3 Introducing credit constraints (LTI)

Finally, we apply LTI to our parsimonious model, which demonstrates how the credit constraint of 5 times income affects entrants' ability to buy a dwelling. Based on the assumption of an annual gross income of 600,000 NOK, the bank will at maximum lend 3,000,000 NOK, observed from the table in Appendix 4. When considering LTI on top of LTV, this leads to an additional 2,100,000 NOK needed in equity to buy the 50 SQM dwelling for 6,000,000 NOK. The total amount first-time buyers need to save when introducing both LTV and LTI amounts to 3,000,000 NOK. We look at the two equity-saving options introduced in the previous section and continue with the same assumptions.

In the first option, reducing monthly consumption from 25,000 NOK to 10,000 NOK at a 2 percent interest level leads to approximately 17 years of saving before sufficient equity is obtained. This is more than three times as many years compared to the same scenario when the only lending restriction was the LTV. No matter how much entrants are willing to reduce consumption, it will take more than a decade before they will be able to afford a dwelling; reducing consumption to 2,000 NOK will indicate 11 years until sufficient equity.

If the interest rate decreases from 2 percent to 1.5 percent, even tough consumption is reduced to 10,000 NOK, number of years before sufficient equity is achieved increases from 17 to 25 years. However, with a 2.5 percent interest rate, entrants only need approximately 8 years before they have enough equity.

Monthly Consumption	2% interest rate	1.5% interest rate	2.5% interest rate
10,000 NOK	17 years	25 years	8 years
8,000 NOK	15 years	22 years	7 years
6,000 NOK	13 years	20 years	6 years
4,000 NOK	12 years	18 years	6 years
2,000 NOK	11 years	16 years	5 years

Table 3.3: *Summarized results from Appendix 5 "Saving to fund own equity with LTI LTV"*

Next, we look at the effect of reducing the rent. By lowering the rent from 10,000 NOK to 8,000 NOK, the years of saving until sufficient equity is obtained amounts to 88 years, assuming everything else stays constant. The number of years was substantially lower, at 38, when the LTV was the only financial stability regulation. Even lowering the rent to 2,000 NOK per month will indicate saving for 22 years before sufficient equity is achieved.

If the interest rate decreases to 1.5 percent, and monthly rent is reduced to 8,000 NOK, the equity needed takes 141 years to acquire. Nevertheless, an increase in the interest rate to 2.5 percent implies saving for 34 years. We see that when the interest rate fluctuates between 1.5 percent and 2.5 percent, years of saving varies with up to 100 years.

Monthly Rent	2% interest rate	1.5% interest rate	2.5% interest rate
8,000 NOK	88 years	141 years	34 years
6,000 NOK	44 years	70 years	17 years
4,000 NOK	29 years	47 years	12 years
2,000 NOK	22 years	35 years	9 years

Table 3.4: *Summarized results from Appendix 5 "Saving to fund own equity with LTI LTV"*

When implementing the LTI regulation, the amount of equity increases and so does the equity's sensitivity to changes in the interest rate. It will take longer for equity constrained first-time buyers to enter the market when facing yet another financial stability regulation. The sensitivity is observed through the large effect of how only half a percentage point change in the interest rate affects the number of years needed to acquire sufficient equity. An increase in the interest rate will reduce housing prices and the equity needed, however, considering both the financial stability regulations, equity-constrained first-time buyers is forced to save for a long time, preventing them from entering the housing market.

3.4 Findings

Through this parsimonious model we have shown a relationship between the interest rates, housing prices, and the consequences of financial stability regulations on equity constrained first-time buyers. In the first, frictionless case, we established that there is a negative relationship between the interest rate and house prices. Housing is a long-term duration asset, which, like other long-term duration assets, are sensitive to interest-rate changes. Higher interest rates lead to lower house prices, and vice versa. An important finding from our frictionless model is that an increased interest rate did not affect the interest expenses for a potential entrant to the housing market, as house prices also adjust to higher interest rates. This makes the economic situation irrelevant for entrants, as borrowing opportunities are neither limited nor affected by changes in the interest rate. Secondly, we introduced the first out of two financial stability regulations considered in this exercise, namely the equity requirement. In this case we demonstrated how increased interest rates benefited first-time buyers with equity constraints. This is because house prices will decrease following the interest increase, reducing the level of equity required for a given dwelling. For a first-time-buyer, this will indicate less required savings to obtain sufficient equity when the interest rate increases, in comparison to the scenario with a constant or declining interest rate. In other words, a higher interest rate makes it easier for entrants to buy a dwelling when housing prices decrease, since equity needed decreases, leading to a reduced number of years required to save for equity. Oppositely, when the interest rate was lowered, required savings increased. In the final scenario, we continued our analysis by including the second financial stability regulation, LTI. In this case, the amount of equity needed was more sensitive to changes in the interest rate when both financial stability regulations were included. When the interest rate decreased, the amount of sufficient equity increased, strengthening the consequence of a lowered interest rate. Entrants to the housing market seem to be facing barriers due to the increased equity following higher housing prices, which again is a result of lower interest rates.

As shown in Figure 2.1 in the literature review, number of first-time buyers has decreased over the last years, which our mechanism introduced in this chapter suggest is a result of a secular downward trend in interest rates. This analysis has illustrated the unintended consequences of how low interest rates, in conjunction with financial stability regulations, prevent first-time buyers with limited equity from entering the housing market.

