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Investing in Residential Real Estate: A Smart Decision?

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Declaration of Authenticity

I hereby declare that the Master´s Thesis presented herein is my own work, or fully and specifically acknowledged wherever adapted from other sources. This work has not been published or submitted elsewhere for the requirement of a degree program.

Prague, May 14, 2018 Signature

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Abstract:

My goal for this thesis is to provide a deeper understanding of the housing market in Oslo, by comprehending why and how the prices fluctuates the way they do. In order to do so, I have analyzed the housing prices over the past 18 years. Furthermore, I have performed a regression analysis to understand the main influencing factors affecting the housing prices. I have then calculated the price-to-rent ratio as well as using the Hodrick-Prescott filter to detect if there are any "bubble tendencies" in the housing market in Oslo. Based on this I have been able to understand the underlying factors and whether or not it is a smart decision, investing in residential real estate in any of the specified areas.

Key words:

Residential real estate, housing prices, investment, Oslo

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List of Abbreviations

NOK	The Norwegian Krone
EU	European Union
EEA	European Economic Area
GDP	Gross Domestic Product
DNB	The Norwegian Bank
NHO	Confederation of Norwegian Enterprises
CPI	Consumer Price Index
Q	Quarter
SSB	Statistics Norway
OECD	Organization for Economic Co-operation and Development
nth	Several values in a sequence (ex. nth time buyers, not first-time)

1. Introduction

Oslo has over the past years, experienced a dramatic increase in its housing prices. There have been many discussions worldwide, regarding the Norwegian market, Oslo in particular. Many people assume that there has been and still is a housing bubble present in the market, and that there is just a matter of time before the prices start falling. Numerous models exist on how to analyze the influencing factors as well as predicting potential bubbles. Several analysts use a mixture of these models in order to come to a useful conclusion of the housing market and have based on this constructed their own models. For now, there are more than one model able to do so. Among these are Case and Shiller (2003) who have predicted a housing bubble in Norway over the years. Furthermore, Jacobs and Naug (2005) has constructed a housing model in order to determine the explanatory variables influencing the increase or decrease in housing prices.

There are many reasons why the prices have fluctuated the way they have; the decreasing interest rate and low unemployment rate. Furthermore, the government has acted accordingly, in order to slow down the development, by imposing stricter models on the banks as well as even stricter legislations on investors, increasing the equity financing of nth time buyers from 15 to 40 percent. This is in order to calm the interest of speculators investing in real estate.

The aim of this paper is to provide a deeper understanding of the housing market in Oslo, moreover, why and how the price fluctuates the way they do. This by giving a detailed explanation of the previous and current state of the market, and the factors influencing the real estate prices. I will illustrate the development of the real estate prices in specific areas of Oslo. Furthermore, in order to understand the real estate market, it is of great importance to define what a "housing bubble"[1] is and how to predict whether there is one and if there is a possibility of it bursting in the near future. The bubble theory is explained in detail from several sources, in order to find the most appropriate one.

1.1 Outline

The second chapter is the underlying theory, the literature review. In this part, I will introduce the theory behind the factors influencing the housing market. Furthermore, I am explaining the theories behind housing prices and household consumption, supply and demand, housing bubbles and lastly, the market forecast and clustered areas of Oslo. In this part I have mentioned prices on several occasions. The currency used in NOK, where €1 is worth 9.5 NOK (Bloomberg, 2018), which I have taken into

[1] Definition of a housing bubble is presented in chapter 2.5

consideration when calculating the prices into Euro in this part and can be further used when understanding the empirical results.

In chapter 3 I have presented the methodology, the data selection and the functions and limitations of using such methodology in the context of housing prices. Then, in chapter 4, I will present the data provided in order to assess the housing market. Here I will present the empirical results, conducted by doing a simple linear regression and multiple regression analysis based on previous findings from (Jacobsen & Naug, 2005), calculating a price-to-rent ratio and the Hodrick-Prescott Filter (Hodrick & Prescott, 1997).

In chapter 5, I will look at the findings from chapter 4 and apply discussions and theory from chapter 2, in order to analyze my findings, based on other aspects that I have not taken into considerations yet. Lastly, chapter 6, is the conclusion, where I seek to summarize the main objectives and findings of my paper.

1.2 Problem Definition

The aim of this paper is to understand the development of the housing prices in Oslo. The effect of the real estate market will be seen in an 18 to 5-year period from 2000 until 2018. This has led me to the problem definitions:

I. *What are the underlying factors influencing the real estate market in Oslo?*

II. *Could a housing bubble exist in the market?*

III. *Based on this, I will try to determine if it would be smart investing in an apartment in Oslo City center.*

1.3 Motivations and Objectives

My motivations for choosing this topic is primarily based on my fascination for the real estate market. I have closely monitored the housing market in Oslo since I started my studies in Real Estate, 5 years ago. As the prices, over this period, have increased considerably, it has always been an interest of mine to understanding the fundamental reasons behind this rapid rise. Especially, due to all the speculations and discussions over the years, around this topic. As the real estate market is an important part of the Norwegian economy, I wanted to focus on the specific influencing factors, as well as the bubble tendencies discussion, in order to expand my horizons and fully comprehend all aspects of the housing market.

1.4 Limitations and Work Difficulties

At first, my limitations were to find the accurate data. Overall, it was considerably easier to find data based on Norway as a whole, compared to only Oslo. Moreover, when I found the data, finding the data in English was nearly impossible at times. Therefore, some of the sources are, unfortunately, only available in Norwegian. Therefore, there is of course a possibility of information being lost in translation. However, I have done my best in order to translate as precisely as possible.

Furthermore, I chose to focus on predetermined areas rather than Oslo as a whole, which might have led to less precise findings. As there has been a difficulty in finding equal amounts of information for each clustered area. I must emphasize that I have never written any thesis before and struggled a lot in the beginning to find the right balance on how to structure the paper, later how to structure my sentences and finally to explain my findings. As I have not worked in STATA, or with regressions since 2014, I spent some time re-gaining my knowledge in the field of econometrics. Luckily, I had the opportunity to ask a professional within the field of statistics, Ing. Karel Helman, Ph.D., who recommended me to simplify my analysis. As I have limited knowledge within this field, I was unable to fully produce the high-level analysis, done by economists with doctorates within this area. However, I managed to simplify the models, as recommended by Helman, in order to build on the analysis and managed to produce somewhat similar results.

2. Literature Review

According to a survey of consumer finances from The United States, housing comprises two thirds of a homeowner's assets (Sinai & Souleles , 2013), and is one of the most important investment decisions that can be made (Statistics Norway, 2005). Prior to investing, however, it is important to understand the historical price fluctuation, the cause for that fluctuation and how it impacts the homeowner's decision making. Additionally, gathering data on the past years development, the current market, market forecasts and scientific reviews, aids the determination on whether or not investing in residential real estate in Oslo is a smart decision.

This chapter seeks to give an overview of relevant litterateur within the research area including connected topics. Focusing on the Norwegian real estate market, previous research within the same field from both Norway and different parts of the world, and general economic factors known to influence the housing prices, how they work separately and together.

2.1 Market Overview

In 2013, the Financial Times warned of a potential housing bubble within the Norwegian housing market. At this time, the prices had increased by 71 percent since 2005. The inflation-adjusted prices had risen 6 percent from 2008 to 2012, while the disposable income of households had only increased by 3.8 percent in the same period (an average of 0.8 percent ahead of other western economies) (Financial Times, 2013). The article also referred to how there had been concerns regarding the effect of oil and the inflation-bursting wage agreements. The potential of a bubble was not a topic that people wanted to discuss, however the article argued that there is reason to believe the Norwegians have something to fear, especially when housing prices are currently a hot topic.

According to Bloomberg (2017a), due to the rapid increase in housing prices on the Norwegian market, there is concern that a bubble is about to burst. As the figure below clearly states, there has been remarkable growth in the Norwegian housing prices since the financial crisis in 2008. Within the past year, however, there has been a sharp decline in prices, which led to an increase in the number of homes for sale by 17 percent. Naturally, a decline in prices leads to sellers quickly putting their homes in the market, as they wish to sell their houses for as high of a price as possible and before the prices hit "bottom". This, according to Bloomberg explains part of the reasoning behind the increase in homes on the market as well as the decline in prices in the respective period.

Figure 2-1: Annual house price growth, Norway
Source: https://www.bloomberg.com/news/articles/2017-07-05/norway-s-housing-market-downturn-gathers-pace-amid-bubble-fears

The Norwegian home prices, according to Bloomberg may have reached a tipping point after surging 75 percent at the end of the financial crisis, while the prices have declined by approximately 3 percent over the past six months (Bloomberg, 2017b). Simultaneously, household debts have risen from 120 percent of disposable income in the beginning of 2000, to 223 percent today. Norway's Finance Minister, Siv Jensen explains the difficulty in determining the market forces regulating demand and supply but emphasizes that there must be a distinction between this and the build-up of debt, and states that at the moment steps should not be taken concerning this debt.

Norway has recently gone through the worst oil-industry crisis in a generation. As western Europe's largest oil and gas producer the Norwegian economy was heavily affected by this, proving how the economy was more vulnerable to the dropping prices than expected. Siv Jensen stated that investing in other sectors of the economy is pivotal (Bloomberg, 2017b). It is discussed that the downturn in the oil industry has led to a decrease in the population growth, considering Norway does not attract the same amount of job seekers from abroad as previously (Berglund, 2017). Moreover, the Norwegian economy is still highly affected by the oil downturn. The GDP growth was at its lowest since 2009, in 2016, but it is indicated to continue growing in the period ahead. Investment excluding oil and gas is predicted to grow, due to the strong growth in residential real estate and public spending (Union Gruppen , 2017).

Looking back to 2014, The Financial Supervisory imposed stricter models for banks to estimate potential residential mortgage risk (Finanstilsynet, 2014). The Ministry of Finance raised the floor on loss given default estimates (LDG) from 10 to 20 percent. From 2017, the government again imposed extra restrictions on mortgage lending from the banks. A borrower has a lending cap of five times his or her income, requiring 15 percent equity financing on first-time purchases, while 40 percent is required by nth time buyers. Thus, trying to address a potential housing bubble, with the particular focus on Oslo (Reuters, 2016).

Moreover, the average debt per household has increased considerably since 2000, consisting of 1.3 million NOK in 2016. There are many reasons for this, but a major factor is the cultural and social norms as 77 percent of households own their homes (Statistics Norway, 2017b). Housing is considered to be one of the pillars of the Norwegian welfare state and 95 percent of the population become homeowners over the course of their lives (Sandlie & Gulbrandsen, 2017).

2.2 Factors Influencing the Norwegian Real Estate Market

The Norwegian real estate market is influenced by several factors including interest rates, changes in income, oil prices and fluctuation of the exchange rate. It has been testified that 98 percent of the changes in the housing prices in Calgary are affected by oil prices, interest rate, exchange rate and employment level (Padilla, 2005). Furthermore, other factors such as population growth, urbanization, unemployment, demand, supply and households' consumption as well as income influence the housing prices in both the short- and long-term horizon.

2.2.1 *Norway's Economy*

Since the 1990s the housing prices have increased considerably. There are several reasons why the Norwegian housing market has boomed over the past years. According to DNB, it reflects an "exceptional economic performance throughout the past 20 years, and high-income growth" (DNB, 2014). As illustrated in Figure 2, high purchasing power is one of the main drivers. DNB states that the factors influencing the strong housing market and economy are oil and gas activity, limited planned constructions, increased disposable income and record high population growth.

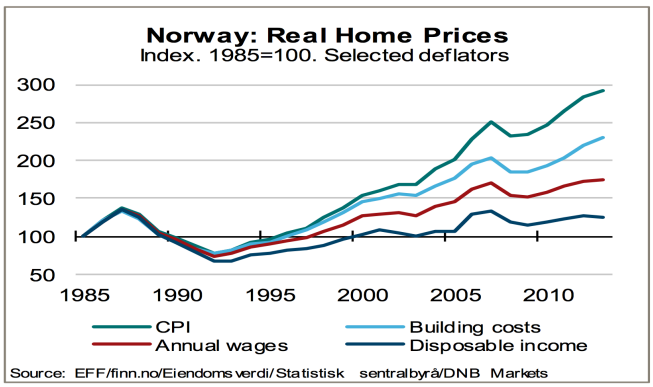

Figure 2-2: Real Home Prices, Norway
Source: https://www.ir.dnb.no/sites/default/files/140410-norwegian-home-prices.pdf

Norway is not a part of the EU, but a member of the EEA, where they contribute substantially to the EU budget. Furthermore, Norway has a stable economy, with a bright private sector, a large state sector and a considerable social safety net. Norway is one of the world's leading petroleum exports, with exports of 37 percent. Oil and gas

provides 9 percent of the jobs, 12 percent of the GDP and 13 percent of the state's revenue. They are also the world's second largest exporter of seafood, following China (Central Intelligence Agency, 2017).

In order to secure the future generations economically, the Norwegian government has created a wealth fund run by the Norwegian Bank Investment Management. This wealth fund invests most of the income from the petroleum industry activities in different sectors all over the world. Their policy, the "fiscal rule" is to spend the amount, which corresponds to the expected real rate of return on the fund. In 2017, this rate fell from 4 percent to 3 percent (Central Intelligence Agency, 2017). 66.6 percent is invested in equity investments, 30.8 percent in fixed-income investments and the remaining 2.6 percent in unlisted real estate investments (Norges Bank, 2018).

The GDP (purchasing power parity) of 2017 was estimated to be €305.3 billion, while the GDP per capita was €57,300. The distribution in terms of end-use of the GDP is 44.77 percent in household consumption, 24.6 percent in government consumption, 23.8 percent in fixed capita and 4 percent investments in inventories (Central Intelligence Agency, 2017).

2.2.2 *Interest Rate and Inflation*

The interest rates, in particular the mortgage rate is closely related to consumers' decision of purchasing housing and potentially investing in a second dwelling. With a relatively low interest rate, the consumers are attracted into borrowing money to afford buying their own home, boosting the demand for housing and pushing prices of residential real estate up.

Norges Bank has set the interest rate on new loans at 2.42 percent (Statistics Norway, 2018h) to achieve price stability, a moderate inflation through monetary policy. The low interest rates of the European Central Bank clearly reflect upon the Norwegian rate. Due to the close ties and trade with other EU countries, Norway is naturally influenced. Several European countries, among Sweden and Denmark, have pushed their interest rates below zero (Khan, 2016), which cause immense pressure on Norway's key policy rate through trade and investment actives. In early 2017, Norges Bank chose to keep the key policy rate unchanged from 2016 at 0.5 percent. It is, however, predicted that the key policy rate will gradually rise again in 2019 due to the uncertainties the low rate has brought to the economy, prevailing the risk of further financial imbalance. Moreover, "a weaker NOK pushes up inflation, while lower wage growth results in projected inflation in 2020 at around 2 percent" (Norges Bank, 2017).

2.2.3 *Exchange Rate*

Considering the fact that Norway does not operate with euro as their currency, it leads to a risk of fluctuation. The development of NOK is therefore crucial to follow in order

to understand the economic situation. During the last years, the NOK has depreciated, in particular against the US dollar, euro and pound sterling. In regard to the slight change in interest rate differential between trade partners and Norway, may indicate that the risk premium of NOK has increased (Norges Bank, 2017).

2.2.4 *Taxes*

The property tax system also affects the housing prices. As each municipality is responsible for determining if they want to charge a property tax, the prices often vary accordingly. With the floor of tax deductible properties at nearly €420,000, 25 percent of the property owners in Oslo are subject to the tax. The property tax rate in Oslo is 0.3 percent of a property's value (Bloomberg, 2018). Moreover, when selling your property there are situations when you have to pay a tax on the capital gains. There is a tax-exempt on the capital gains if you have owned the home for more than one year and have lived in it at least during one of the two last years prior to the sale. The losses however, are tax-deductible as long as any gains would have been taxable. The tax rate of 2017 when selling a property was 24 percent (Nordisk eTax, 2017).

When investing in real estate it is common to rent out the space in order to obtain an income on the investment. This income is also taxable, which naturally affects the housing prices. When it is more expensive to invest in properties, there will be fewer speculators on the market and this can lead to prices dropping. While, low costs and favorable conditions for the speculators might lead to higher prices and increasing competition on the real estate market. As for now, the income is tax-exempted if:

- Up to half of the property is rented out
- The property is rented out for less than €2,105 annually

2.2.5 *Households' Income*

Income is directly linked to a households' housing budget. The demand for housing is often treated as a luxury good and income is directly linked to the investment budget. Therefore, a rise in income leads to a higher portion of the income being spent on housing (Pettinger, 2017). When the household earn less, they have a lower ability to pay for the bank loan, thus less demand for purchasing dwellings.

The median income, after tax, of all households was €51,700 yearly in 2015. However, there is a notable difference when comparing couples with adult children, earning almost €100,000, and persons living alone (under 45, aged 45 – 64 and 65+), who earn between €26,700 and €33,200. Furthermore, the average gross monthly earnings sum all sectors is approximately €4,700 as seen in Figure 3. A comparison of income between men and women can also be made, overall men still earn more than women. An average gross monthly salary for a man in 2017 is €660 higher than for a woman. Furthermore, the wage-increase from 2016 compared to year 2017 was 2.3 percent. The wage growth has steadily increased over the past ten years according to Statistics

Norway as seen in Figure 2-3 (2018e). However, there exists a large gap between poor and rich, the top 20 percent earn nearly four times as much as the bottom 20 percent, according to OECD better life index. There are also slightly more men who are in payed jobs than women, 76 percent men against 73 percent women (OECD, 2018a).

Figure 2-3: Monthly Wage, Norway
Source: https://www.ssb.no/en/arbeid-og-lonn/statistikker/lonnansatt/aar

2.2.6 *Unemployment*

The unemployment rate has been a common indicator of the state of the economy and the business cycle. A sudden increase in this rate often happens after an economic downturn, impacting several aspects of the market. This includes a decrease in consumer spend and investments as their expectations for the future market growth is depressed. This all leads to a decline in housing demand due to the unstable income of the consumer, forcing the government to develop policies in order to boost the economy through creating jobs and encouraging investments.

The unemployment rate in Norway decreased by 0.3 percent points from December 2016 to 4.1 percent in December 2017 (Statistics Norway, 2018f). 74 percent of people between the age of 15 and 64 years have a paid job, one of the highest rates in the OECD, where the average is 67 percent (OECD, 2018a). The unemployment rate of Norway is quite low compared to the EU average, which is 8.6 percent in January 2018 (eurostat, 2018). Moreover, the Norwegian unemployment rate is estimated to stand at 3.9 percent in the end of 2018, and as low as 3.7 by 2020 (Trading Economics, 2018c).

2.2.7 *Population Growth*

Demand for housing is directly influenced by changes in population. If the population grows rapidly, the households' demand for housing can increase just as fast.

Norway has a population of 5.32 million with a population growth of 1.01 percent annually. The majority of the population, 41.01 percent, are between the age of 25 and

54 years, while 18 percent are between 0 and 18 years and 28.42 percent are 55 years and older (Central Intelligence Agency, 2017).

From Figure 2-4 it can observed that the population has seen a steady growth since the 1980s. Furthermore, it appears that the first population growth was mainly due to excessive birth, while today the net immigration has a greater bearing on the population growth than the excess of births (Statistics Norway, 2018a). It is reason to believe that the net immigration has a rather short-term effect on the demand for housing, since there is a need to find housing after immigrating, while the households most probably own a home before giving birth. Moreover, an increasing number of households' due to the shrinkage of members per household might also contribute to the increasing demand for housing and higher prices over the past years (Molden, 2011).

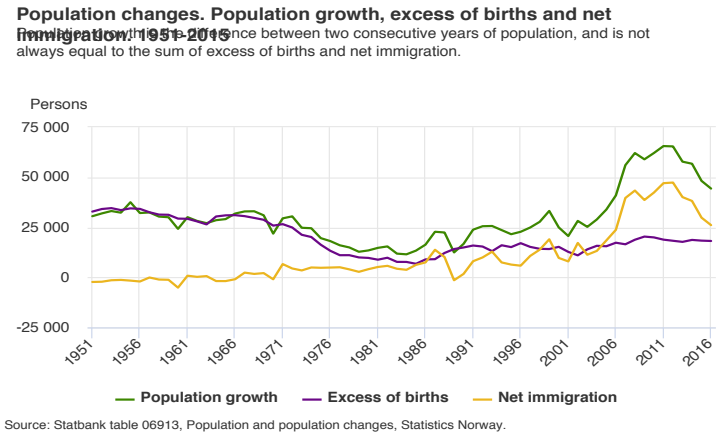

Figure 2-4: Population growth, excess of births and net immigration, Norway 1951-2016
Source: https://www.ssb.no/en/befolkning/nokkeltall/population

According to NHO, the Norwegian real estate market is "out of balance" due to its considerably higher population than the rate of new dwellings. Oslo (Norway's capital) is the city affected the most by the lack of real estate construction, with a population which has increased by approximately 130,000 since 2000. Yet, the construction of new dwellings has not followed the fast growth in households' and their demand for housing. Accordingly, the lack of new residential developments and rapid growth in population has been a pivotal reason for the waste demand in the market.

2.2.8 *Geographical Preference*

The geographical location of the population has an impact in the need for housing. One-way migration patterns can lead to an excess of housing, leading to an increasing demand for housing in the area of destination (Molden, 2011). At the end of The World War II only 50 percent of the population were living in urban areas (Statistics Norway, 2017b). The population in Norway is not evenly distributed, and the geographical preference for internal migration can lead to demand for settling down in various regions.

Today, 81 percent of the population are settled in urban areas. According to Statistics Norway, there was an increase of 53,200 residents in urban settlements in 2016 (Statistics Norway, 2017a). Oslo was the city with the highest increase in urban settlements with a rise of 1.3 percent from the previous year. Oslo is also known as the city with the highest housing prices. Consequently, it is reasonable to assume such urban geographical preferences contributed to the increasing demand for regional difference in housing demand, due to the trend of urbanization over the past 60 years.

2.3 Housing Prices and Households' Consumption

The private consumption counts for half of the GDP in mainland-Norway (Grindaker, 2018). As house prices fluctuates quite vigorously, housing price volatility poses great risk on household welfare (Saxena & Wang, 2017). The changes in consumption can therefore make a severe impact on the economy. Thus, it is important to understand household consumption patterns. This part aims to emphasize the role households' consumption play in then increasing house prices.

In 2012, the average household spent €45,800 annually, four times less than in 1958. Norwegians are spending 31 percent, the largest part of their money on housing, followed by 17 percent spent on transportation, 13 percent on food and beverages, while the last proportion on other (Statistics Norway, 2017b). Due to the fall in oil prices, the growth in real disposable income of households has been weak because of high consumer price inflation, moderate wage growth and weak employment developments, which leads to a stagnant growth in household consumption. The saving ratio has however fallen, while the consumption has increased considerably more than income. It is suggested that there will be an increase in household consumption due to the higher employment and higher real wage growth. "On the other hand, a slower rise in house prices and housing wealth is likely to pull down consumption growth somewhat. Annual growth in household consumption is projected to increase from 1.5 percent in 2016 to 2.4 percent in 2017" (Norges Bank, 2017).

It is proven that the growth in households' consumption correlates with the house price inflation (real house prices) over time, as illustrated in Figure 5 below. A related factor could be the relationship between the value of dwellings and the amount at which a household can borrow. With the increase in wealth, the household can borrow more, and with declining prices they are forced to reduce consumption. Furthermore, Grindaker shows that a 10 percent fall in the housing prices lead to a 2 percent decrease in both retail sales and car sales (Grindaker, 2018).

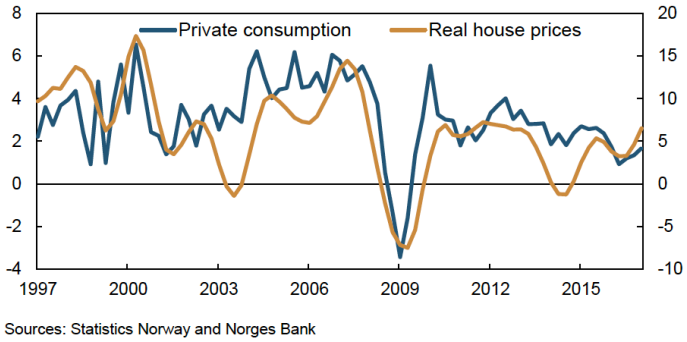

Figure 2-5: Private consumption and real house prices Norway 1997 – 2017
Source: House price and household consumption by Grindaker

Saxena and Wang were able to demonstrate which channels affect household consumption over the life cycle of housing prices. Firstly, the housing wealth effect increases by age where the optimal consumption should increase with rising housing wealth. Furthermore, less-wealthy and middle-aged homeowners are more sensitive to change in house prices. Therefore, the higher the housing wealth, the higher the amount they are able to borrow for current consumption. Lastly, young households are highly affected by changes in housing price as they can, in times of need, smoothen their consumption by borrowing more when there is a rise in the house value (Saxena & Wang, 2017).

2.4 Demand and Supply in the Housing Market

The housing prices are determined by the supply and demand factors in the housing market. Due to regional differences, there are wide variations in the rise of housing prices in Norway. Molden emphasizes how the mismatch between housing demand and supply can lead to noticeable change in prices. Low construction rate together with high population growth might be one of the reasons for the sharp rise in real estate prices (Molden, 2011). Accordingly, the change in prices reveals a market surplus or shortage.

2.4.1 *Demand*

Housing demand is heterogeneous and varies greatly from city to city. The demand is dependent on several factors. An important element according to Molden, in discovering the need for housing, is the rise in number of households. In 2016 there were approximately 2.3 million households in total, nearly twice as many as in 1970 (Statistics Norway, 2017b). Furthermore, in the long term, the income of households is pivotal in order to determine what they are willing to pay for a dwelling. In short term on the other hand, the demand is affected by the interest rate level, credit standards, expectations of a rise in future housing prices and the labor market situation (Molden, 2011).

Larsen states that "the house price level is the function of realized home equity and realized home equity is a function of the house price level" (Larsen, 2010). According to his model, when demand from first-time buyers is highly inelastic it is more likely that unstable conditions occur, purchase from nth time buyers are therefore more frequent than first-time buyers. The reason for this is because housing not only is considered an investment asset, but also a consumption good due to the fact that buyers also are sellers. Jacobsen and Naug agree with Larsen's model and states that "housing demand consists of two components: household demand for owner-occupied dwellings and demand for dwellings as a pure investment" (2005). However, they emphasize how the first component is significantly larger than the second. As previously mentioned in the market overview, the majority of households owns their home and therefore the rental prices and further details regarding rent will not be included in this analysis. Jacobsen and Naug (2005) expresses the demand function as:

Equation 2.1: $H^D = f\left(\frac{V}{P}, \frac{V}{HL}, Y, X\right), \qquad f_1<0, \quad f_2<0, \quad f_3>0,$

where

H^D = *housing demand*
V = *total housing costs for a typical owner*
P = *index of prices for goods and services other than housing*
HL = *total housing costs for a typical tenant (rent)*
Y = *households' real disposable income*
X = *a vector of other fundamentals that affect housing demand*
f_i = *the derivative of f(•) with respect to argument i*

Equation 2.1 states that the demand for housing decreases if ownership in correspondence to housing costs increase in connection to housing rents or prices of other goods. The vector X include common variables such as demographics, lending policies and expected future income and expenses of households'.

Real housing expenses is defined as:

Equation 2.2: $\frac{V}{P} = \frac{PH}{P} BK = \frac{PH}{P}[i(1-\tau) - E\pi - (E\pi^{PH} - E\pi)],$

where

BK = *housing cost per real krone (NOK) invested in a dwelling*
PH = *price for an average dwelling (in NOK)*
i = *nominal interest rate*
τ = *marginal tax rate on capital income and expenses*
$E\pi$ = *expected inflation (expected rise in P and HL, measured as a rate)*

$E\pi^{PH}$ = *expected rise in PH (measured as a rate)*

The real after-tax interest rate is expressed as $[i(1-\tau) - E\pi]$. This part of the equation measures the real interest costs associated with the mortgage loan and the alternative costs (income loss) of placing the down payment in the bank. Thus, higher interest costs lead to rising housing costs. The expected real rise in housing wealth is specified by $[E\pi^{PH} - E\pi]$. If this part of the equation is positive, the expected housing wealth increases, which proves it is relatively more advantageous to own rather than to rent, thus, demand rises.

A simplification of equation 2.2 is:

Equation 2.3: $$\frac{V}{P} = \frac{PH}{P} BK = \frac{PH}{P}[i(1-\tau) - E\pi^{PH}].$$

BK is now the expected rise in nominal housing prices subtracted from the nominal after-tax interest rate.

Although equation 2.2 and 2.3 are based on owner-occupied housing, it is reasonable to expect that these factors also affect investment motivated ownership. Thus, investment motivated ownership strengthen demand even further.

If equation 2.2 and 2.3 are placed together and solved for price of an average unit in specified area, PH, the equation would be:

Equation 2.4: $$ln\, PH = \beta_1\, ln\, P + (1-\beta_1)\, ln\, HL + \beta_2\, ln\, Y + \beta_3 BK + \beta_4\, ln\, H + \beta_{5g}(X),$$

where

H = *total housing stock*

Real disposable income, Y, can be defined as:

Equation 2.5: $$Y = \frac{YN}{P^{\alpha_1} HL^{\alpha_2} PH^{\alpha_3}}, \qquad \alpha_1 + \alpha_2 + \alpha_3 = 1, \quad \alpha_1 < \beta_1,\ \alpha_2 < \beta_2.$$

where

YN = *nominal disposable income*

Equation 2.5 shows that higher house prices reduce purchasing power in the housing market. The population's real disposable income, Y, decrease if house prices, PH, house rent, HL, or the price level, P, increases. Leading to a decline in demand for housing.

Most owner-occupied properties are financed by loans. Therefore, it is important to look at the bank's lending policies as this may be directly linked to the developments in housing prices. The banks policies are dependent on their profitability, the government policies and customers' ability to repay loans.

Equation 2.6: $L^S = h\left(O, REG, Y, U, \frac{PH}{P}\right), \quad h_1 > 0,\ h_2 < 0,\ h_3 > 0,\ h_4 < 0,\ h_5 > 0,$

where

L^S = *banks' supply of credit to households*
O = *banks' profitability*
REG = *measure of government regulation of bank lending*
U = *unemployment rate*
h_i = *the derivation of h(•) with respect to argument i*

Following equation 2.6 it appears that if banks profitability falls the supply of credit also falls, which leads to a tightening of government regulations, expected income decline or unemployment increase.

Total housing demand also relies upon other factors such as the population size, internal migration, demographic changes, urbanization effects and number of people in the start-up-phase.

2.4.2 *Supply*

In short-term housing supply is relatively inelastic due to the long-lasting construction process of residential properties and the low per-year construction relative to the housing stock. Therefore, the housing prices in the short-term will fluctuate with changes in the demand. In order to make residential construction profitable, it is necessary that there is a correspondence between building costs, including the price of land and the price likely achieved in the market (Molden, 2011). In the long run it should include development in the housing stock, such as construction and building site costs and price for new dwellings (Jacobsen & Naug, 2005). Furthermore, according to Hendry (1984) the supply of housing can be expressed as:

Equation 2.7: $H_t^S = (1 - \delta)H_{t-1} + C_t$

where

H_t^S = *housing stock in period t*
δ = *depreciation rate*

H_{t-1} = *housing stock in previous period t-1*
C_t = *new dwellings in period t*

Equation 2.7 display how housing supply relies on the quantity of housing offered in the previous period, number of new dwellings in the current period and depreciation rate. The depreciation rate is however expected to be close to zero in the short run, proving that the supply is inelastic.

Jacobsen and Naug stated that in a perfect market, the market equilibrium is where housing supply equals demand.

Equation 2.8: $H^D = f\left(\frac{V}{P}, \frac{V}{HL}, Y, X\right) = H^S = P$

Higher demand leads to an increase in house prices due to the time lag connected with constructing dwellings. Moreover, the housing market will in the long run adapt to the increased demand, seeing that there are no restrictions related to policies or regulations. Growth in contractions together with the rise in offered dwellings will reduce housing prices.

The difference in supply and demand in the short- and long run is illustrated in figure 2-6 below. From equilibrium A, the demand is pushed to the right leading to the intersection with short-run supply in point B, which increases price from P_1 to P_2. When more dwellings are constructed, the supply curve shifts to the right, which push the prices down. Thus, equilibrium C occurs, at the price P_3.

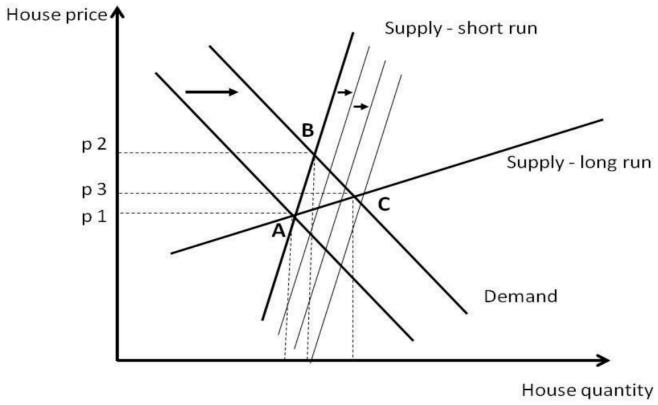

Figure 2-6: Price setting of the housing market

Source: Housing Investment and House Prices, Jacobsen and Naug (2007)

Residential Construction

Residential construction adds up a great part of the housing supply and is one of the drivers needed in order to obtain a balanced market. Norway has held a relatively high level of residential construction compared to other Nordic countries between 2000 to

2015. However, the building sector fails to meet housing needs (Tunström, 2016). On the report of Statistics Norway, the net growth in flats from 2007 to 2017 counted for 120,000 (2017a), which compared with the population growth there is much indicating too few buildings have been built.