4 Empirical model

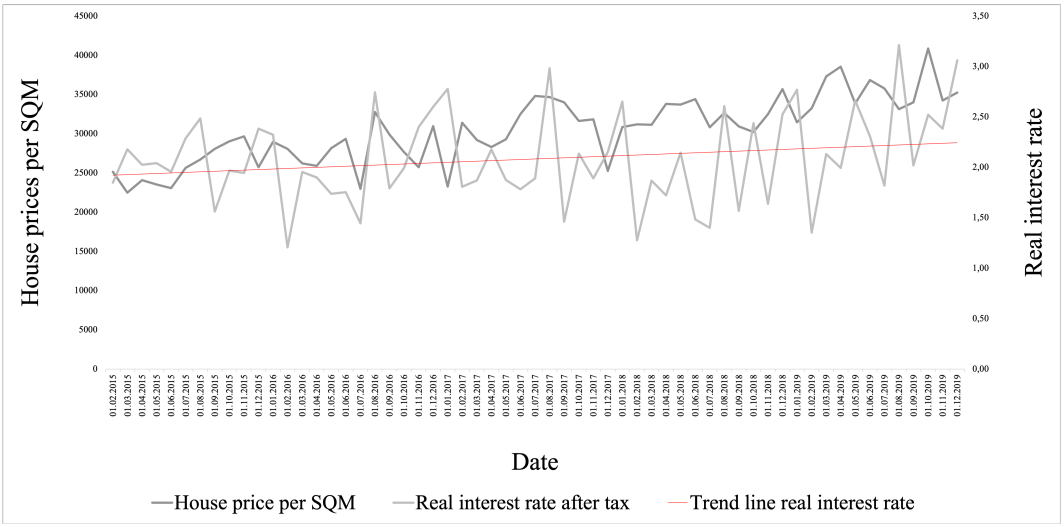
In the second part of our analysis, we introduce an empirical model of housing prices. At least two factors may affect house prices: interest-rate changes, which affect the price of long-term duration assets such as housing, and changes in households' preferences, which affect the relative valuation of different dwellings in the cross section. As our model shows, there may be unintended distributional consequences of financial-stability regulations in combination with interest-rate changes. In contrast, preference effects are rather a result of relative scarcity. We start by investigating the real interest rate effect on housing prices in order to determine the importance of our mechanism introduced in the theoretical model. We then explore whether there is a preference effect of living in metropolitan areas.

4.1 Data description

All effects following this empirical analysis is tested using a univariate time series[2]. Univariate series helps describe the data because it summarizes it, and looks for patterns. When estimating a linear regression the objective is to explain changes in one dependent variable based on changes in one or more independent variables (Brooks, 2014). We use the standard regression procedure OLS to estimate all our linear regressions.

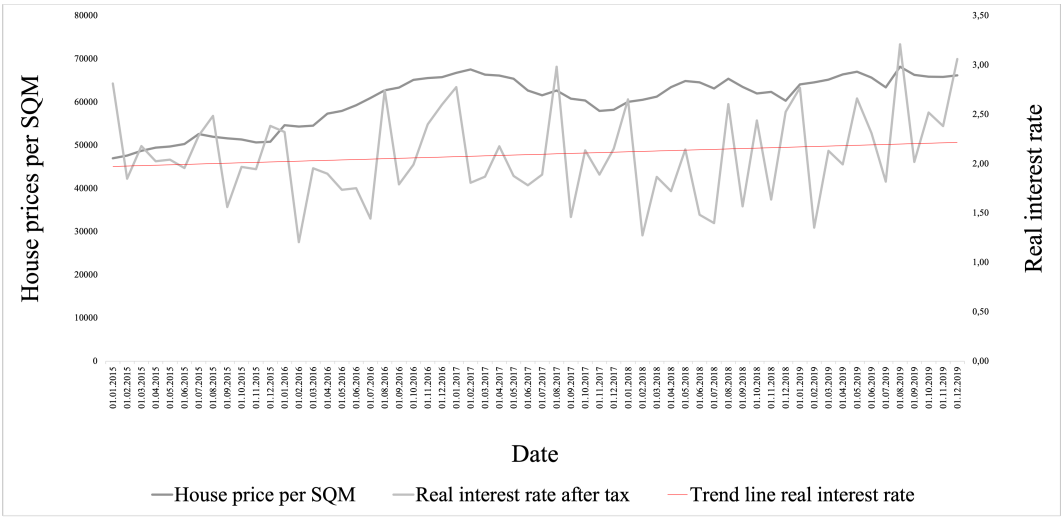
[2]Univariate time series is a time series that consists of single (scalar) observations recorded sequentially over equal time increments (Brooks, 2014).

Figure 4.1: Relationship between house prices per SQM and the real interest rate, Hamar 2015-2019



Source: Statistics Norway (SSB)

Figure 4.2: Relationship between house prices per SQM and the real interest rate, Oslo 2015-2019



Source: Statistics Norway (SSB)

We observe from Figure 4.1 and 4.2 that there is no noticeable correlation between the real interest rate and the house prices in Oslo and Hamar between 2015-2019, as the interest-rate has been relatively stable in this time frame. Therefore, we use two distinct datasets to estimate two effects; the interest rate effect and preference effect, starting with the former. The interest rate effect is estimated using data on house prices over a ten-year period between 2010 and 2019 from SSB, whereas the preference effect is estimated with data on house prices in Oslo and Hamar from Eiendomsverdi in the period 2015-2019. Since

the interest rate stays relatively flat in the time frame 2015-2019 we exclude it from the second regression along with the inflation.

4.1.1 House prices

In the first regression we collected data on the quarterly house price index in Norway between 2010-2019 from SSB, whereas the second regression is estimated with data on house prices in Hamar and Oslo between 2015-2019 from Norway's largest house price database, Eiendomsverdi (Eiendomsverdi, 2022). We convert the data from Eiendomsverdi into price per SQM. Since they only could provide us with 100,000 observations, the data solely covers a short time period. In addition, we narrow down our observations to make the data between Hamar and Oslo comparable. As housing prices vary based on size, we limit our search to dwellings between 50-60 square meter. Further, we filter the observations to only apartments to ensure that we compare dwellings with similar characteristics. To generate an equal amount of observations for the two areas, we take the average monthly price per square meter for both municipalities. We then obtain 120 house price observations in total, evenly split between Hamar and Oslo. It is crucial to distinguish between the different municipalities, as we create dummies in our regressions to investigate a preference effect on house prices between areas. Due to the short time period in our dataset, we convert prices into logarithmic prices to capture the effect of how changes in the independent variables lead to a percentage change in house prices.