Furthermore, there has been a decline of 6 percent, in the number of building permissions for dwellings over the past year (Statistics Norway, 2018c). This could be due to the planning regulations in the housing market and inefficient use of land. "In recent years, the regulations on building have been strengthened". Developers must contribute to building more local infrastructure, new buildings are required to be 25 percent more energy efficient and in the newest law of development agreements of 2010 (TEK10) the accessibility requirements were introduced. The background to the measures taken in TEK10 were due to the ageing population and lack of accessible dwellings. Moreover, the change in law would lead to additional construction costs of approximately €120 per square meter (OECD, 2014). It is clear that this change in regulation did not serve the supply side of the housing contractions in any way, as higher prices and more complex regulations rather lead to slower processes and in worst case less projected constructions of residential real estate.

The construction cost index of residential buildings counts to 184.8 in February 2018 (Statistics Norway, 2018d), while the price index for new dwellings in 2017 is 118.3 (Statistics Norway, 2018g). Detailed data is included in Appendix 1. The cost index also includes wage rate for labor. Thus, the rise in construction costs include both material and labor costs.

2.5 Housing Bubble Theory

Stiglitz' has the most recent discussion about bubbles and his definition is: *"if the reason that the [asset] price is high today is only because investors believe that the selling price will be high tomorrow – when "fundamental" factors do not seem to justify such a price – then a bubble exists"* (1990). According to Himmelberg et al. (2005) there are four common misconceptions about the costliness of the housing market that needs to be considered when doing a bubble analysis based on Stiglitz' definition. First, annual costs of owning a home is not synonymous with the price of a house. Second, a house is not necessarily overvalued because of a high price growth. Third, a difference in expected appreciation rates and taxes might cause a considerable "variability in the price-to-rent ratio across markets". Lastly, house prices are sensitive to changes in fundamentals, in particular when real long-term interest rates are low with an expected high price growth. Therefore, rapidly increasing house prices do not fundamentally indicate signs of a bubble.

According to Case and Shiller (2003) *"a tendency to view housing as an investment is a defining characteristic of a housing bubble"*. Furthermore, they elaborate that *"a housing bubble exists when homebuyers buy houses that would normally be*

considered too expensive and is now an acceptable purchase because they believe they will be compensated by a further increase in price". In other words, there might be a housing bubble that a rise in house prices is affected by households' assumption that prices will increase. Thus, a bubble exists when there are no fundamental factors that explain the housing price.

Additionally, Kindleberger (1987) states: *"A bubble may be defined loosely as a sharp rise in the price of an asset or a range of assets in a continuous process, with the initial rise generating expectations of further rises and attracting new buyers – generally speculators interested in profits from trading rather than in its use or earning capacity. The rise is then followed by a reversal of expectations and a sharp decline in price, often resulting in severe financial crises, which is when then bubble bursts"*.

2.6 Market Forecast

Over the past years, several economists and real estate agents have predicted the growth of residential real estate in Oslo. As the housing prices have had quite a steep increase lately, there has also been many magazines and newspapers from both Europe and the USA discussing the future of Oslo's real estate market.

In 2016 real estate agent Terje Tinholt stated that the housing prices in Oslo would increase by 35 to 38 percent in total over the year of 2016 and 2017. Furthermore, he predicted that it would stabilize in 2018 as not everything goes sky-high, after a period of this much growth. He then states that the prices would gradually increase, by 2 to 3 percent in 2019, followed by a normal growth of 5 to 6 percent from 2020 to 2023 by which construction of new dwellings will balance out the market (Haugen, 2016). His forecast of 2016 and 2017 was highly optimistic, as the increase of 2016 alone counted for 23.3 percent (NRK, 2017), however over the whole period of 2017 the prices decreased by 6.2 percent (Eiendom Norge, 2017), leading to a total increase of 17.1 percent over the two year period.

Eiendom Norge also predicted that 2017 would be a great year, with a price increase between 9 and 11 percent. They too blame few dwellings being built and assume that the high increase from 2016 will "kick-start" the new year. Furthermore, they state that there are less insecurities regarding the interest rate and unemployment than in 2016, which are influencing factors determining the housing prices. Eiendom Norge has earlier been pessimistic in their forecasts and state that this time it should be right (Wig, 2016), however that was not the case.

Norges Bank predicted there would be more new dwellings than households in 2017. They expected approximately 38,000 new dwellings to be started, and that the number of households would rise by only 20,000 compared to more than 40,000 in 2013. However, their prediction regarding the residential constructions were fairly optimistic

as there were only 30,200 new dwellings. The number of households were not accurate either, considering there was an increase of 28,000 households (Norges Bank, 2017).

Moreover, the future is forecasted by Danske Bank, who assume that the housing prices will return to fundamental levels. However, they expect the prices in Oslo to drop another 2-5 percent over the next few months of 2018, which is a total fall of 12 to 15 percent from their peak. This predicted drop is justified due to the steep increase in the stock of unsold dwellings, mainly in Oslo. However, nationwide the prices are expected to fall until Easter, then trend up, leading to a total price fall of 3 percent in 2018, but a rise of 1.5 percent in 2019 (Danske Bank, 2018).

2.7 Division of Oslo

Oslo is divided into several parts. The inner-city region has six main areas, while the outer-city region and suburbs are divided into several parts covering the rest of Oslo. In this brief introduction of each area the concentration will lie on the inner-city region as this is the location consisting mostly of apartment buildings, which is my focus for this analysis. Furthermore, the inner-city region has a higher number of resales over the past five years compared to the suburbs, where families with long-term horizons live in primarily house and villa settlements.

2.7.1 *Frogner*

Frogner is one of the most expensive areas in Oslo. Near the royal castle, there are town houses in a 19th-century setting, Parisian-style buildings, a famous sculpture park and museums. A two-bedroom apartment in Frogner is estimated at €1.8 million (Roberts, 2017). Frogner is a highly attractive area, with 57,000 inhabitants distributed on an area of 8.3 square kilometers.

2.7.2 *Gamle Oslo*

Old Town is the most ethnically diverse location, where value for money close to the city is much higher than in any of the other areas. Here you not only get the cheaper accommodation, but the restaurants and shops also offer lower prices. Moreover, this area has a higher percentage of smaller studio apartments than in the other locations (Roberts, 2017). Old Town is one of the areas with the highest number of residential constructions being built and it is predicted to be the area, which will have the highest population growth in Oslo over the next few years (Oslo Municipality, u.d.). The Old Town consists of approximately 50,000 people and has a size of 7.5 square kilometers.

2.7.3 *Grünerløkka*

This is the more popular neighborhood for the younger generation, known for its hipster and trendy bars, restaurants and shops. Its proximity to the city center is also a factor influencing many people to move here (Roberts, 2017). 56,000 people live in this area of Oslo distributed over 4.8 square kilometers.

2.7.4 *Sagene*

This area is closely located to the Norwegian Business School and therefore attracts several students. However, it is also an area well suited for younger single or couples in their 30s due to its close proximity to the woods and also the trendy area of Grünerløkka (Oslo Municipality, u.d.). There are 42,000 inhabitants in this area of 3.1 square kilometers.

2.7.5 *Sentrum*

The city center is not known for its residential population, rather the restaurant and bars (Life in Norway, u.d.). However, the area also covers the harbor and several attractive neighborhoods close to the Oslo fjord, such as Aker Brygge, Tjuvholmen and Bjørvika. Aker Brygge has many attractive restaurants and diverse shopping. However, above, in the apartment buildings there are several flats and offices. Tjuvholmen, Thief Island, is Aker Brygge's closest neighbor with a slightly higher average price per square meter. It has emerged as an arts district, housing the most prestigious collection of contemporary arts as well as Oslo's first boutique hotel, The Thief. The apartments for sale in this area overlook the sea and are usually sold for around €2 million, with parking, terrace and sometimes even a boat moorage. The last attractive neighborhood in the City Center is Bjørvika, a newly developed and in development area around the Opera House. There are newly constructed and projected flats, offices and parks. This includes Barcode consisting of five high-rise towers, including the DNB, Deloitte and PwC buildings (Roberts, 2017). There are only 1,063 people living in this area, which is 1.8 square kilometers large (Oslo Municipality, u.d.), and the first sales data to be found for this area is from 2001[2] as this was the first time it was registered as its own district on Eiendomsverdi.

2.7.6 *St. Hanshaugen*

This area consists of more adults and one-person households' than in any of the other locations. Furthermore, it is the area which has an above average number of people working and who has graduated from upper secondary school and other studies. St. Hanshaugen has 39,000 inhabitants at a size of 3.6 square kilometers.

[2] This information was discovered when collecting housing data for Sentrum through www.eiendomsverdi.no

3. Methodology

In order to tackle the main research problem, I employed a quantitative method study design. To determine if it is smart investing in a residential property in Oslo, it is of utter importance to gather the sales data from the six areas of Oslo, over the last five to eighteen years, including all necessary information to be found through *Eiendomsverdi, finn.no* and *Statistics Norway*. This data will be used to run a simple and multiple linear regression to test if the fundamental factors Jacobsen and Naug (2005) found are the most important explanatory factors influencing the housing prices, and whether those factors still affects the price. Moreover, by using the least squares method, I can determine to what extent these factors influence the price and if there are any differences across the areas of Oslo.

Furthermore, to predict if there might be a housing bubble in the market, I will construct a Price-to-Rent analysis. It is crucial to investigate the potential ratio between owning a housing and renting one. This method can also help us to predict if it is worth investing in housing in the short-term.

I will also do a Hodrick Prescot Filter to see how the housing prices deviates from the long-term trend. This will help determine if the real estate market is over- or undervalued. I have chosen to create two HP-filters, one for annual data dated back to 2000, and the other for quarterly data going five years back.

3.1 Data Selection

3.1.1 *Clustering of Data*

The data is clustered into six different areas of Oslo city center; Frogner, Gamle Oslo, Grünerløkka, Sagene, Sentrum and St. Hanshaugen. These areas are explained in chapter 2.7 and are predetermined by the municipality, as well as how the data is separated into locations in *Eiendomsverdi*. Furthermore, the analysis will focus on apartments as this is the main housing type available in these areas and most often sold after closely monitoring *finn.no* over the past two months. According to Statistics Norway (2013), 25 percent, which is the largest part of the inhabitants in Oslo lives in housing consisting of 40 to 59 square meters. Thus, I have chosen to focus on the apartments in Oslo within the size category, 40 to 59 square meters. However, as Statistics Norway is basing their rental survey on two room apartments, I will collect sales prices in Oslo with the size of 37 to 54 m2, to determine the P/R ratio.

3.1.2 *Eiendomsverdi*

Eiendomsverdi is a database that closely monitors the Norwegian real estate market. It is a platform that estimates the market value of the residential real estate in Norway based on information tools and systems supplied by the shareholders, which are the four largest banking constellations in Norway. Well over 90 percent of the real estate agencies are participating in the usage of Eiendomsverdi. Every detail regarding residential properties sold on the open market is automatically added to the database and is only accessible for people working in the industry. Data such as the transaction price, previous sales price, size and current as well as previous owners is listed (Eiendomsverdi, 2018).

In order to tackle the main research problem, I need to gather sales data on the specific properties in the selected areas of Oslo. This is done through a quantitative research design. The data for my quantitative analysis is provided by Eiendomsverdi. It consists of 65,297 observations, including apartments sold in previously mentioned areas of Oslo in the time period 1st of January 2000 to 31th of March 2018 within the chosen size category of 40 to 59 square meters. Eiendomsverdi includes 29 variables in their data, as shown in table 3-1.

Registration Date	Value	City District
Actual Sales Date	Price per Square Meter	Council Number
Public Registration Date	Rent	Council Name
Sales Date	Living Area (size)	Country Number
Sales Price	Utility Floor Space	Building Year
Price Assumption	Gross Area	Site Area
Value Valuation	Floor	Estate Number
Loan Valuation	Rooms	Ownership
Common Debt	Bedrooms	Site Type
Price	Year Renovated	

Table 3-1: Variables in Eiendomsverdi Dataset
Source: Eiendomsverdi

Not all variables will not be used, as several of them are missing and not directly linked to my analysis. The variables I have used when collecting the data are registration date, sales price, living area (size) and city district. I argue that these are the variables necessary in order to do the regression analysis. Out of the 65,297 observations I had to delete 949 observations as they do not contain all the information of interest. I find this of utter importance in order to achieve interpretable results.

Moreover, in order to tackle the housing bubble analysis and whether it is worth investing in a residential housing in Oslo, I will gather sales data on two room apartments in Oslo, as Statistics Norway is basing their data on this. This data consists of 23,248 observations, including the average annual price of apartments sold in Oslo over the period from 1st of January 2013 to 31st of December 2017.

Furthermore, when using the HP-Filter I needed more data in order to find a more precise long-term trend. Therefore, I chose to focus on both quarterly data from 1st of January 2010 to 31st of March 2018. This data consists of 185,566 observations, including apartments sold in Oslo within the chosen size category. The other data used in this part is the annual data used in the multiple regression when comparing the different areas.

3.1.3 *Finn.no*

Finn.no is a Norwegian website that specializes in advertising and offering services such as housing for sale and rent through both real estate agents and private people, cars, travel, jobs and so on. This website has been open for the public since 2000 and is the most visited website in Norway in terms of page views. It is considered an easy platform to sell and buy any product or service, with approximately 300,000 offers available daily, where an average Norwegian spends 21 hours a year (FINN.no, 2018).

In order to tackle the housing bubble calculations, I have gather information regarding sizes of two room apartments, according to the listed apartments for sale on *finn.no*. This has given me an overview of the sizes I have to specify in *Eiendomsverdi* when finding the previous sales prices. Based on this I found that an average two room apartment is between 37 and 54 square meters, as mentioned in the introduction to 3.1 Data Selection.

3.1.4 *Statistics Norway*

Statistics Norway, as the name states, provides official statistics yearly and collect data on most aspects of society. They are responsible for National Accounts and other important economic statistics, as well as data on tax revenues, unemployment, inflation and production (Government.no, 2018). Moreover, they provide price index for existing dwelling as well as rental market survey's.

In order to determine if the economy is facing a housing bubble, I need to collect the nominal household income, rent prices and interest rates on mortgage loans provided by Statistics Norway. This data will be further analyzed through the regressions and P/R method in chapter 3.3 and 3.4.

3.2 Linear Regression

I will conduct a simple linear regression based on Jacobs and Naug's (2005) study, proving the most important factors which influence prices. As their model is quite complex, I have chosen to simplify it and only focus on the most explanatory factor and the top four explanatory factors determining the housing prices, in respectively a simple linear regression and a multiple regression. Moreover, I will use the least

squares method to find the extent at which the independent variables determine the dependent variable, *houseprice*.

3.2.1 *Jacobs and Naug House Price Model*

Jacobs and Naug's (2005) found in their study that interest rates, housing construction, unemployment and household income were the most important explanatory factors influencing the housing prices in the Norwegian market. A fall in the interest rate explained substantial portions of house price inflation. Their empirical models tested the reaction of multiple explanatory variables for housing prices, including:

- households' total (nominal) wage income
- indices for house rent paid and total house rent in the consumer price index (CPI)
- other parts of the CPI adjusted for tax changes and excluding energy products (CPI-ATE)
- various measures of the real after-tax interest rate
- the housing stock (as measured in the national accounts)
- the unemployment rate (registered unemployment)
- backdated rise in house prices
- household debt
- the total population
- the shares of the population aged 20-24 and 25-39
- various measures of relocation/centralization
- TNS Gallup's consumer confidence indicator of households' expectations concerning their own financial situation and the Norwegian economy

With these variables they estimated a model in order to interpret the house price fluctuations. Their model is listed below:

$$\begin{aligned}\Delta houseprice_t = {} & \beta_1 \Delta income_t + \beta_2 \Delta\big(INTEREST \cdot (1-\tau)\big)_t + \beta_3 \Delta\big(INTEREST \cdot (1-\tau)\big)_{t-1} \\ & + \beta_4 EXPEC_t \\ & + \lambda[houseprice_{1-t} + \theta_1 \Delta(INTEREST \cdot (1-t))_{t-1} + \theta_2 unemployment_t \\ & + \theta_3 (income - housingstock)_{t-1}] + \alpha + \beta_5 S_1 + \beta_6 S_2 + \beta_7 S_3\end{aligned}$$

This model uses different operator for the variables in order to convert them into stationary data sets. Furthermore, they took the logarithm of variables in lower case. The period estimated was from Q2 1990 to Q1 2004. The results show how most of the variables are significant at 5 percent level, with R-squared = 0.8773, indicating that the explanatory variables explain the dependent variable well.

The model contains banks' lending rate, marginal tax rate, unemployment rate, total wage, housing stock and household expectations concerning own financial situations. The long-term and short-term effects are included, where long-term effects are

illustrated in the square brackets, containing lagging factors of interest rate, household income, unemployment and housing stock. As these can vary a lot over time, there is no surprise the past will be able to influence the following periods.

The model developed by Jacobsen and Naug is frequently utilized when discussing housing prices in Norway. However, as this model is quite complex and, includes several variables I am unable to get a hold of, I will construct a simplified model including the four factors mentioned in the beginning of this sub-chapter.

3.2.2 *Simple Linear Regression*[3]

Regression analysis is used when modeling and analyzing several variables and is done by looking at the relationship between two variables. The one variable (Y) is seen as a function of the other (X). Where the relationship includes a dependent variable and one independent variable. The equation for a straight line is known as $y = \alpha + \beta x$, where α is a constant, which explains when the line intersects with the x-axis, and β is the slope of the line. The equation for a straight line is not completely realistic, therefore we include a random disturbance term denoted by u_i to the equation, which gives us:

Equation 3.1: $Y_i = \alpha + \beta x_i + e_i$

The observation number is denoted as the subscript t (=1, 2, 3…). The error (u_i), also known as the residual, gives a stochastic variable that disturbs the linear relationship given by the unknown line $\alpha + \beta x$. The residual is given by the distance between a point and the regression line. Optimally, this (vertical) distance should be as small as possible. The residual is an independent variable and is distributed normally with an expected value of zero and an unknown variance σ^2. The unknown variables α and β is estimated based on the collected data. The best assumption of the unknown line, is called a regression line:

Equation 3.2: $\hat{y} = \hat{\alpha} + \hat{\beta} x$

I will first construct a simple linear regression based on one independent variable, interest rate, which according to Jacobsen and Naug explained a substantial portion of the changes in housing prices. This regression will be conducted on each of the six different areas of Oslo. To compare and see if each of the areas are equally influenced by the change in interest rate.

[3] Chapter 3.2.2 is based on (Brooks, 2008)

The most common model for finding the regression line is the least-squares method. It "calculates the best-fitting line for the observed data by minimizing the sum of the squares vertical deviations from each data point to the line" (Yale, 1997-98).

3.2.3 *The Least Squares Method*[4]

The least squared method takes into account a random line. In each of the points the distance between the line and the point is measured, then taking the squared distance, which gives the residual sum of squares. Furthermore, we take the summation over all of the observations, from i = 1 to T, where i is number of observations. According to least squares method we need to find the line that is closest to the data, which minimizes the residual sum of squares to find the values of α and β. The estimated coefficient for the constant, $\hat{\beta}$, and the intersect, $\hat{\alpha}$ is given by:

Equation 3.3: $$\hat{\beta} = \frac{\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{\sum_{i=1}^{n}(x_i - \bar{x})^2} = r \cdot \frac{S_Y}{S_X}$$

Equation 3.4: $$\hat{\alpha} = \bar{y} - \hat{\beta}\bar{x}$$

Where r denotes the correlation, S_X denotes the standard deviation to the x's and S_Y denotes the standard deviation to the y's. $\bar{y}$ denotes the average of the y's and $\bar{x}$ denotes the average of the x's.

To make sure the model is good enough, it is necessary to make sure that the assumptions mentioned in sub chapter 3.2.4 are fulfilled, to avoid any misinterpretation. To check if the residuals are fulfilling the requirements for the residuals, one can make residual plots. Since the residual (e_i) are unknown, they can be estimated by the equation below. The residual plots need to be interpreted in order to determine if the assumptions are fulfilled.

Equation 3.5: $\widehat{e_i} = Y_i - \hat{\alpha} - \hat{\beta}x_i$

Attributes by estimating the least squares method

If the assumptions in 3.2.4 are fulfilled, then the estimators $\hat{\alpha}$ and $\hat{\beta}$ determined through the least squares method have several attributes, which can be explained through the use of best linear unbiased estimator (BLUE).

"Best": The estimator $\hat{\beta}$ has a minimum variance among the expected estimators. $\hat{\beta}$ also need to have a variance, which is not less than the estimator of the least squared method.

[4] Chapter 3.2.3 is based on (Brooks, 2008)

"Linear": $\hat{\alpha}$ and $\hat{\beta}$ are linear estimates.
"Unbiased": On average the actual values of $\hat{\alpha}$ and $\hat{\beta}$ should be equal their true values.
"Estimator": $\hat{\alpha}$ and $\hat{\beta}$ are estimated by the true value of $\hat{\alpha}$ and $\hat{\beta}$.

T-test
To test if there is a relationship between x and y, one uses a t-test. Confidence intervals is also a way to determine if there is a relationship between the dependent and the independent variable, also by looking at the p-values.

Is the model good enough?
To make sure the model is good enough, one can look at the determination coefficient, R-squared. The determination coefficient can say whether or not the estimated model actually fit together with the gathered data material.

R-squared needs to lie between 0 and 1 (given there is a constant in the model). If the value is close to 1 it indicates that the model explains nearly all the variation of the dependent variable and its average value. A value close to 0 indicates that the model does not fit well with the data material. It is important to take into consideration that a high determination coefficient does not necessarily indicate a sufficient model.

Another problem with the R-squared is that of several independent variables are included in the model, the R-squared always will be as at least as large as the model with an extra variable compared to the model with on less variable. To avoid such a problem on can calculate an adjusted R-squared. The adjusted R-squared takes into account the loss of the degree of freedom when an extra variable is included. The adjusted R-squared can be used to decide if a new variable should be included to the model or not. The rule of thumb is: include the variable if the adjusted R-squared increases, and do not include the variable if the adjusted R-squared declines.

Furthermore, to get a better picture of the result, it might be necessary to analyze the housing prices where several independent variables are taken into account simultaneously. The theory states that, "if the regression coefficient from the simple linear regression model changes by more than 10 percent, then X_2 is said to be a confounder. Once a confounder is identified, we can use the multiple linear regression analysis to estimate association between the risk factor and the outcome adjusted for that confounder" (Boston University School of Public Health, 2016).

3.2.4 *Multiple Linear Regression*[5]

Multiple regression is an extension of simple linear regression. It is used when we want to predict the value of a dependent variable based on two or more independent

[5] Chapter 3.2.4 is based on (Brooks, 2008)

variables by fitting a linear equation to observed data samples, by including k independent variables. Mathematically the multiple linear regression is given as:

Equation 3.6: $Y_i = \beta_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots + \beta_k X_{ki} + e_i$

where

Y_i = Dependent variable
β = Coefficients or risk factor. β_1 is the intercept or constant, while $\beta_2, \ldots, \beta_k$ is the slope of the line.
X = Independent variables, predictor, explanatory or regressor variable
u_i = the error term, the randomness that the model can't explain.
i = Number of observations

F-test
The F-test is used in order to test several hypotheses simultaneously.

Equation 3.7: $Test\ statistic = \frac{RRSS - URSS}{URSS} \cdot \frac{T-k}{m}$

where

URSS = residual sum of squares from unrestricted regression
RRSS = residual sum of squared from restricted regression
m = number of restrictions
T = number of observations
k = number of regressors in unrestricted regression

A residual sum of squares, which is not that much higher than the unconstrained model's residual sum of squares, concludes that the restriction was supported by the data. However, if the residual sum of squares considerably increased after imposing the restrictions, one would conclude that the restrictions were not supported by the data, therefore the hypotheses should be rejected. Therefore, it can be stated that $RRSS \geq URSS$.

How to test the assumptions of the linear regression model?

- Assumption 1: $\mathrm{E}(e_i) = 0$

The first assumption states that the residuals average is equal to zero. If there is a constant in the model, the intersection will start in the origin. Unwanted consequences might occur if the model does not have a constant, and the residuals' average is unequal to zero. A consequence might be that R-squared turns negative, indicating that the average of the selection explains more of the variations of the responsive variable than the explanatory variable.

- Assumption 2: $\mathrm{Var}(e_i) = \sigma^2 < \infty$

The other assumption states that the variance must be constant, and final. Also known as the prerequisite for homoscedasticity. If the residual does not hold a constant variance, it is known as heteroscedastic. A way to discover heteroscedasticity, is by using Whites general test for heteroscedasticity.

If the residual confirms heteroscedasticity, and this is ignored, we can still find the unbiased estimates through the least squares method. However, these estimates are no longer BLUE, as the coefficient no longer has a minimum variance among the unbiased estimators. If the residual is heteroscedastic, the formula for the standard error will no longer be sufficient. Thus, using the least squares method even though there is heteroscedasticity, the standard errors will be wrong, and a potential conclusion might be misleading. Generally, the standard error will be too large for the intersection when the error is heteroscedastic. A possible solution to handle heteroscedasticity properly might be to use the heteroscedasticity-consistent standard error estimator. Most software for econometrics has an option[6], which allows the user to use the estimators for standard errors, which has been modified to discover heteroscedasticity by following White (1980).

- Assumption 3: $\mathrm{cov}(e_i, e_j) = 0$ for $i \neq j$

Assumption 3 states that the covariance between the residuals over a period of time must be equal to zero. The residuals are uncorrelated. If the residuals are not uncorrelated, they are autocorrelated, also known as serial correlation. It is therefore necessary to test this assumption. This autocorrelation test can be done through a Durbin-Watson test. There are three conditions that needs to be met in order for a Durbin-Watson test to be valid: 1) the regression must contain of a constant, 2) the independent variables must be non-stochastic as in assumption 4, and 3) there must be no lags in the dependent variable in the regression. The consequences of ignoring a present autocorrelation is the same as with heteroscedasticity. If the formula for autocorrelation is known, it will still be possible to use the least squares method. Similarly, to this is the Cochrane-Orcutt procedure.

- Assumption 4: $\mathrm{cov}(e_i, x_i) = 0$

Assumption 4 states that there is no relationship between the residual and the appurtenant x variance. x_i is therefore non-stochastic. If one or more of the dependent variables simultaneously correlate with the residual, the least squares method will not give consistent estimators.

- Assumption 5: $e_i \sim N(0, \sigma^2)$

Assumption 5 states that the residuals are distributed normally, and this assumption is important as the t-test and f-test assume normal distribution. One of the most common tests for normal distribution is the Bera-Jarque test.

[6] Often called «robust»

Multicollinearity
An implicit assumption when using the least squares method is that the explanatory variables are not correlated. The explanatory variables imply orthogonality with respect to each other, as long as there is not coherence between the two. That explanatory variables are orthogonal means that if one adds or subtract variables in the regression model, it does not lead to a change in the coefficients on the other variables. In most practical cases there will always exist a little correlation between the variables. This correlation is usually benign, as there often will exist some coherence between the explanatory variables, which will not lead to big loss of precision. The problem occurs when the explanatory variables are highly correlated. This problem is known as multicollinearity, which is very difficult to test.

3.2.5 *Time Series Analysis*[7]

A time series analysis fulfills the following equations 16 to 18 for $t = 1, 2, \dots, \infty$, the time series are stationary.

Equation 3.8: $E(Y_i) = \mu$

Equation 3.9: $E\left(Y_{i_1} - \mu\right)\left(Y_{i_2} - \mu\right) = \sigma^2 < \infty$

Equation 3.10: $E\left(Y_{i_1} - \mu\right)\left(Y_{i_2} - \mu\right) = \gamma_{i_1 - i_2} \ for\ all\ t_1, t_2$

Equation 16 to 18 states that a stationary process must hold a constant average, a constant variance and a constant autocovariance structure. A series is integrated of first order, *I(1)*, because it takes the first difference, a stationary process is produced. A non-stationary process is intergraded of *d*-order, $I(d)$, if it is stationed after being differentiated *d* times.

Test of non-stationarity
To determine if a time series is stationary or non-stationary is important. This is because the characteristics of a stationary process might have great influence on the time series attributes and behavior. The use of non-stationary data can lead to spurious regression. If two variables follow the same trends over a period of time, a regression of one variable on the other variable might have a high determination coefficient (R-squared) even if the variables are uncorrelated. If one uses standard regression techniques on non-stationary data, one can get something that looks like a good end result considering standard measures (measures of significant coefficients and a high R-squared), but they might still be worthless. Such a model is called spurious regression. The use of non-stationary data might lead to proving a standard assumption for asymptotic analysis to be invalid. This means that the t-values do not

[7] Chapter 3.2.5 is based on (Brooks, 2008)

follow a t-distribution, and that the f-values do not follow the f-statistics. There are several tests to determine if a time series is stationary or non-stationary, like the Dickey-Fuller test.

Cointegration
If two variables that is $I(1)$ are linear-combined, then the combination also is $I(1)$. Generally, this means, the variables with different integration-order combines, the combination will consist of the order which is the higher-order.

Given the equation $y_i = \beta x_i + e_i$. If y_i and x_i are $I(1)$, one would normally expect that $y_i - \beta x_i$ is $I(1)$ no matter what value of β is, and not $I(1)$ (thus, non-stationary). However, if y_i and x_i both are $I(1)$, there might be a β, which gives $e_i = y_i - \beta x_i$ is $I(1)$. Intuitively, if the two series are both $I(1)$, the partial difference between them are stable around a constant average. The implication might be that the series works in the same pace. Two series that fulfill this requirement are cointegrated. It is possible to test cointegration; the most common method is developed by Engle and Granger (1987).

3.2.6 *Model Assumption and Weakness*

Simple linear regression
These assumptions must be fulfilled

- $\mathrm{E}(e_i) = 0$.
  The residual average is equal to zero.
- $\mathrm{Var}(e_i) = \sigma^2 < \infty$.
  The residual variance must be constant, and final for all values of X_i
- $\mathrm{cov}(e_{i,}e_j) = 0$.
  The residuals must be independent of each other
- $\mathrm{cov}(e_i, x_i) = 0$.
  There is no relationship between the residual and the associated x variance
- $e_i \sim N(0, \sigma^2)$.
  The residuals are distributed normally

3.3 Price-to-Rent Method

A price-to-rent method (P/R-method) evaluates the housing market and potential bubbles. Poterba (1984) created this model in order to estimate the house prices through observing the relationship between cost of owning and renting. He assumed that buyers compare rental costs with the costs of owning your own dwelling, by looking at the present discounted value of its future profit stream.

The P/R ratio is based on the well-known price-earnings model (P/E), used to determine a stocks' value. This model was developed by Gordon and Shapiro in 1956 and further developed by Miller and Modigliani in 1961. Potential bubble tendencies in

the stock market are measured through this model, by weighting the current stock price against the expected future cash flow. A bubble is therefore detected if the P/E value exceeds the fundamental P/E value.

Rent in the P/R method corresponds to earnings in the P/E method. Thus, the fundamental value is signified through the expected present value of potential earnings of owning a dwelling. It is expressed in the following equation:

Equation 3.11: $\frac{P}{R} = \frac{Housing\ Market\ Price}{Annual\ Rent\ Income}$

Moreover, Poterba (1992) developed the cost of homeownership equitation, taking into account the alternative cost of owning a dwelling, deducting tax, mortgage, depreciation property tax, interest rate, maintenance and renovation costs from the increase in value.

Equation 3.12: $Cost\ of\ Homeownership = P[i(1-\tau) - \pi^e + \delta - \pi_P^e$

where

P = house price index
i = nominal interest rate
τ = tax rate
π^e = expected inflation
δ = depreciation rate
π_P^e = expected rise in house prices

Equation 10 shows how the cost is influenced by the house prices and expected inflation.

A perfect market would lead to revenues from renting to be equal to the cost of homeownership in the long run. Thus, the rational outcome would be; if renting is relatively cheaper than owning a dwelling, homeowners will be interested in selling to become tenants. On the contrary, if the cost of homeownership is less than the rent, renters would prefer to buy a home rather than renting one. However, in the long-run the expected cost of owning a dwelling will be equal to the rent, expressed in the equation below:

Equation 3.13: $R = Cost\ of\ Homeownership = P[i(1-\tau) - \pi^e + \delta - \pi_P^e$

where

R = cost of renting

When rearranging the equation for P/R the formula can be written as:

Equation 3.14: $\frac{P}{E} = \frac{P}{R} = \frac{1}{i^a + \tau + f - \pi}$

Equation 12 states the long-term fundamental relationship between housing prices and rent. Furthermore, the equilibrium will in periods deviate from the fundamental P/R due to several influencing factors, resulting in fluctuations in both housing prices and rent. Changes in explanatory factors such as, interest rate, maintenance costs or tax regulations, can lead to alterations in housing prices, which might cause changes in expectations of future prices. A profit opportunity might occur if the investors expect higher prices. Speculations as such, might lead to a rise in demand for properties, causing further pressure on the house prices. If the prices increase rapidly over a short period of time and exceeds the long-term trend, there might be indications that the economy is facing a housing bubble.