4.1.2 Parameters

The variables included in our regression models are the real interest rate, income, unemployment, and a dummy for the municipality or district we want to investigate. The variables of main concern are the interest rate and the dummies, as we are investigating the interest rate effect and preference effect on housing prices. We include income and unemployment in addition to better

describe the financial aspects of the economy when estimating the preference effect (The Bank of Norway, 2021a). In the following section, we briefly explain the parameters we have included in our regression analysis.

4.1.2.1 Income

For a period of time, the growth in housing prices have been greater than the growth in income. As a result, individual's purchasing power in the housing market has weakened, as they have less economic flexibility (Lindquist et al., 2019). The average monthly, gross income is collected from Statistics Norway (SSB), where we use data from 2015 to 2019 to obtain data for the same time period as housing prices. This is a monthly average based on an annual average, meaning we have the same monthly income for all observations within the same year in the same municipality.

4.1.2.2 Unemployment

As the labor market changes, so does the level of unemployment, and with lower unemployment follows economic growth. Demand for goods and services rises as a result of increased market activity, resulting in higher house prices. In comparison to many other countries, Norway has experienced low and stable unemployment over the last decade (Norwegian Labor and Welfare Administration, 2022). To avoid the social and economic problems that can arise during recessions, it is critical for monetary policy to keep unemployment low and stable. We retrieve monthly unemployment data in Hamar and Oslo from the Norwegian Labor and Welfare Administration (NAV).

4.1.2.3 Real interest rate

The Bank of Norway set the interest rate in Norway in order to maintain a stable and low inflation in the economy, as interest rate changes stimulate market activity and have an impact on unemployment (The Bank of Norway,

2019). A high income level combined with a lower interest rate over time results in increased funding for households. This could act as a buffer against unexpected interest rate increases, dampening volatility in the housing market (Norwegian Ministry of Finance, 2021). Interest rates are therefore an important leading indicator of how the housing market will evolve over time. To regress the interest rate effect on housing prices, we collect quarterly interest rates on outstanding loans secured by housing between 2010 and 2019 from SSB, and subtract tax on ordinary income of 22 percent (The Norwegian Tax Authorities, 2022). In addition, we subtract inflation to obtain the real interest rate.

Inflation is defined as the continuous growth in a country's price level, which reduces the purchasing power of a currency (Stoltz, 2019). Moreover, a decrease in the interest rate will increase demand and thereafter increase inflation, which in turn will lead to higher housing prices. Subtracting inflation from the nominal interest rate gives us the real cost associated with interest expenses on homeowners' mortgages. When estimating the preference effect, our estimates was not affected by excluding inflation, and were therefore irrelevant to include.

4.2 Methodology

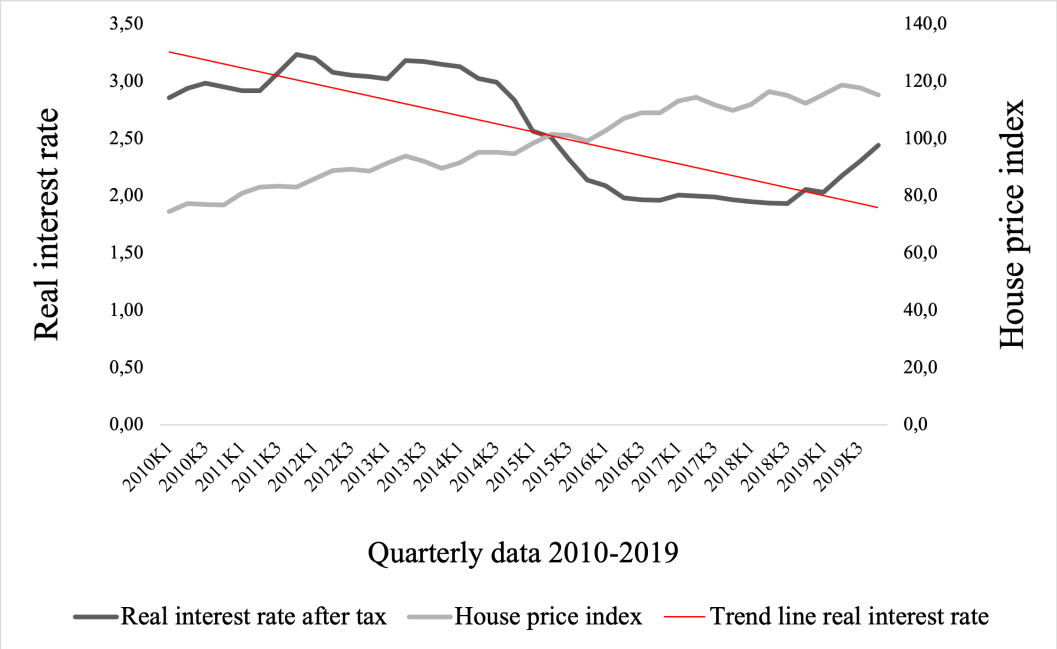
Despite the fact that there are numerous variables influencing house prices, we will in this empirical analysis concentrate on two key effects; the interest rate effect and a potential cross sectional preference effect. Our motivation is to analyze how the prices of long-term duration assets such as housing are determined by interest rate changes compared to household's preferences. The first regression test if the parsimonious model introduced in Chapter 3 holds in the data, and gives an empirical estimate of how large the interest-rate effect on housing prices is. The second regression demonstrates whether changes in housing prices are solely attributable to movements in the interest rate, or if they may also be influenced by a preference effect of residing in a metropolitan region.

4.2.1 The interest rate effect

In this part of our empirical analysis we study how changes in the real interest rate affect house prices to establish the importance of our mechanism introduced in the parsimonious model. The estimate will tell us how sensitive housing prices are to changes in the interest rate based on a time-series dimension. Moreover, it will indicate to what extent unintended consequences of a declining interest rate along with financial stability regulations affects equity constrained first-time buyers when entering the housing market. Regardless of location, the interest rate effect is general for all dwellings. The data obtained from Eiendomsverdi has particularity among the observations as it only includes prices in Hamar and Oslo for a 5 year period. We want to discover the general relationship between the interest rate and housing prices, not just for dwellings in certain areas, and therefore estimate a separate model based on average prices across the country. When the interest rate changes, the effect of changes in housing prices will only be observable if the change is permanent. A temporary change in the interest rate will not affect housing prices in any significant way. This means that, when looking at changes in the interest rate, we focus on trends. It takes time before demand is affected by an interest rate change, as households must realize whether the new interest rate is permanent or not (The Bank of Norway, 2018). The data in this model therefore considers a longer time horizon to represent the real interest effect in a more compelling way.

In Figure 4.3 below we have plotted the real interest rates against house prices between 2010 and 2019. From the plot we observe that the interest rate has experienced a secular downward trend over the past 10 years, while house prices simultaneously have been increasing. The negative relationship between the variables indicates that, when interest-rate decreases, house prices increase and vica versa.

Figure 4.3: Relationship between house prices and the real interest rate, Norway 2010-2019



Source: Statistics Norway (SSB)

We empirically estimate the causality between the real interest-rate on house prices using a linear regression, with the null- and alternative hypothesis:

H0: The mechanism in the parsimonious model do not hold in the data

H1: The mechanism in the parsimonious model do hold in the data

Resulting in the following regression:

$$P = \beta_0 + \beta_1 R + \epsilon \tag{4.1}$$

4.2.2 The preference effect

The preference effect is the additional amount households are willing to pay for a dwelling in a desired area. Such preferences can for instance be living in metropolitan areas, along the lake, or in the mountains. When testing for this effect, we aim to discover if preferences impact house prices beyond what is captured by changes in the interest rate. In our parsimonious model from Chapter 3 we discovered the unintended consequences from a lower interest rate and financial stability regulations, affecting, among others, the entrance for first-time buyers with limited equity. Estimating the preference effect cross sectionally helps us distinguish between how much of the changes in house prices can be explained by changes in the real interest rate, and how much is explained by preferences of living in a specific area. If the preference effect influences the relative valuation of house prices, we cannot conclude that the only factors preventing first-time buyers from entering the housing market in Oslo are decreasing interest rates along with financial stability regulations. Moreover, if there is a preference effect, it only prevents first-time buyers with limited equity from entering the house market in specific areas.

4.2.2.1 Frogner and Grorud

The first regression estimates the relative price difference from a preference effect between dwellings in Frogner and Grorud. We study this to see if there is a preference effect within the municipality Oslo, indicating if people are more inclined to live in the west compared to the east. This effect is captured by a dummy variable we introduce as "Frogner". More precisely, we test the following hypothesis:

H0: Households do not prefer to live in Frogner compared to Grorud

H1: Households do prefer to live in Frogner compared to Grorud

Regression (4.2) below is used to estimate the impact of income (INC), unemployment (UNEMP), and the preference effect on square meter prices in Frogner compared to Grorud.

$$log(P) = \beta_0 + \beta_1 INC_i + \beta_2 UNEMP_i + \beta_3 Frogner_i + \epsilon_i \tag{4.2}$$

The dummy estimate from this regression indicates how much house prices in Frogner, compared to Grorud, are driven by a preference effect. The subscript "i" will differ based on whether we are in Frogner or Grorud when estimating the dummy, but we have not collected income and unemployment in different districts, it´s general for all over Oslo. Data for income and unemployment will therefore be the same for both districts in this model and all following models, except the case where we compare Oslo to Hamar.

Further, we analyze the preference effect between Grorud and Hamar, and Frogner and Hamar to study whether it applies for certain areas in Oslo. We want to study if people prefer to purchase a dwelling in both the eastern and western parts of Oslo rather than Hamar. We introduce two new regressions with two new dummies, namely "Grorud" and "Frogner*"[3], and test the following two hypotheses and run the following regressions:

H0: Households do not prefer to live in Grorud compared to Hamar

H1: Households do prefer to live in Grorud compared to Hamar

$$log(P) = \beta_0 + \beta_1 INC_i + \beta_2 UNEMP_i + \beta_3 Grorud_i + \epsilon_i \tag{4.3}$$

and

[3]Frogner* is the preference of living in the district Frogner compared to Hamar.

H0: Households do not prefer to live in Frogner compared to Hamar

H1: Households do prefer to live in Frogner compared to Hamar

$$log(P) = \beta_0 + \beta_1 INC_i + \beta_2 UNEMP_i + \beta_3 Frogner_i^* + \epsilon_i \tag{4.4}$$

4.2.2.2 Oslo and Hamar

Finally, we estimate the preference effect of living in metropolitan areas compared to the countryside, to see if the preference effect can be generalized for Oslo. We introduce a new dummy called "Oslo". This variable indicates to what extent individuals are willing to pay more per SQM when purchasing a dwelling in Oslo on a general basis compared to Hamar. We test the following null hypothesis against the alternative:

H0: Households do not prefer to live in metropolitan areas

H1: Households do prefer to live in metropolitan areas

The regression we obtain is then:

$$log(P) = \beta_0 + \beta_1 INC_i + \beta_2 UNEMP_i + \beta_3 Oslo_i + \epsilon_i \tag{4.5}$$

4.3 Results

4.3.1 The interest rate effect

In the first regression following the empirical analysis we aim to capture the interest rate effect on house prices in a time-series dimension. We find empirical support for a casual relationship between the real interest rate and housing prices. The object for this exercise is to validate the mechanism introduced in Chapter 3.