By simply calculating the average price divided by the average yearly rental prices, the P/R ratio will be determined. An example of an apartment worth 2,000,000 NOK, which can be rented for 100,000 NOK yearly gives a P/R of 20. Which is quite a normal ratio in Norway nowadays. Simplified, this means that it will take 20 years to down pay such an apartment, putting all other factors aside. According to the American real estate company, Trulia, the P/R ratio indicates that it is better to buy than rate if the ratio is between 1 and 15, a ratio between 16 and 20 indicates it is mostly better to rent than to buy and a ratio above 21 indicates it is considerably better to rent than to buy. I will therefore base my calculations regarding investing in residential real estate, while I will determine if there is a bubble according to Miller and Modigliani.

To examine the P/R ratio development in Oslo, I will collect the quarterly and annual house price and the quarterly and annual rent price from Q1 2013 to Q4 2017. As this is an outlook on Oslo as a whole, there is no reason to separate the calculations into different areas of Oslo as done in the previous methodologies. Furthermore, I will in this analysis be focusing on prices for apartments consisting of two rooms, considering Statistics Norway uses this in their provided rental price data (2013-2017b). The price information will be retrieved from Eiendomsverdi.

3.3.1 *Model Assumption and Weaknesses*

The P/R ratio has several assumptions and weaknesses that needs to be taken into account when conducting the analysis. They are presented below (Bertelsen & Bremnes, 2007).

- *The housing is assumed to be homogeneous, and there exists corresponding rental prices*: this means that there are strong reasons to believe that the localization does not have any impact on the housing prices. These are

assumptions, which clearly contradicts with the reality, as any property is unique particularly when taking location and the construction into account. Therefore, the P/R analysis needs to include numbers that include the necessary residential property types (apartments in this case) and rents.

- *To rent and buy housing is perceived as perfect substitutes:* one assumes that a price increase in one leads to increased demand of the other. From the housing market we know well that there are strong preferences to own rather than rent. As mentioned in 2.1 Market overview 77 percent own their home. Implying that the rental market is relativly small, and limited in type and location. Consequently, renting will not always be a appropriate subsitute for owning.

- *Zero transaction costs:* it is assumed that there are zero transaction costs when buying and selling a dwelling, which obviously is not true. Often there is a documentary duty cost of 2.5 percent of the total sales price, which is a noticeably cost (Kartverket, 2018). Furthermore, the model assumes there are not cost of searching for housing to be insignificant. These are costs that might imbalance the P/R-ratio.

3.4 Hodrick-Prescott Filter

The Hodrick-Prescott Filter, HP-filter, is a mathematical algorithm presented by Hodrick and Prescott (1997). The HP-filter is used to estimate the long-term trend component of a time series. It was originally developed to promote the analysis of fluctuations in economic activity. The model shows smoothed-curve by decomposing a data set into trend and cyclical components. The trend component in a time series is calculated by removing the cyclical component of the series from the raw data. This method seeks to find value of the trend, T_t, minimizing the deviation, C_t linking the observed value and the trend. When using this model to evaluate the housing market, the values of the cyclical component might indicate under- or over-estimated house prices. By looking at the trend-line one can observe if there are great deviations from it, which could signal that there are bubble tendencies in the housing market. Furthermore, it can identify potential seasonality differences, if the trend is fluctuating and not a straight line.

An observed time series is seen as the sum of the cyclical components and the trend component. A time series is given by following equation:

Equation 3.15: $Y_t = G_t + C_t \ \ for\ t = 1, \dots, T$

The measure of the smoothness of the $\{t_t\}$ is the sum of the squares of its second difference. Where the C_t is a deviation from T_t, and the time series is assumed to be over a long time period, averages equal to zero. It is practical to use the natural

logarithm of the variables, instead of the variables itself, as the changes in the logarithm of the variable *X* predict the percentage change in *X*. By taking the logarithm on both sides of the equation 3.15 and define $y_t \equiv \ln G_t$, $g_t \equiv \ln G_t$ and $c_t \equiv \ln C_t$ we get:

Equation 3.16: $y_t = g_t + c_t$

It is possible to estimate the trend component, g_t and the cyclical component, c_t separately given only the observation y_t. It might be tempting to look at the linear regression line, but there is a need for a more sophisticated method in order to separate the trend from the cyclical component of a variable. A method, which allows variations over time in the underlying trend but, which also secures that the short-term fluctuations are categorized as temporarily cyclical deviations from the trend, is necessary. By using the HP-method we can find the values of the trend component, minimizing the deviations from actual to potential trend, where it at the same time it includes limitations to how much the growth of the trend might variate. This leads to the following equation:

Equation 3.17: $HP = \sum_{t=1}^{T}(y_t - g_t)^2 + \lambda \sum_{t=2}^{T-1}[(g_{t+1} - g_t) - (g_t - g_{t-1})]^2$

Where y_t-g_t defines the cyclical component, c_t in period t (the cyclical component is defined as observed values deducting the trend component). The parameter λ is decided outside the model by the observer and has a value between zero and infinite. λ determines to what degree the variations in the trend allows. g_{t+1}, g_t and g_{t-1} denote the trend components in the following period, the present period and the previous period respectively. The expression in the squared brackets therefore measures the changes in the estimated trend from a period until the next. To minimize the expression in equation 3.17, gives a compromise between the two goals. On one side, we wish to minimize the changes in the estimated trend over a period of time, as this will minimize the other terms in the equation 3.17. On the other side, it is desirable to get g_t as close to y_t as possible, in order to minimize the first part of equation 3.17. The relative weighted estimates between these two contradictory goals depends upon the choice of λ. The higher the value of λ, the less variations over time we will experience over the estimated trend. In the opposite case, the smaller the λ, the smaller the deviations between estimated trend g_t and observed value of y_t will be. When estimating the trend, one can easily calculate the cycles by reformulating equation 3.17 to:

Equation 3.18: $c_t = y_t - g_t$

By looking at the cycle deflections we can observe, as mentioned earlier, the percentage deviation from the trend.

3.4.1 *Model Assumption and Weaknesses*

Due to the simplicity of the method, there are some weaknesses related to the model. It is necessary to take these limitations into consideration before coming to a conclusion in the analysis. The weaknesses I find the most important are mentioned below.

- *The smoothing parameter, λ:* when choosing the value of λ, it is important to keep in mind that this will affect the result of the model to a great extent. This is because the value of λ is subjective, thus one can choose a value that supports your desired result. It is therefore difficult to make sure that the results of the model produce the actual trend of the time series.

- *The cyclical component values are given equal weights*: the up- and downturns in the economy, also known as the positive and negative cycle component values, are given equal weights when using the HP-filter. It is therefore assumed that the up- and downturns last for the same amount of time. However, Christina D. Romer (1999) contradicts this assumption in her research. She states that the life cycles of upturns last longer than the downturns, thus awarding them equal weights might give misleading results.

- *End-point errors:* as the HP-filter uses future, current and previous observations to calculate the trend in the time series, it can be seen as a two-sided model (Gerdrup, Schaanning, & Kvinlog, 2013). This is visible in the second part of equation 3.17. Since the method is two-sided, it creates difficulties for the end point values. In the beginning (end) of the time series, only future (previous) values are available, which might be a challenge, in particular if the first or last observation is uncertain (Brubakk, Jore, & Bjørnland, 2004). Consequently, the first and last parts of the time series will be more affected by current observations, thus the method goes from being two-sided to one-sided.

- *Problem connected to long cycles*: if it exists a negative long-term deviation from the trend in the data set, the HP-filter might come to a wrong conclusion. This deviation, will be seen as a falling trend in the model. Therefore, the longevity of the cycles makes an impact on the results from the HP-filter.

- *Real time issues*: as regards to the end point errors, there exists some real-time concerns. Often, the most recent observations are more uncertain than the other observations, which can be enhanced due to the end point errors. A main criticism against the HP-filter is the fact that it assigns more weight to the recent observations.

- *Lack of fundamental strength*: the last presented problem regarding the HP-filter is its lack of fundamental strength. It only looks at the observed trend without any economic rationality for the trend. If there are big fundamental changes in the market, the HP-filter indicates if there is an over- or underpricing, even though the price is fundamentally correct (Furuseth, 2012).

Choice of lambda

There is a rule of thumb when selecting the correct value of λ

- $\lambda = 100$ is used for yearly observations
- $\lambda = 14{,}400$ is used for monthly observations
- $\lambda = 1{,}600$ is used for quarterly observations. This value is proposed by Kydland and Prescott (1990), and has become an international standard for quarterly data.

However, there have been many discussions regarding what λ one should use in different scenarios. Statistics Norway argues that the quarterly smoothing constant for Norwegian GDP should be 40,000 (SSB). This constant is 25 times higher than the proposed value of 1,600 (Kydland & Prescott, 1990) suggested for the American market. Furthermore, it is important to keep in mind to not choose a λ which is too low, considering the growth in the housing prices in Oslo over the last years, which might cause the end-point errors to be considerable. As I am focusing on quarterly data, I have chosen to use the standard λ-value of 1,600. I believe this value also is relevant for Oslo considering the quarterly data, and will give the most accurate trend-line, even though Statistics Norway use a fairly higher value.

As I am also constructing an annual HP-filter there might be interesting in looking at more λ, considering the discussions regarding annual data. Backus and Kehoe (1992) find the usage of a $\lambda = 100$ for annual data the most appropriate, while Ravn and Uhlig (2001) recommend a $\lambda = 6.25$. It could be argued that a λ of 100 is too low in an analysis of housing prices. As the prices has had such a considerable growth in Oslo over the past years, it is important to not apply a too low λ, since this might lead the end-point errors to be substantial. Using a $\lambda = 100$ might lead to an emphasis on the extreme values in the end of the time series, which might lead to an underestimation of a potential bubble. I will therefore use two $\lambda -$ values in my annual HP-filter, in order to eliminate potential underestimations. Thus, I have chosen to use the standard $\lambda -$ value of 100 and a much higher, 25 times higher $\lambda -$ value of 2,500. I believe this value also is relevant for Oslo considering the annual data and will give the most accurate trend-line.

4. Data

4.1 Data Description

The variables I will use in my analysis are based on the Norwegian housing market and are chosen based on the method described in the previous chapter. The chosen variables are housing prices, interest rate, housing construction, unemployment rate, household income and rental prices. I have chosen these variables based on Jacobsen and Naug's housing price model (2005) and based on the necessary variables in order to conduct the P/R-method. Below, I will describe the variables by including graphs, sources and descriptive statistics. Furthermore, all the data used are attached in appendix 2 to 10.

4.1.1 *Housing Prices*

I have through Eiendomsverdi, found the housing prices for the period 2000 to 2018. One part of the data are yearly sales prices per clustered area, while the other part is based on quarterly sales prices for Oslo as a whole. Figure 4-1 shows the development of the yearly prices from each of the areas from 2000 to Q1 2018, while figure 4-2 shows the quarterly prices from Oslo over the period 2010 to Q1 2018.

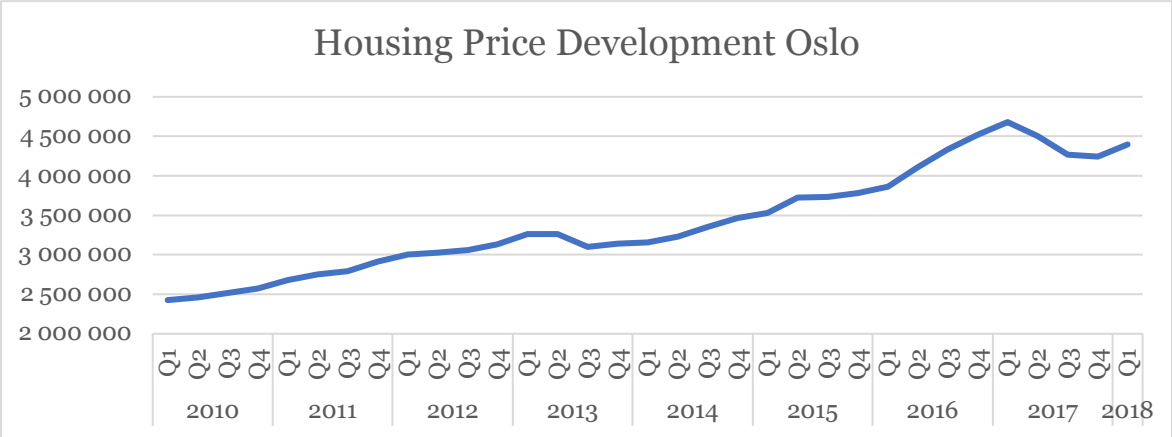

Figure 4-1: Housing Price Development based on data from Eiendomsverdi
Source: Eiendomsverdi, created by author

From figure 4-1 one can observe the development of the housing price in Norway from 2010 to Q1 2018. The prices steadily increased over the period 2010 to 2013, followed by a little dip in Q2 to Q3 of 2013. From Q3 2013 the prices have increased considerably until the beginning of 2017, growing by approximately 50 percent. After this however, the prices experienced a decline until the beginning of 2018. While, in the first quarter of 2018 the prices have experience a gradual growth.

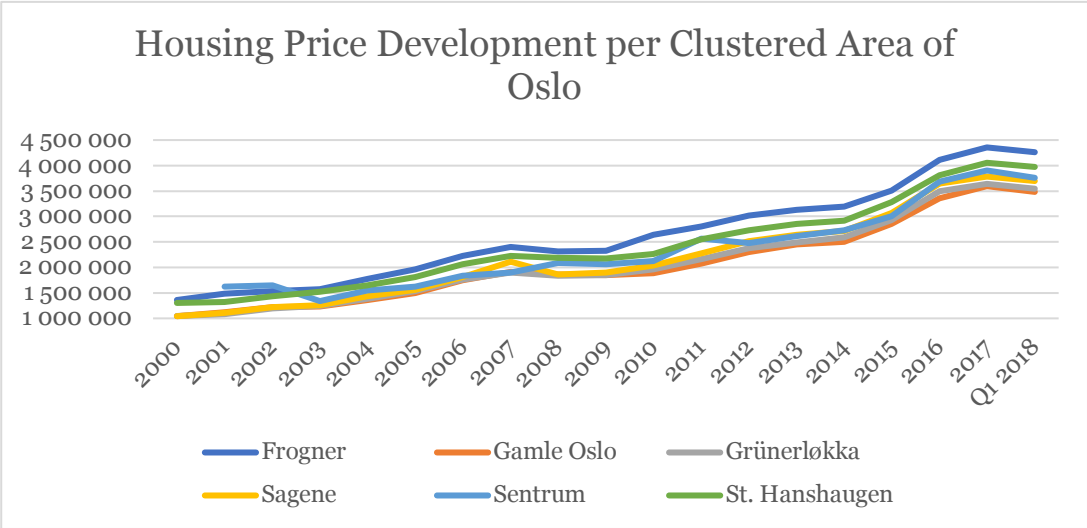

Figure 4-2: Housing Price Development per Clustered Area, 2000 – Q1 2018
Source: Eiendomsverdi, created by author

From figure 4-2 the development of prices for each of the clustered areas are represented, from 1st of January 2000 to 31st of March 2018. The graph clearly shows how Frogner is the area with the highest prices, followed by St. Hanshaugen, while Gamle Oslo held the lowest prices over the period. The graph also shows how the prices were affected by the financial crisis in 2007/2008, as all of the areas experienced a steep decline after the crisis hit. Furthermore, one can observe how all of the areas has followed the same growth pattern over the past 18 years.

4.1.2 *Interest Rate*

Statistics Norway provided me with the interest rates on mortgage loans from 2000 until Q1 2018. The interest rate statistics includes the average interest rates on mortgage loans. My data material is collected from the table 08175 "The banks' annual lending rate and deposit" www.ssb.no, search: 08175 (Statistics Norway, 2018b).

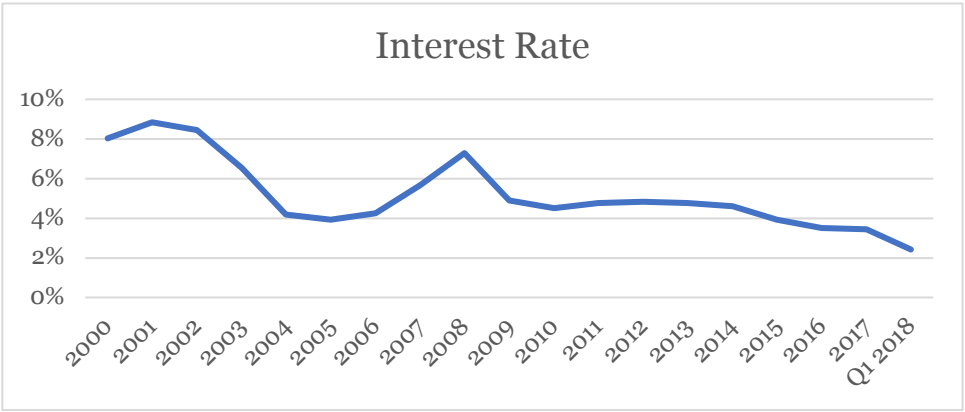

Figure 4-3: Interest Rate Norway, 2000 – Q1 2018
Source: Statistics Norway created by author

Figure 4-3 shows the development of the interest rate in the respective period. As we can see, the interest rate is at its all-time low. Steadily declining from 2000 until 2004, followed by a sharp climb of 3 percentage points from 2006 until 2008, and a quite steady decline until today. The interest rate has declined by approximately 6 percentage points from 2000 until today.