Following the model in Chapter 3, the negative relationship between the house prices and the real interest rate affects the equity requirement from the financial stability regulations. In the case of a lowered interest rate, it is not the price increase in itself that prevents first-time buyers from entering the housing market, but the increased equity requirement following the higher prices. This is the unintended consequence first-time buyers must face due to the restrictive financial stability regulations in an economy experiencing a downward sloping trend in the interest rates.

The estimated coefficient determines how sensitive housing prices are to the interest rate. According to the estimate in Appendix 6, there is a negative relationship between the real interest rate and the house prices of 23 percent, significant at all levels. This indicates that, if the interest rate increases by one percentage point, house prices decrease by 23 percent. When the market experiences decreased interest rates, our results confirm it will be harder for equity constrained entrants to buy a dwelling since prices will increase. The mechanism from the parsimonious model is of importance as the negative relationship between the interest rate and housing prices holds in the data, and we reject the null hypothesis.

4.3.2 The preference effect

To investigate the difference in house prices between municipalities and districts, we conducted four regressions using OLS. The p-value results from the estimation are summarized in the tables below.

	Income	Unemployment	Frogner
Price	0.0156*	0.0445*	0.0001***

Table 4.1: *Summarized results from Appendix 7: Regressing the districts Frogner and Grorud on prices per square meter.*

From table 4.1 we observe that all estimates from the independent variables are statistically significant[4]. The significant price difference could be considered in conjunction with the fact that income and unemployment varies across different districts in Oslo. From the living standard indicator retrieved from Oslo Municipality (2019), we know that households in Frogner are more highly educated compared to Grorud. In addition there are almost half as many low-income families living there. Since the estimates for income and unemployment are significant, one could argue that due to higher wealth in Frogner, this leads to higher prices per square meter. However, we do not have any data on income and unemployment between districts, only for Oslo in general. Therefore, even though we obtain significance for these two estimates, they don't have any economic significance.

The dummy estimate gives first-time-buyers an indication on how much more they must be willing to pay if they decide to buy an apartment in Frogner. It demonstrates that home buyers must pay approximately 60 percent more (Appendix 7) per extra square meter in the preferred area Frogner compared to Grorud.

The preference effect in this case is capturing the difference in square meter prices between the west, Frogner, and the east, Grorud. The significance of the dummy Frogner indicates that households are willing to pay a significantly

[4] * indicates significance at a 5 percent level, ** indicates significance at a 1 percent level, and *** indicates significance at a 0.1 percent level.

higher amount per square meter in this district compared to Grorud. This implies that there is a preference effect influencing housing prices in different districts in Oslo, and we reject the null hypothesis.

	Income	Unemployment	Grorud
Price	0.0001***	0.153	0.659

Table 4.2: *Summarized results from Appendix 8: Regressing the district Grorud and municipality Hamar on prices per square meter*

The significance of the estimates when regressing the areas Grorud against Hamar on housing prices is shown in table 4.2 above. Unemployment is not significant, and does not have an economic importance in this case. However, income is still significant, which is not surprising given that we were unable to distinguish between income in specific districts.

In this case, we observe that the effect on square meter prices in Grorud is negative at 7 percent. This indicates that households are willing to pay 7 percent less per square meter in Grorud compared to Hamar. However, we discovered that the preference effect was not significant in this case. As a result, there is no empirical evidence supporting the statement that people are more inclined to buy a dwelling in Hamar in comparison to Grorud, and we fail to reject the null hypothesis. The results show that equity-restrained first-time buyers will not face any restrictions caused by a preference effect when entering the housing market in Grorud compared to Hamar.

	Income	Unemployment	Frogner*
Price	0.0001***	0.411	0.0001***

Table 4.3: *Summarized results from Appendix 9: Regressing the district Frogner and municipality Hamar on prices per square meter*

From table 4.3 we see that both the estimates income and Frogner* are statistically significant, whereas unemployment is still insignificant. The significance of income is expected since we are unable to distinguish between income in specific districts. According to the table in Appendix 9, there is a

preference effect indicating that prices in Frogner are about 86 percent higher per square meter compared to Hamar. This mean that households are willing to pay substantially more for a dwelling in Frogner compared to Hamar. Since the effect is significant at all levels, we reject the null and conclude that households do prefer to live in Frogner compared to Hamar.

	Income	Unemployment	Oslo
Price	0.0001***	0.893	0.0001***

Table 4.4: *Summarized results from Appendix 10: Regressing Hamar and Oslo on prices per square meter*

According to table 4.4, income and the preference effect are both significant at all levels when describing prices per square meter in Oslo and Hamar. Unemployment is, however, not significant, indicating that it does not adequately describe any changes in prices per square meter between Oslo and Hamar. The significance of income indicates that, if income changes, the square meter price will change by a given percentage. In this case, we have data on income and unemployment in Oslo and data on income and unemployment for Hamar. We can therefore state that income helps describe differences in prices between different municipalities. Looking at the coefficient estimate, we see that if income increases by one unit it results in a 0.05 percent increase in housing prices. The economic interpretation is that households with higher incomes are willing to pay more for a dwelling simply because they are able to. However, considering the fact that the coefficient estimate is very close to zero, the effect is of minor importance. Furthermore, living in Oslo on a general basis has a significant impact on the square meter price compared to living in Hamar. According to the table in Appendix 10, households must pay 48 percent more for a dwelling in Oslo compared to a dwelling in Hamar. In other words there is a preference effect of living in metropolitan areas, and we end up rejecting the null hypothesis.