4.1.3 *Housing Construction*

Kommuneprofilen has provided a report on the construction of new dwelling specifically related to Oslo This data goes from 2017 back to 2000 and is divided into a number of started constructions of new dwellings and number of finished new dwellings (Kommuneprofilen, 2018). The reason for creating such a report, is in order to compare the number of started and finished dwellings per year. As I am fully concentrating on constructed dwellings in Oslo, I have chosen to focus on the number of finished housing.

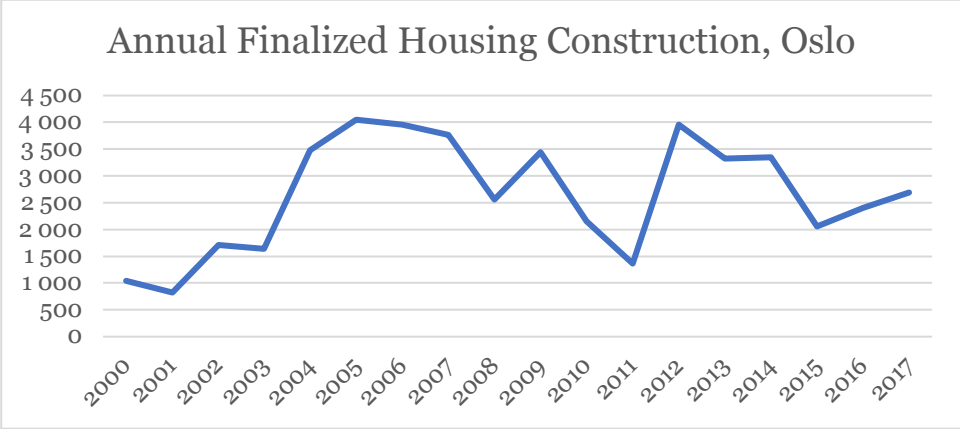

Figure 4-4: Annual Finalized Housing Construction Oslo, 2000 – 2017
Source: Kommuneprofilen created by author

Figure 4-4 shows the development of the number of finalized dwellings over the period 2000 to 2007. Furthermore, it is visible that 2001 was the year with the least number of finalized new dwellings, while 2005 and 2012 are the years with the highest number of new constructions. It is clear from the graph that the number of constructions has fluctuated considerably over the period. The total increase from 2000 to 2005 was approximately four times higher. It is also visible that the financial crisis affected the finalized residential constructions as well, considering the steep fall between 2007 and 2008.

Figure 4-5 shows the average house prices compared to the annual housing construction over the period 2000 to 2017.

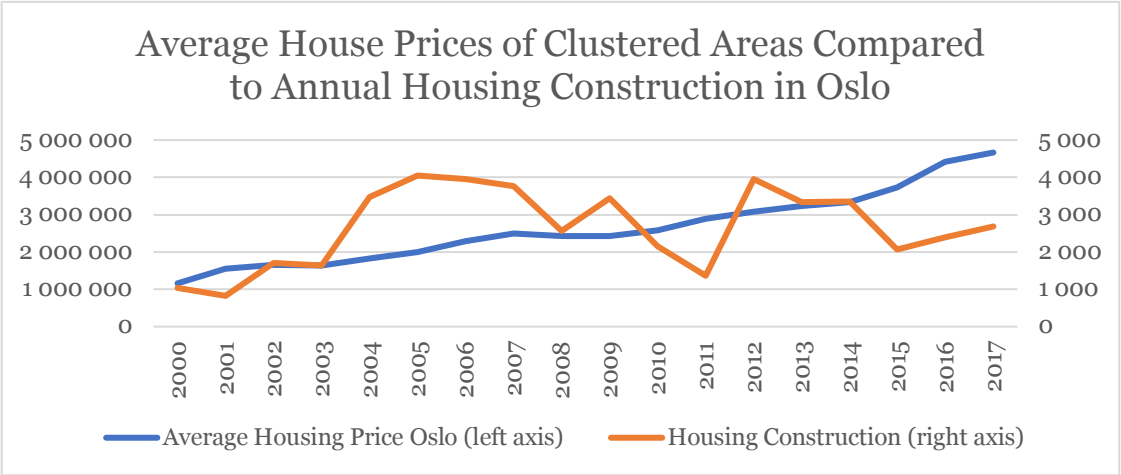

Figure 4-5: Average Housing Price of Clustered Areas Compared to Annual Housing Construction Oslo, 2000 – 2017
Source: Eiendomsverdi & Kommuneprofilen created by author

4.1.4 *Unemployment Rate*

OECD has the statistics of the unemployment rate in all OECD countries. Unemployment is defined as a person registered looking for a job, who is fully without any work providing an income over the past two weeks. My data set is collected from table "unemployment rate: total, % of labor force, 2000 to 2017" by filling in Norway as highlighted countries (OECD, 2018b).

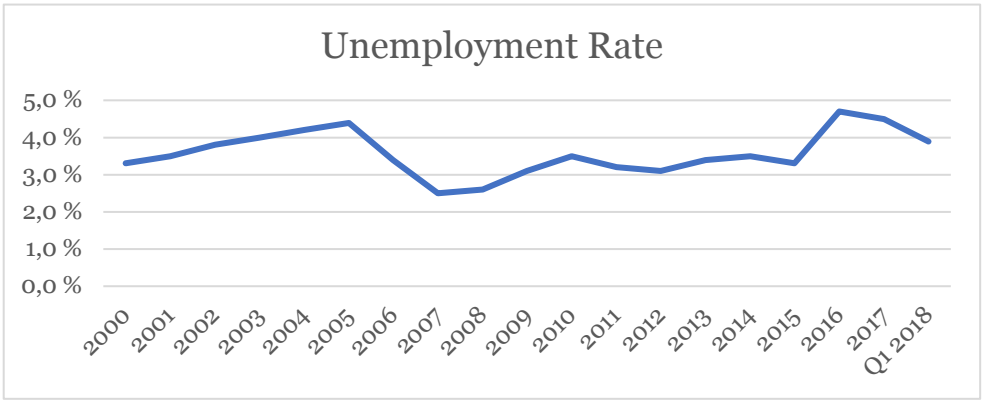

Figure 4-6: Unemployment Rate Norway, 2000 – Q1 2018
Source: OECD created by author

Figure 4-6 shows the changes in the unemployment rate in Norway from 2000 to Q1 2018, and how it has fluctuated between 2.5 percent and 4.7 percent. We can see how 2007 experienced the lowest rate, while 2016 had the highest unemployment rate over the analyzed period. The unemployment rate is an indicator of the economic performance of a country, where a low unemployment rate reflects high performance

and a high rate reflects a poor performance. Due to the financial crisis the rate increased until 2010, followed by a decline until 2015. From 2015 until today there has been a steady average increase in unemployment.

4.1.5 *Households' Income*

Through Statistics Norway's annual report "income and wealth statistics for households". I have gathered the yearly nominal income of households'. The data is collected for 2000 until 2017.

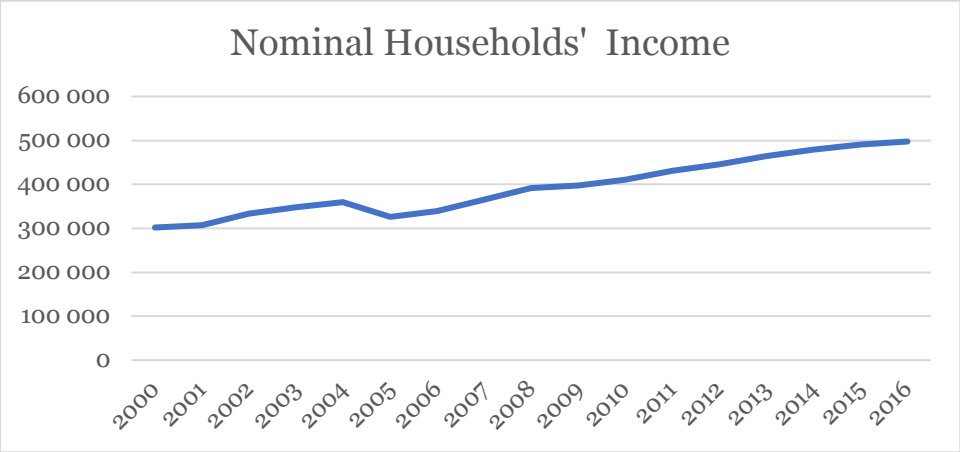

Figure 4-7: Nominal Household Income Norway, 2000 – 2016
Source: Statistics Norway created by author

The nominal households' income, represents the annual wealth of a family after taxes. On average the income has gradually increased over the period. However, from 2004 until 2005 the income declined, followed by the steady annual growth. It is reason to believe this growth is causing the general price increase, the society experiences on an annual basis.

4.1.6 *Rental Prices*

I have through Statistics Norway, collected the data for rental rates for Oslo over the period 2013 to 2018. The data is collected through the "rental market survey" conducted each year, focusing on two room housing in Oslo.

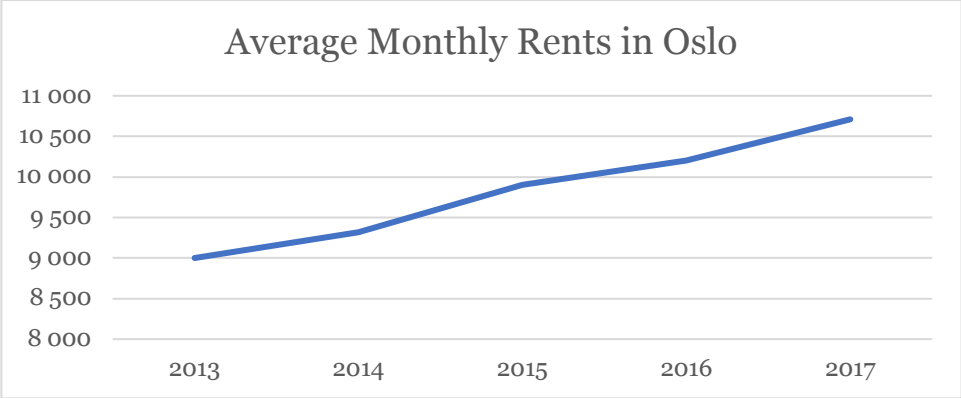

Figure 4-8: Average Monthly Rents in Oslo, 2013 – 2017
Source: Statistics Norway created by author

Figure 4-8 shows how the rental prices in Oslo have developed from 2013 to 2017. It is clear that the prices have increased, from 9,000 NOK in 2013 to 10,710 NOK in 2017, which is an increase of 19 percent.

4.2 Empirical Data

In this sub-chapter I will present the results from this study. From the methods presented in chapter 3, I have employed a linear regression and a multiple regression procedure in STATA, analyzing the p-values as well as doing a t-test. This is in order to compare how the factors influence the housing prices across the six clustered areas. Furthermore, I have done a simplified price-to-rent analysis to tackle at the potential bubble discussion and questions regarding investing in residential real estate in Oslo. Lastly, I will use the HP-filter. I have used Excel to do my HP-estimations by downloading the HP-filter developed for Excel by Kurt Annen[8]. This will show me the long-term trend compared to the housing prices. By studying it, one can determine if the prices are over- or underestimated and if there might be fundamental factors influencing the prices. All the necessary data, tables and graphs are included in appendix 2 to 10. All my estimations in this chapter is based on the information and gathered data presented previously in this chapter.

4.2.1 *Linear Regression*

Simple Linear Regression Analysis
I employed a linear regression procedure in STATA by uploading the data presented in appendix 3. Furthermore, I had to convert the variables from string to numeric, in order to do the regression analysis. Then I typed "regress housingprice (dependent variable) interest_rate (predictor variable). STATA then automatically use the least

[8] The HP-filter can be downloaded through (Annen, 2005)

squares method in order to provide the correct results. I did this separately for all the six clustered areas. The outcomes from STATA are presented in appendix 4. The outcome shows (as my predictor variable is of percentage), that an increase of one unit, also known as a one percent increase in this variable, leads to on average, the change presented in the box below.

	Frogner	**Gamle Oslo**	**Grünerløkka**	**Sagene**	**Sentrum**	**St. Hanshaugen**
Interest_rate	-564871.1	-521059.5	-524656.8	-528570.1	-574398.6	-557274.1
P>[t]	0.019	0.020	0.020	0.020	0.024	0.016

Table 4-1: Linear Regression Results

The results from the analysis in STATA is presented in table 4-1. Each of the six areas are presented with the predictor value and the p-value in order to do the T-test. As there is only one explanatory variable, we have a paired relationship. Therefore, we are unable to compare these results with the results from the multiple linear regression.

On the basis of this model I can see that the interest rate has a negative effect on the housing prices. I estimate that for every percentage increase in the parameter interest rate leads to on average a house price decrease of 76,000 NOK in Frogner, 20,636 NOK in Gamle Oslo, 38,212 in Grünerløkka, 42,135 in Sagene, 2,520 in Sentrum and 52,176 in St. Hanshaugen. I therefore estimate that Frogner is more dependent on the change in interest rate than Sentrum. However, it is important to keep in mind that Frogner has a considerably higher number of sales over the analyzed period then Sentrum. There is therefore reason to believe that the results of Sentrum is slightly unrealistic as there is not enough data to find such a specific result as in the other areas.

By looking at the adjusted R-squared one can see how the models are all lying between 0.69 and 0.75. This proves how the interest rate explain the housing prices very well, by approximately 70 percent. Furthermore, As, these models are under 95 percent confidence intervals for the coefficients, we need to look at the p-value in order to prove how the data is statistically significant or not. Therefore, if the P>[t] is below 0.05, the data is statistically significant. On the basis of this model I estimate that all of the areas are statistically significant, as the p-values are between 0.016 and 0.02.

The findings by doing a simple linear regression are completely related to what I think one could expect:

- Increased interest rate will lead to a decrease in the housing prices all over Oslo. If the interest rate increased rapidly, people will no longer afford to own their own home (assuming they have a mortgage loan), and people will not have the opportunity to enter the real estate market in order to get their first housing. It will therefore be too expensive to own your own home if you have a large mortgage loan, as the cost of the interests will increase proportionally with the interest rate. Furthermore, if the interest rate increases rapidly, people will

struggle to sell their homes to the expected price, since it is too expensive for people to buy a new home or enter the housing market as first time buyers.

Before the increase in the interest rate, people could borrow 3 million kroners to buy a dwelling that was put on the market for 3 million, after the increase however, they would only be able to borrow 2.5 million, thus not afford to buy the desired housing for 3 million. The consequences of this is that, people who once borrowed 3 million before the increase in interest rate, do not manage to pay down their mortgage, since their income no longer cover the costs. These people are forced to selling their homes, but because of the high interest rate, potential buyers might struggle to afford a housing for 3 million but might afford 2.5 million. This change puts immense pressure on the housing prices, pushing them down to the demand.

When interest rates increase, the supply will adapt towards the demand. Consequently, prices are pushed down.

Multiple Regression Analysis

I employed a multiple regression procedure in STATA by uploading the data set including all four of the explanatory variables, interest_rate, housingconstruction, unemployment_rate and nominalhoushold income. In order to get valid results, I had to convert the variables with _ from string to numeric. After this, I computed “regress housingprice (dependant variable) interest_rate housingconstuction unemployment_rate nominalhousehold income. STATA automatically uses the least squares method in order to produce the results presented below. I did this separately for each of the clustered areas. The data from STATA is attached in appendix 6. The outcome shows, as two of my predictor variable (interest_rate and unemployment_rate) are of percentage, that an increase of one unit, one percent in this variable, leads to on average, a change presented in table 4-2 and 4-4. While, the numeric outcomes of the two other predictor variables (housing construction and nominalhouseholdincome), shows how an increase of one unit in this variable, leads to on average, a change presented in table 4-3 and 4-5.

I will look at all of the four explanatory variables for the areas separately. This is because one always analyzes the data based on how one explanatory variable changes the dependent variable, considering all other variables are kept constant. As there are several explanatory variables, we have a partial relationship. We are therefore unable to compare these results with the results from the simple linear regression. Furthermore, by looking at the adjusted R-squared one can see how all the models are all lying between 0.89 and 0.81. This proves how the different explanatory variables explain the housing prices very well, by approximately 85 percent.

	Frogner	Gamle Oslo	Grünerløkka	Sagene	Sentrum	St. Hanshaugen
Interest_rate	-76000.09	-20635.67	-38211.91	-42135.3	-2519.86	-52176.48

Table 4-2: Multiple Regression Results for Interest_rate

Table 4-2 shows how the explanatory variable, interest_rate has a negative effect on the housing prices in the respective areas. On the basis of this model I estimate that a one unit increase of interest rate leads, on average, to a decrease of 76,000 NOK in housing prices in Frogner, 20,636 NOK in Grünerløkka, 38,212 NOK in Sagene, 2,520 NOK in Sentrum and 52,177 NOK in St. Hanshaugen. Clearly, Frogner is the most vulnerable to a change in interest rate, followed by Grünerløkka with nearly 20,000 NOK difference. Looking at the data set in appendix 5 we can see that Frogner has the overall highest prices over the period, followed by St. Hanshaugen. Grünerløkka and Sagene however, seem to be the only two areas affected more or less intact with each other, by the interest rate.