5 Conclusion

Throughout this thesis, we have presented a two-part analysis of the housing market. In the first part we presented a parsimonious model where the price of housing, as a long-term duration asset, adjusted to interest-rate changes. In the second part, we estimated how sensitive house prices are to interest rate changes and distinguished between interest-rate changes in the time-series dimension and preference effects on the cross section. Together this shows how interest-rate changes may have distributional consequences through changing the ability for young buyers' to purchase their first dwelling.

The Norwegian housing market has experienced exponential growth over the last 20 years. The most significant increase in house prices has been in Oslo, resulting in a higher average age of first-time buyers there compared to the rest of Norway. Even though the growth has been general in Oslo, it appears to be more significant in the western part compared to the eastern part of the city. This is since the wealthy tend to live in the west, but it can also be due to scarcity of housing. In turn, this increases prices, making it more difficult for first-time buyers to enter the market in the western part. In addition, The Bank of Norway has imposed financial stability regulations, restricting the ability for households to obtain financing.

In the first part of our analysis, we investigate potential unintended consequences for first-time buyers facing a declining interest rate along with financial stability regulations. From a parsimonious model we illustrate how housing prices adjust to interest rate changes. This theoretical model exemplifies how a declining real interest rate along with financial stability regulations such as the equity requirement and loan-to-income, unintendedly makes it more difficult for equity constrained entrants to buy their first dwelling.

We studied three different cases; a frictionless market, a market with equity requirements, and a market with both equity requirements and debt constraints. In the first case the interest rate changes did not affect first-time buyers, as

interest expenses adjust to housing prices. The second case found that a declining interest rate increased housing prices and therefore also the equity requirement, forcing equity constrained first-time buyers to save in order to obtain sufficient equity to buy a dwelling. Due to the equity requirement of 15 percent, entrants must either reduce their consumption or standard of living to save sufficient equity. Reducing consumption is the most efficient way of saving, whereas the latter would require saving for more than a decade. When including both the equity requirement and the credit constraint, entrants had to save half of the market value in order to afford a dwelling of 50 square meter in Oslo. Our findings from the parsimonious model illustrate that the negative relationship between interest rates and housing prices increases the equity required as the interest rate declines. The distributional consequences of a lowered interest rate are unintendedly reinforced by the financial stability regulations for equity constrained first-time buyers in Oslo.

Furthermore, we conducted a two-part empirical analysis to investigate how sensitive house prices are to interest rate changes and distinguished between interest-rate changes in the time-series dimension and the preference effect on the cross section. The interest rate effect demonstrated the importance of our mechanism discovered in the theoretical model. We find that the mechanism is of importance and that housing prices are sensitive to changes in the interest rate. However, we discovered that the housing prices are not only sensitive to interest rate changes, but also to scarcity of housing. In metropolitan areas we observed a significant preference effect through a cross section analysis, which was limited to specific districts of Oslo, such as Frogner. Additionally, we found a general preference effect in Oslo compared to less metropolitan areas, like Hamar.

These analyses of the housing market show that first-time buyers are not only met with banks' restrained lending regulations, but also with high house prices in preferred areas. Despite the fact that housing prices vary depending on location, the interest rate and financial stability regulations apply to everyone. This makes it more difficult for equity constrained first-time buyers to buy a dwelling in metropolitan areas. Entrants must therefore be willing to move

outside the city center, for instance to Grorud, or to a different municipality, for instance Hamar, to be able to afford a dwelling.

Our initial parsimonious model did not incorporate any preference effect when analyzing how entrants are affected by interest rate movements and financial stability regulations when purchasing a dwelling. The case we assumed was a 50 square meter apartment in Oslo. This indicates that the unintended consequences of the financial stability regulations following a lowered interest rate is not the main factor preventing first-time buyers from entering the housing market in general, nonetheless it holds them outside the market in specific areas.

5.1 Future predictions on the Norwegian housing market

Based on our findings in this thesis, we will make predictions on future house prices in Norway. From The Bank of Norway's Monetary Policy Report from June 2022, the committee projects that within 2024, the interest rate on mortgages will rise to about 4.3 percent (The Bank of Norway, 2022). Our findings in this thesis have revealed a negative correlation between the real interest rate and house prices. Accordingly, rising interest rates will cause a decline in housing prices in the future. We therefore predict that it will be easier for equity constrained first-time buyers to enter the housing market because the amount of equity needed will decline as housing prices fall. However, we have also found that, in addition to interest rate changes, the preference effect also significantly influences house prices within and between Norwegian municipalities. We anticipate that the decline in housing prices as a result of increased interest rates will not be as significant in Oslo where we discovered a sizable preference effect, notably in the city center of Oslo. Consequently, the increase in the real interest rate will not make it simpler for first-time buyers to enter the market anywhere, since the interest rate effect will be less important in preferred areas of Norway.

References

Aastveit, K. A. and Anundsen, A. K. (2018). Renteendringer og boligpriser. Retrieved from. The Bank of Norway.

Aastveit, K. A., Juelsrud, R. E., and Wold, E. G. (2020). Mortgage regulations and financial vulnerability at the household level. *Working paper 6/2020*, Retrieved from. The Bank of Norway.

Adelino M., S. A. and F., S. (2012). Credit supply and house prices: Evidence from mortgage market segmentation. *Working paper 17832*, Retrieved from. NBER.

Borgersen, T. and Greibrokk, J. (2012). A comment on ltv, risk and incentives in mortgage markets. *Working paper 4*, Retrieved from. Høyskolen i Østfold.

Brooks, C. (2014). *Introductory: Econometrics for Finance*. 3rd ed. UK: Cambridge University Press.