	Frogner	Gamle Oslo	Grünerløkka	Sagene	Sentrum	St. Hanshaugen
Housing Construction	3.12	42.22	27.28	34.91	-33.47	19.29

Table 4-3: Multiple Regression Results for Housing Construction

Table 4-3 shows how the independent variable, housingConstruction has a positive and a negative effect on the housing prices in the areas. On the basis of this model I estimate that a one unit increase of housing construction leads on average to an increase of the housing price by 3 NOK in Frogner, between 19 and 42 NOK in Gamle Oslo, Grünerløkka, Sagene and St. Hanshaugen, in Sentrum however, it leads to a decrease by 33 NOK. Accordingly, on the basis of this model I estimate that the housing prices are not as dependent on the annual housing constructions. However, it seems that Gamle Oslo is the most positively affected on the number of housing constructions, while Sentrum is negatively affected by the change.

	Frogner	Gamle Oslo	Grünerløkka	Sagene	Sentrum	St. Hanshaugen
Unemployment_rate	-14476.74	57614	65684.39	38717.16	74609.19	20868.34

Table 4-4: Multiple Regression Results for Uneployment_rate

Table 4-4 shows how the independent variable, unemployment_rate has a negative and a positive effect on the housing prices in the different areas. On the basis of this model I estimate that a one unit increase of unemployment rate leads to a decrease in the housing price by 14,477 NOK in Frogner, while an increase in the housing price

between 20,868 NOK and 65,684 NOK in Gamle Oslo, Grünerløkka, Sagene, Sentrum and St. Hanshaugen. It is interesting to observe how the increase in the unemployment rate leads to lower prices only in Frogner, while in the other areas there would be quite a significant growth in the housing prices. It is clear that the house prices in Frogner are more sensitive to a change in the unemployment rate, in regard to declining prices. While, the prices in Sentrum are increasing the highest with the increasing unemployment rate. It is therefore, reason to believe that all the areas except from Frogner are more "attractive" when there is a higher unemployment rate.

	Frogner	**Gamle Oslo**	**Grünerløkka**	**Sagene**	**Sentrum**	**St. Hanshaugen**
NominalHousholdIncome	10.24	8.72	9.08	9.73	9.14	9.45

Table 4-5: Multiple Regression Results for Nominal Household Income

Table 4-5 shows how the independent variable; nominalhouseholdsincome has a positive effect on the housing prices in the different areas. On the basis of this model I estimate that a one unit increase of the nominal household income on average leads to an increase by between 9 and 10 NOK in all of the mentioned areas of Oslo. It is therefore reason to believe that the housing prices in Oslo are slightly affected by the change in nominal household's income.

The findings by doing a multiple regression are completely related to what I think one could expect:

- Increasing interest rate leads to an overall decrease in the housing prices in all areas. The reason for this is, as mentioned in the linear regression results, that people will no longer afford to own their homes, as their loan gets more expensive. This might force people to sell their house, therefore buyers wanting to get into the housing market will not afford to pay the same prices as previously, thus prices are pushed down.

- Increasing number of finalized dwellings leads on average to nearly no change in the housing prices. The reason for this, is because over the observed time period there has been few new dwellings newly constructed than what the estimated need in the market is. Furthermore, the data is identical in all the areas, as there is no data specifically assign each of the areas. Therefore, if there had been a higher number of constructions in the data set, as well as area-specific data, it is reason to believe that the prices would have decreased by the number of new dwellings in the market. This is because more housing leads to increased supply, the prices will therefore meet the demand by decreasing.

- Increasing unemployment rate leads to a decrease in the housing prices in the most expensive area, Frogner. However, it seems that Sentrum, Grünerløkka

and Gamle Oslo are the two areas where the unemployment rate is beneficial for the homeowners. As the unemployment rate has kept a quite stable amount, it is reason to believe that it would have been considerably different if it had fluctuated more. In general, one thinks that higher unemployment rate leads to a decrease in housing prices. In this case, it is possible to think that with the increasing unemployment rate, people living in areas such as Frogner are forced to move, they therefore choose to move to the less expensive areas. As Sentrum is the closest area for people living in Frogner, there might be a relationship between this and the high increase in price with increasing unemployment. Furthermore, Gamle Oslo and Grünerløkka are the "cheapest" areas in Oslo[9], which might be the next two areas one moves to. Logically, on moves to a cheaper neighborhood if the one you live in is too expensive. Especially if a household loses one of their sources of income. I also have to emphasize how the number of unemployed in Norway is a small fraction of the population, and since it has not fluctuated much over the estimated period, it is not considered to be as influential as the other factors.

- Increasing households' income leads to an increase in the housing prices. When people or the household gets a higher income, they have a higher amount to spend. Following the trend that people spend the most on housing, it is reasonable to believe that a higher income leads to a higher fraction of the income being spent on housing. Consequently, demand exceed supply, and the prices increase accordingly. When the income increases, one has the ability to borrow more money, leading to an increase in housing prices.

4.2.2 *Price-to-Rent Method*

This section will look at the changes in the real P/R ratios for each quarter from Q1 2013 to Q4 2017 and asses the development in the housing market in Oslo, relative to the average and linear trend. Furthermore, the average change in percentage will be included in order to compare the annual change in price and rent, to understand how the P/R ratio develops accordingly.

Figure 4-9 illustrate that the real P/R-ratio for the housing market in Oslo has had an increasing trend over the past five years. The real P/R has fluctuated between 20.9 and 29.3, holding an average of 24.4 over the time period. As previously mentioned, any ratio above 21 indicates that it is significantly better to rent rather than buy. However, it is important to keep in mind that the reasons for buying rather than renting is a

[9] Considering the areas of Oslo, I have chosen to analyze in this paper

subjective assessment based on preferences. Furthermore, these numbers are based on the American market, which might slightly differentiate from the Norwegian market.

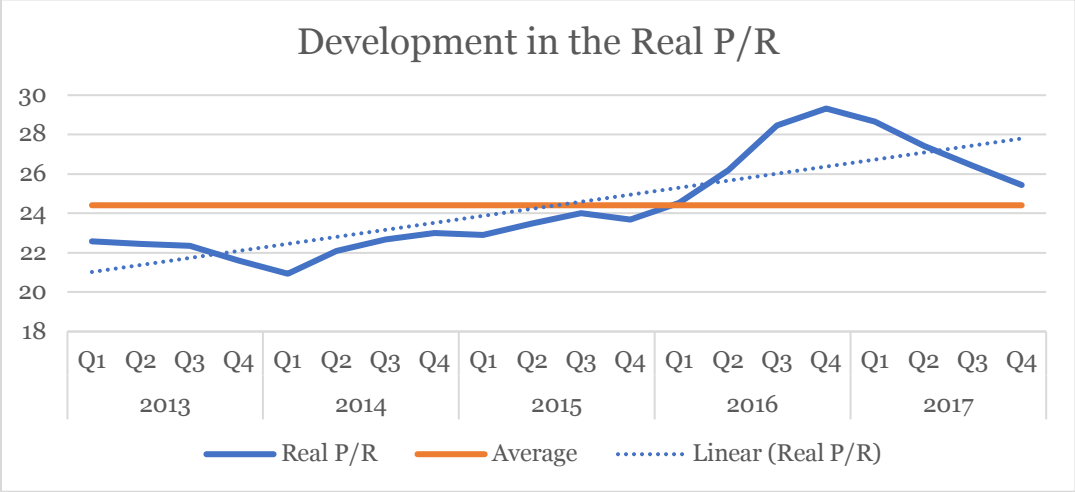

Figure 4-9: Development in real P/R, quarterly from 2013-2017
Source: Author (2018), Appendix 7

The theory states that the ratio should be close to equal in long-term. Following, Kindleberger's (1987) theory on determining if there is a bubble present, there are reasons to believe there is a bubble if there is a sharp rise in prices, followed by a sharp decline. As seen in the figure, the trend-line indicates a stable rise in the P/R-ratio during the whole period, while the real P/R-ratio in Q1 2016 to Q4 2016 experienced a sharp increase, followed by a quite steep decline until Q4 2017. As these fluctuations are quite rapid compared to the trend line, it might indicate a housing bubble in the market. In particular, the negative deviation from the trend-line from 2014 to end of 2015, as well as a positive deviation between beginning of 2016 to the middle of 2017. In order to gain better insight on whether or not there is a housing bubble present, it is necessary to do further analysis through other methods. By comparing the results, one can come to a more reliable conclusion.

Table 4-6, compares the rent and housing price percentage changes, which shows how there was a proportional change in both housing and rental price in 2013, followed by significantly higher increases in housing prices compared to the rent, till 2017 when the rental price and housing prices were nearly growing proportionally again. This is indicated in figure 4-9, as the ratio, as mentioned above, fluctuates from the trend-line between 2013 and 2015, as well as between 2016 and the middle of 2017. It is therefore, clear from the table below that the price and rent has not followed the same development, and this supports the discussions regarding potential bubble tendencies in the housing market in Oslo.

Year	Average Monthly Rents	Yearly Rents Increase	Average Yearly House Price	Yearly Price Increase
2013	9 000	N/A	2 402 482	N/A
2014	9 320	3,4 %	2 479 848	3,1 %
2015	9 900	5,9 %	2 795 207	11,3 %
2016	10 200	2,9 %	3 319 858	15,8 %
2017	10 710	4,8 %	3 468 053	4,3 %

Table 4-6: Percentage change in average yearly rent and average housing prices of Oslo, 2013 – 2017
Source: Author (2018), Appendix 7

4.2.3 *Hodrick-Prescott Filter*

In this section I will look at the trend component of the housing prices through a HP-filter. I have chosen to construct two HP-filters. One with the annual prices from 2000 to 2018, the other one consists of quarterly prices over the period 2010 to 2018. This in order to see if there are big differences in deviations from the long-term annual data going back 18 years, and the shorter quarterly data going back 5 years.
Figure 4-10 and 4-11 illustrates the development of the housing prices and the trend component with one graph using λ of 1,600, and another using λ of 100 and λ of 2,500 from Q1 2010 to Q1 2018 and 2000 to 2018 respectively.

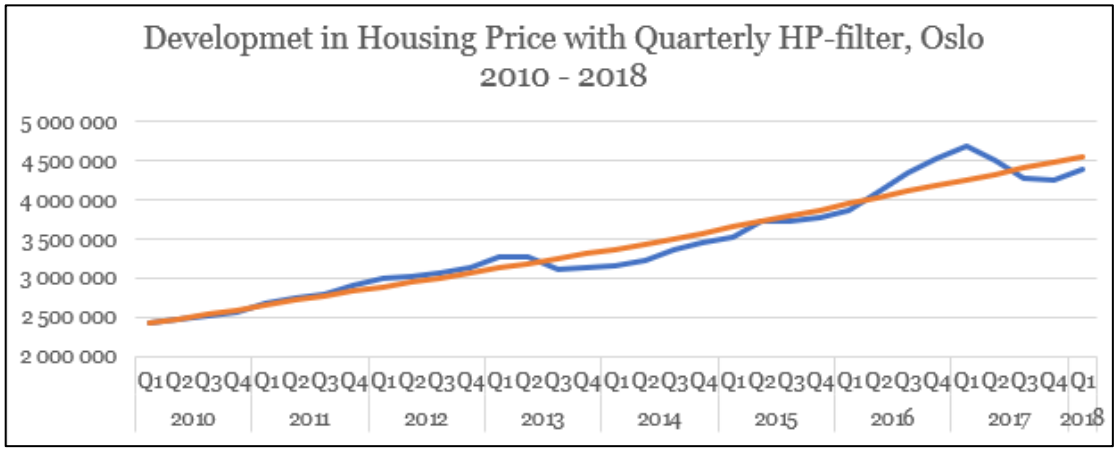

Figure 4-10: Development in quarterly housing prices with HP-filter, 2010 – 2018
Source: Author, Appendix 8

With a smoothing parameter of 1,600, the trend deviates further from the house pricing, then when using a smaller λ. As one can see from the graph, there are only some periods where the price seems to be over-/undervalued and therefore deviates from the trend. The HP-filter has discovered a linear trend over the analyzed time period. Furthermore, the figure illustrates that the housing prices have been

overvalued from 2011 until the middle of 2013, while undervalued between 2013 and 2015, and again considerably overvalued looking at the deviations between the trend and housing prices in the period from 2016 to the middle of 2017. Accordingly, it can be concluded that there has been bubble tendencies in the housing market in Oslo, with a trend line of $\lambda = 1600$.

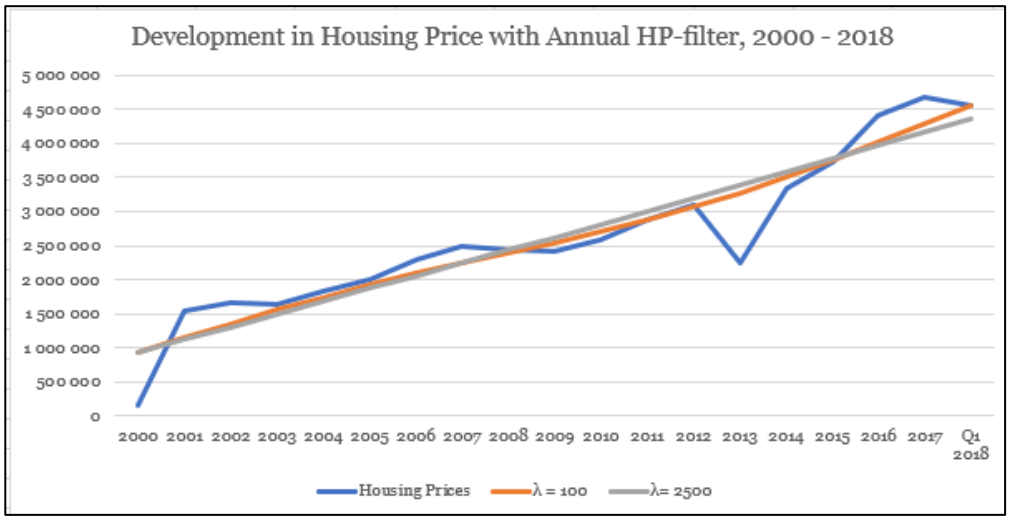

Figure 4-11: Development in annual housing prices with HP-filter, 2000 – 2018
Source: Author, Appendix 9

In the annual HP-filter following the development from 2000 to 2018, it is visible that there is a difference between using a $\lambda = 100$ and a $\lambda = 2{,}500$. With a smoothing parameter of 100, the trend moves closer to the housing price, as one can observe that it lies above and below the trend with a $\lambda = 2{,}500$ according to the housing price fluctuation. There are five main deviations from the trend over the analyzed period. The figure shows that in the period 2000 to 2003, the housing prices were overpriced followed by a slowly increase in the prices.

In the period between 2005 and 2007 the housing prices appeared again to be overvalued, until the financial crisis hit, and the bubble appeared to have burst in 2008. Leading to undervalued housing prices until 2010. Then the most significant deviation of the period is illustrated, the considerably undervalued housing prices relative to the HR-trend between 2012 and 2015. Moreover, this lead to a period of overvalued housing prices, which just stabilized and intersected with the HP-trend in 2018.

Consequently, the analysis with a smoothing parameter of 100, shows clear patterns of both over- and underprice periods over the observed time series. However, we must keep in mind the limitations of using such a small λ, as this might not give the most reliable and accurate results. There might exit end-point errors due to the strong growth in the housing market in Oslo, which might lead to underestimated values.

Thus, the market might have experienced even higher over- and underpricing than what a model using a λ of 100 shows.

In order to get a better picture of whether or not the market is more over- or underpriced than previously discussed, it might be better to use a trend line with a higher smoothing parameter of 2,500. This trend line clearly observes the same historical bubble tendencies as previously. However, they appear to prove even higher values of under- and overpricing over the periods. Also, it seems that the underpriced period after the financial crisis lasted much longer than with a λ of 100, as it seems to continue for a long period, until 2015. Including even larger deviations, the last part of the period, from 2012. Hence, using a trend line with a $\lambda = 2{,}500$ gives reason to believe that there are housing bubbles in the housing market in Oslo. Nonetheless, it must be taken into consideration that using a higher λ reduces end-point errors, but it can also provide more fluctuation. Thus, the result might be slightly overestimated.

Furthermore, in order understand the housing price deviations from the trend more clearly, it is interesting to look at the cycle deviations in the two time periods. We are able to find the cycle deviations by calculating the housing price deviation from the trend line.