Bø, E. (2010). Om rentens effekt på konsum og sparing. Retrieved from. Statistics Norway.

Eerola, E. and Määttänen, N. (2017). Borrowing constraints and housing market liquidity. Retrieved from. Statistics Norway.

Eiendomsverdi (2022). Eiendomsinformasjon satt i system. Retrieved from. Eiendomsverdi.

Hammernes, L. M. (2006). Hvorfor stiger boligprisene? Retrieved from. Nettavisen.

Haurin, D. R., Hendershott, P. H., and Wachter, S. M. (1996). Borrowing constraints and the tenure choice of young households. *Working paper 5630*, Retrieved from. NBER.

Iversen, K. O. (2016). En toroms til bare 50 000 kroner!? Retrieved from. DNB Eiendom.

Larsen, E. R. and Sommervoll, D. E. (2004). Hva bestemmer boligprisene? Retrieved from. Samfunnsspeilet.

Lindquist, K. and Vatne, B. H. (2019). Utviklingen i husholdningenes kjøpekraft i boligmarkedet. *Staff memo 2019/4*, Retrieved from. The Bank of Norway.

Løyning, T. (2020). Re-politicizing financial regulation: a sociological analysis of the debate on loan-to-value regulation in norway. Retrieved from. Routledge.

Mamre, M. O. (2021). Boligkjøper kraften til en representativ lokal førstegangskjøper. *Scientific publication*, Retrieved from. Universitetsforlaget.

Mian, A. and Sufi, A. (2009). The consequences of mortgage credit expansion: evidence from u.s. mortgage default crisis. Retrieved from. Oxford Avademic.

Norwegian Labor Welfare Administration, . (2022). The labour market situation in norway. Retrieved from. Norwegian Labor and Welfare Administration.

Olsen, (2017). Pengepolitikkens formål og muligheter. *SLecture by Øystein Olsen at Handelshøyskolen BI*, Retrieved from. The Bank of Norway.

Oslo Municipality, . (2019). Levekårsindikatorer. Retrieved from. Oslo Municipality.

Oslo Municipality, . (2022). Boligpriser. Retrieved from. Oslo Municipality.

Skorve, (2021). Urovekkende få boliger til salgs. Retrieved from. DNB Eiendom.

Statistics Norway, . (2019). Færre unge kjøper bolig. Retrieved from. Statistics Norway.

Statistics Norway, . (2022). Fakta om befolkningen. Retrieved from. Statistics Norway.

Stoltz, G. (2019). Inflasjon. Retrieved from. SNL.

Sættem, J. B., Hellerud, H. T., and Johansen, T. G. (2012). Slik har norske boligpriser utviklet seg gjennom de neste 200 årene. Retrieved from. NRK.

The Bank of Norway, . (2008). Finansiell stabilitet. Retrieved from. The Bank of Norway.

The Bank of Norway, . (2016). Analyses of mortgage lending requirements. Retrieved from. The Bank of Norway.

The Bank of Norway, . (2018). Får folk med seg norges banks signaler om renten? Retrieved from. The Bank of Norway.

The Bank of Norway, . (2019). Hvordan påvirker renten økonomien og inflasjonen? Retrieved from. The Bank of Norway.

The Bank of Norway, . (2021). Utsiktene for finansiell stabilitet. Retrieved from. The Bank of Norway.

The Bank of Norway, . (2022). Pengepolitisk rapport med vurdering av finansiell stabilitet. Retrieved from. The Bank of Norway.

The Norwegian Ministry of Finance, . (2021). Long-term perspectives on the norwegian economy 2021. Retrieved from. The Norwegian Ministry of Finance.

The Norwegian Real Estate Association, . (2021). Førstegangskjøpere q2 2021. Retrieved from. The Norwegian Real Estate Association.

The Norwegian Tax Authorities, . (2022). Alminnelig inntekt. Retrieved from. The Norwegian Tax Authorities.

Wig, K. (2017). Her skrelles førstegangskjøperne; - en alvorlig utfordring. Retrieved from. E24.

Appendix

A1 Parsimonious model in a frictionless market

3.1 A Frictionless Market					
Annual Interest rate	**1,00%**	**2,00%**	**3,00%**	**4,00%**	**5,00%**
% Change in interest		100%	200%	300%	400%
Monthly PV	10 000	10 000	10 000	10 000	10 000
Annual PV	**120 000**	**120 000**	**120 000**	**120 000**	**120 000**
PV	2 400	2 400	2 400	2 400	2 400
Size	50	50	50	50	50
Market value	12 000 000	6 000 000	4 000 000	3 000 000	2 400 000
Interest expenses	**120 000**	**120 000**	**120 000**	**120 000**	**120 000**

A2 Parsimonious model - Introducing LTV

3.2 Introducing Equity (LTV)			
Inputs			
LTV	85%		
Equity requirement	15%		
Annual Interest rate	**2,00%**	**1,50%**	**2,50%**
% Change in interest		−25%	25%
Market value	6 000 000	7 500 000	4 500 000
Equity	900 000	1 125 000	675 000
Loan value	5 100 000	6 375 000	3 825 000

A3 Parsimonious model - Saving to fund equity with LTV

3.2.1 Saving to fund own equity with LTV

Inputs	
Gross income	600 000
Tax rate	30%
Equity	900 000
Annual PV	120 000

*Savings model when **consuming less with 2% interest rate***

Annual net income	420 000	420 000	420 000	420 000	420 000	420 000
Annual PV	120 000	120 000	120 000	120 000	120 000	120 000
Availble funds	300 000	300 000	300 000	300 000	300 000	300 000
Monthly consumption	25 000	10 000	8 000	6 000	4 000	2 000
Annual consumption	300 000	120 000	96 000	72 000	48 000	24 000
Savings	0	180 000	204 000	228 000	252 000	276 000
Reduction in consumption	0%	60%	68%	76%	84%	92%
Years of saving		5,0	4,4	3,9	3,6	3,3

*Savings model when **renting cheaper with 2% interest rate***

Annual Net Income	420 000	420 000	420 000	420 000	420 000	420 000
Annual PV	120 000	120 000	120 000	120 000	120 000	120 000
New annual PV	120 000	96 000	72 000	48 000	24 000	12 000
Availble funds	300 000	324 000	348 000	372 000	396 000	408 000
Monthly consumption	25 000	25 000	25 000	25 000	25 000	25 000
Annual consumption	300 000	300 000	300 000	300 000	300 000	300 000
Savings	0	24 000	48 000	72 000	96 000	108 000
Reduction in rent	0%	20%	40%	60%	80%	90%
Size of the apartment	50	40	30	20	10	5
Years of saving	0	38	19	13	9	8

A4 Parsimonious model - Introducing LTI

3.3 Introducing LTI

Inputs	
Tax Rate	30%
Equity requirement	15%
Gross income	600 000
LTI	500%

Annual Interest rate	**2,00%**	**1,50%**	**2,50%**
% Change in interest		−25%	25%
Market value	6 000 000	7 500 000	4 500 000
Loan based on LTI	3 000 000	3 000 000	3 000 000
Loss in Loan value	3 000 000	4 500 000	1 500 000
Equity	900 000	1 125 000	675 000
Excess equity due to LTI	2 100 000	3 375 000	825 000
Savings	3 000 000	4 500 000	1 500 000

A5 Parsimonious model - Saving to fund equity with LTI LTV

3.3.1 Saving to fund own equity with LTI & LTV

*Savings model when **consuming less with 2% interest rate***

Annual net income	420 000	420 000	420 000	420 000	420 000	420 000
Annual PV	120 000	120 000	120 000	120 000	120 000	120 000
Availble funds	300 000	300 000	300 000	300 000	300 000	300 000
Monthly consumption	25 000	10 000	8 000	6 000	4 000	2 000
Annual consumption	300 000	120 000	96 000	72 000	48 000	24 000
Savings	0	180 000	204 000	228 000	252 000	276 000
Reduction in consumption	0%	60%	20%	25%	33%	50%
Years of saving		17	15	13	12	11

*Savings model when **renting cheaper with 2% interest rate***

Annual net income	420 000	420 000	420 000	420 000	420 000
Annual PV	120 000	120 000	120 000	120 000	120 000
New annual PV	120 000	96 000	72 000	48 000	24 000
Availble funds	300 000	324 000	348 000	372 000	396 000
Monthly consumption	25 000	25 000	25 000	25 000	25 000
Annual consumption	300 000	300 000	300 000	300 000	300 000
Savings	0	24 000	48 000	72 000	96 000
Reduction in rent	0%	20%	40%	60%	80%
Years of saving	0	88	44	29	22

A6 OLS regression interest rate effect on house prices

Dependent variable: Index house prices in Norway.				
Method: Ordinary least Square.				
Sample: 2010 month 01 to 2019 month 12.				
Included observations: 40 after adjustments.				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Pr(>|t|)**
(Intercept)	5.18705	0.06620	78.357	0.0001
RR	-0.23587	0.02523	-9.348	0.0001
R-Squared	0.6969	**Adjusted R-Squared**		0.6889

A7 OLS regression with Frogner and Grorud

Dependent variable: Natural logarithm of square meter prices in Frogner and Grorud				
Method: Ordinary least Square				
Sample: 2015 month 01 to 2019 month 12				
Included observations: 105 after adjustments				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Pr(>|t|)**
(Intercept)	9.977020921	0.520068489	19.184	0.0001
INC	0.000020053	0.000008154	2.459	0.0156
UNEMP	-0.00002602	0.000012875	-2.035	0.0445
Frogner	0.596336951	0.020658441	28.867	0.0445
R-Squared	0.8992	**Adjusted R-Squared**		0.8962

A8 OLS regression with Grorud and Hamar

Dependent variable: Natural logarithm of square meter prices in Grorud and Hamar				
Method: Ordinary least Square				
Sample: 2015 month 01 to 2019 month 12				
Included observations: 107 after adjustments				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Pr(>|t|)**
(Intercept)	8.110878257	0.275536509	29.437	0.0001
INC	0.000049134	0.000006089	8.070	0.0001
UNEMP	0.000020246	0.000014061	1.440	0.153
Grorud	-0.07428249	0.167672728	-0.443	0.649
R-Squared	0.7846	**Adjusted R-Squared**		0.7784

A9 OLS regression with Frogner and Hamar

Dependent variable: Natural logarithm of square meter prices in Frogner and Hamar				
Method: Ordinary least Square				
Sample: 2015 month 01 to 2019 month 12				
Included observations: 118 after adjustments				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Pr(>|t|)**
(Intercept)	8.470179961	0.219771366	38.541	0.0001
INC	0.000041315	0.000004856	8.509	0.0001
UNEMP	-0.00000886	0.000010748	-0.825	0.411
Frogner*	0.865179927	0.128856526	6.714	0.0001
R-Squared	0.9692	**Adjusted R-Squared**		0.9684

A10 OLS regression with Oslo and Hamar

Dependent variable: Natural logarithm of square meter prices in Oslo and Hamar.				
Method: Ordinary least Square.				
Sample: 2015 month 01 to 2019 month 12				
Included observations: 120 after adjustments				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Pr(>|t|)**
(Intercept)	8.237176649	0.1747934529	47.125	0.0001
INC	0.000046333	0.0000038862	0.135	0.0001
UNEMP	0.000000463	0.0000034231	0.135	0.893
Oslo	0.476707023	0.0482169806	9.887	0.0001
R-Squared	0.9512	**Adjusted R-Squared**		0.9499