These cycles are illustrated in figure 4-12 and 4-13. Figure 4-12 consists of the quarterly data with the cycle of $\lambda = 1{,}600$. Over the analyzed period it is clearly shown how the prices have fluctuated considerably, especially in the identified bubble periods. The positive deviations (overvalued) is noticeable in 2012, 2013 and in particular in the beginning of 2017. The negative deviations (undervalued) however, is present in the beginning of 2014. In general, the housing market has experienced strong deviations from the trend, and there has nearly not been a period, except in the beginning (the whole 2010) where the trend and the prices has been relatively close. Also, during most of the period the deviations are above the trend line, therefore it is reason to believe the housing market is overvalued.

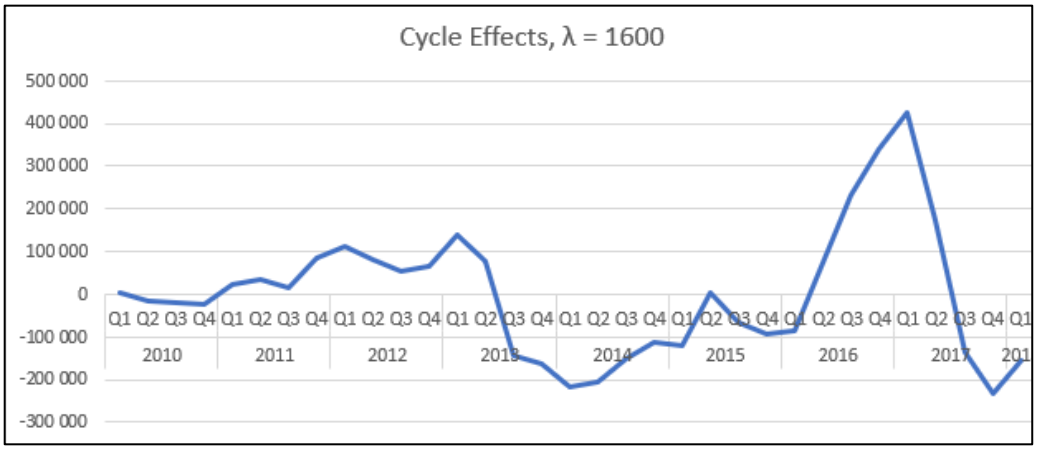

Figure 4-12: Development in Cycle Effects with HP-filter, 2010 – 2018
Source: Author, Appendix 8

From figure 4-13 the cycle effects of both $\lambda = 100$ and 2,500 is illustrated over the annual period from 2000 until the beginning of 2018. Again, the identified historical bubbles are visible. The main positive deviations are present in 2001, 2007 and 2016/2017 depending on which smoothing parameter we look at. On the other hand, the negative deviations are clearly from the beginning of the period, 2000 and in between 2013 and 2014. We can also observe how the recession after the crisis in 2007, which caused the housing prices to decline until 2013. Even though we observe a steep increase in the prices, it is perceived as a negative deviation from the trend, still touching the trend line again. Furthermore, we notice a strong growth in the trend from after 2013, most likely due to the strong price increase, lasting until 2017.

From the figure we can see how the deviation's size (the housing bubbles) depend on the size of the λ. With a higher λ we get a more linear trend, consequently, a clearer illustration of the deviations. Moreover, as mentioned above, the trend line based on annual data indicate that the current[10] housing prices are slightly overvalued. However, the trend line based on the quarterly data indicate slightly undervalued prices.

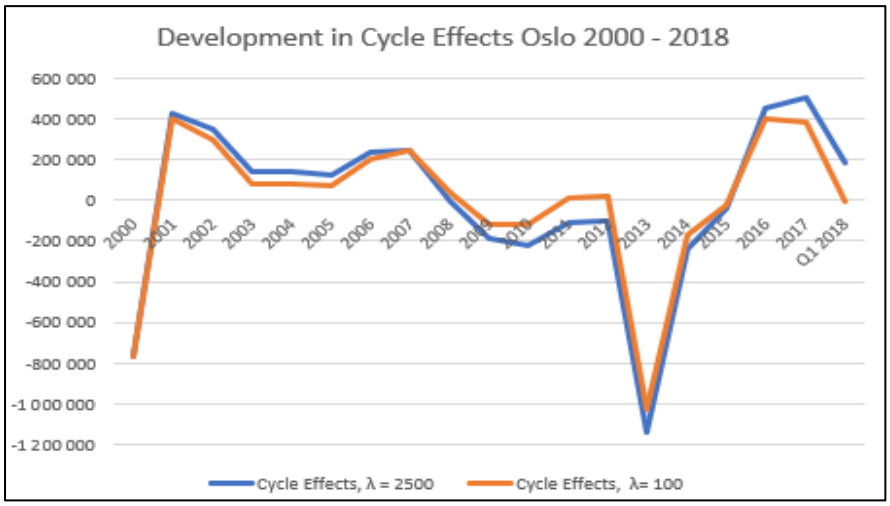

Figure 4-13: Development in Cycle Effects with HP-filter, 2000 – 2018
Source: Author, Appendix 9

Consequently, both models illustrate the previous housing bubbles in Oslo. The housing prices have mostly been above the estimated HP-trends, for $\lambda = 100$, $\lambda = 1{,}600$ and $\lambda = 2{,}500$. Comparing the models, one can see how usually, a high increase in pricing leads to a steep drop. It is understandable, how one would expect, based on this information, that the prices would have dropped even further between 2017 and 2018. When looking back to after the financial crisis, we experienced a "smaller" drop in the beginning, followed by a steeper drop some years later. However, as of the current data available, it seems like the prices are moving closer to the trend line. It is still not certain, whether or not the housing prices will continue to fall after a period of

[10] As of Q1 2018

stabilized housing prices. In general, we have identified several periods where there might have been bubble tendencies. The fundamental factors however, are not taken into consideration, which might cause the model to conclude somehow wrongfully. Therefore, it is important to use the HP-filter together with the other analysis done earlier in the chapter, in order to reach a conclusion regarding the housing market.

5. Market Analysis

In this chapter my aim is to discuss my empirical findings, applying discussions and speculations from the media and people within the industry from chapter 2, in order to understand the underlying factors influencing the housing prices in Oslo.

Based on the estimated data from the regression analysis, I will determine which explanatory factors influence the housing prices more and to what extent. As I first analyzed my data through the simple linear regression, I am able to see how the explanatory variable, interest rate, influenced the prices across the Oslo areas. Then, through the multiple regression, I will look at the four main influential factors, to see, which of them affect the housing prices more. As these two methods are of partial and paired relationships, I am unfortunately unable to compare the results.

Furthermore, I intend to elaborate on my empirical results from the P/R-ratio and HP-analysis in order to prove if there is a housing bubble present in the market. To get the most accurate results it is necessary to combine the results from the different research methods. Therefore, by looking at the P/R-ratio together with the HP-trend, it is possible to compare the results, to see if the two methods produce similar results. These ratios are based on similar prices and are not focusing on the areas of Oslo separately, as one usually concludes if there exists a bubble in a city, and not in the specific areas within.

Lastly, I will, based on all the analysis above, discuss the general reasoning behind the high housing prices and potential psychological effects that might occur. And determine if it is smart to invest in residential real estate in Oslo.

5.1 Findings

When focusing on the simple linear regression, I discovered how the interest rate influence the different areas significantly. Consequently, the housing prices in Oslo are highly influence by a change in interest rate. Based on my regression analysis, I discovered that a one percent change in the interest rate leads to on average a decrease of at least 500,000 NOK. This is following the logic, as, higher interest rates lead to more expensive mortgage loan to pay down[11], forcing many people to sell their home. Furthermore, people who have not yet managed to get on the market, will not be able to borrow as much money as before the change in interest rate. Therefore, leading to an overall decrease of the housing prices.

From the multiple regression analysis, I have looked at the four explanatory variables; interest rate, housing construction, unemployment rate and nominal household's

[11] Assuming most people owning a dwelling have mortgage loans

income in the different areas of Oslo. Here, too the increasing interest rate has led to an overall decrease in the housing prices. It is however, interesting seeing how large price changes there are between Frogner, decline of 76,000 NOK and Sentrum, decrease of 2,519 NOK. There might be several reasons why this occurs. First, Frogner is the area with the highest prices, and it is natural that people spending such high amounts on a dwelling are sensitive to changes in the interest rates, as one can assume most people have high mortgage loans to pay down. Second, Frogner sells 29 times more houses on average over the estimated time period, therefore it is likely that the lack of data in Sentrum might produce less accurate results.

When looking at the housing construction, it is clear how the housing prices are hardly affected by the change in this parameter. There are however, minor differences to the what extent the areas are influenced by this. From Gamle Oslo, with the highest increase of 42 NOK, to Sentrum, with the highest decrease of 34 NOK. There have been several discussions whether there is enough housing being built in the capital. Previous literature has compared the increasing number of population with the annual constructions, and states that there are too few dwellings being built. This might also affect my results, as there is a low number of new dwellings being built in Oslo. Furthermore, considering the data used for this analysis is the same for each of the different areas (as there does not exist any data specifically on different areas of Oslo), one might assume this is a factor producing less valid area-specific data. Also, it is previously stated that Gamle Oslo is the area of Oslo building the most housing. Consequently, attracting more people, increasing overall housing prices.

The unemployment rate, gave one of the most fascinating results. Here only Frogner is negatively affected by the increase in the parameter, while the rest of Oslo is positively influenced. I have come up with the conclusion that, Frogner is the most expensive area, therefore people who are highly affected by an increase in the unemployment are more likely being forced to selling their homes in order to move somewhere else. Consequently, they look for other, less expensive areas to move to. When looking at Oslo city, Sentrum is the closest location, leading to highest increase in the housing prices here, following the least expensive areas Grünerløkka and Gamle Oslo, and then Sagene and St. Hanshaugen.

The last multiple regression analysis is the nominal household's income. Here it is, when discussing the construction factor, nearly no change in housing prices when the income increases. Apparently, the increase of a household's income does not affect housing prices much. This being said, it is as previously discussed most nth time buyers in the housing market. Consequently, first time buyers are a small fraction of the home buyers, and older people tend to stay in the same place over a longer time. Let's imagine a person won the lottery. This person would suddenly increase his or her wealth considerably, expect such a person to spend some of this money quickly. As known from previously stated literature, Norwegians spend the largest portion of their income on dwelling, therefore one could believe this millionaire would trade up, and purchase

a larger dwelling. This however, is not the reality, and as the empirical findings are realistic, in terms of people not immediately purchasing a larger home when their income increases by a small portion, one could assume that the income has to increase considerably for someone deciding to sell their home to buy a more expensive one.

In order to determine if the chosen model have been able to detect potential housing bubbles in the housing market, I have compared the results of the price-to-rent ratio and the HP-trend. The P/R-ratio has illustrated how there has been considerably large fluctuations over the period 2010 to 2018. It is clear, that there have been deviations from both the average as well as the trend-line. Based on these observations one can state that there exist housing bubble tendencies in the market. Furthermore, by including the HP-filter I have also been able to detect several housing bubbles over the period, where the prices have been deviating from the trend. I can therefore also, based on this model conclude that there are housing bubbles tendencies in the market.

By looking at the results from these methods together, one can see how the deviations from the trend in the P/R-ratio are quite similar to the HP-trend. They are both detecting potential bubble tendencies through the deviations from the trends in the period of 2014 to 2015, as well as from 2016 until today. It is interesting seeing how they are moving in the same direction, and simultaneously deviating both positively and negatively according to the trend. Based on this comparison I conclude that there exist housing bubbles in the housing market in Oslo.

Furthermore, regarding the current situation it is difficult to interpret the results as both the HP-method and P/R-ratio indicates the price moving closer to the trend. One can see how the prices increased rapidly over the past years, while since the beginning of 2017, the prices started decreasing, until they slowly started rising again, in 2018. This is following most of the statements from the different newspapers, as well as real estate agents, saying that there might be a housing bubble present in the market and that prices might suddenly drop, while others are assuming a slow increase in getting the prices more stabilized. For now, it seems that the prices are moving back up, but based on the current data, considering, I have not done any forecasts, the future is unpredictable. I am therefore unable to conclude what the housing market will bring.

There are however, other potential reasons for why the prices have increased as much as they have over the last twenty years, especially the past five. First, it is important to state the sociological reasoning behind it. People in Norway aspire towards owning a home, therefore real estate is a great part of a person's expected accomplishments in life. When nearly all 5 million inhabitants want to live in one of the big cities, narrowing it down to Oslo, it is also reasonable to say, that there is not enough space. There will never be enough space and certain people have to live elsewhere. This "life goal" is therefore in my opinion an underlying reasoning for why the prices in Oslo have

increased overall since the 2000s[12]. Even though it has not been analyzed, as it is a complicated process to determine if this is true, I do believe that this is accurate and that one should consider as a reasoning for the prices to never drop as low as in other markets. People will always trade their home for a different one. Once you have bought a dwelling, there are few Norwegians willing to sell and rent instead.

Second, with increasing housing prices, the media starts involving themselves, focusing on the situation in the market. Real estate agents, people from the financial sector and speculators starts predicting the future, by stating how the prices might go up or down, contradicting one another. People who are ready to sell gets anxious, should they wait, or should they sell immediately. This psychological effect, makes people go through with decisions they never would have gone through with, if they were not persuaded by what happens around them. When the main focus of the media is the real estate market in Oslo, people act accordingly, which in the end influence the housing prices. Speculators want to buy low and sell high, therefore when there is a statement on "how the apartments in Oslo will reach sky-high prices", they invest quickly, to gain a part of the profits. Furthermore, normal people under pressure to sell, sell quickly and people who are looking for a new dwelling wants to purchase as soon as possible, to get the best price. Overall, this puts immense pressure on the market, leading to an overall huge rise in housing prices.

I will, based on the discovered findings, state that, yes, it is good investing in residential real estate in Oslo, in particular now when the interest is as low as it is. However, it might be better to buy a dwelling in areas such as Gamle Oslo or Grünerløkka, where the housing prices, according to my regression, on average is positively affected if any of the mentioned factors changes. Furthermore, Gamle Oslo is the area predicted to have the highest population growth. With this being said, I would strongly advice to invest now, as the prices have stabilized and seems to be slowly climbing again. If the prices would fall, I do believe one should stay cool, calm and collected and wait until it takes a turn, before selling. As I have understood from these analysis, what goes down, will eventually go back up. Based on the trend, it seems that the Oslo market has been overvalued, but for now, it is stabilizing and therefore, it is not possible to prove that there exist any bubbles currently in the market.

5.2 Limitations

The data used for the factors in the multiple regression is the same for all of the different areas, which might cause less precise findings. However, this data such as the unemployment rate, the number of residential constructions yearly and households' income unfortunately is unavailable specifically for each of the areas. Also, as Sentrum is a newer predetermined area of Oslo, there does not exist data from the year 2000, which might give slightly uncertain results for Sentrum. Furthermore, I have simplified

[12] And for many years before. However, as my focus is from the year 2000 I will not include conclusions based on what might have happened before this.

the P/R-ratio, which do not include any fundamental factors and is purely based on rent and average housing prices. By excluding the fundamental factors, one might get slightly different results, but I do believe that the difference is marginal and that my results are safe to interpret based on my findings. The only data available was the annual rent, even though I have done a quarterly analysis, which also might give somewhat inaccurate results. In terms of only changes in the housing prices of the ratio in each quarter, and non for the rent. This is due to the fact, that the rental survey constructed by Statistics Norway is done per year, and there is no valid data based on quarters.

6. Conclusion

The aim of this paper was to understand the underlying factors influencing the housing prices in Oslo, this to determine if investing in residential real estate is a smart decision. Furthermore, I wanted to detect if there are potential bubble tendencies in the housing market, in order to grasp the fluctuations and cycles of the real estate market. This resulted in three main methodological approaches, which gave me the desirable results in order to dig deeper and analyze the above-mentioned topics.

To understand the explanatory variables for the housing prices, I did a simple linear regression analysis, including one independent variable; interest rate. I did the regression for each of the clustered areas. First, I had to do a t-test to make sure the variables where significant, which they all where. Then, I came to the conclusion that if the interest rate increases by one percent, the housing prices will on average decrease by at least 500,000 NOK all over Oslo.

Furthermore, to understand to what extent the four main variables influence the housing prices, I conducted a multiple regression analysis. By testing for the variables; interest rate, housing construction, unemployment rate and households' nominal income, I could determine the most influential factor for each of the specified areas. As there are paired relationship, I am unable to compare the results of the multiple regression with the simple linear regression, therefore there might be slightly different changes in the value of the interest rate in the two models[13]. From this analysis, I concluded that, according to my model, the interest rate has the strongest (negative) influence on housing prices in all of the areas. Followed by the change in the unemployment rate, which leads to, on average, the second highest change in housing prices. While, the change in households' income and housing constructions appears to influence the housing prices the least.

Gamle Oslo is in particular positively sensitive to a change in the variable, housing construction, as the prices increase by an increase in the newly constructed housing. Based on my analysis I do believe that, since Gamle Oslo is the less expensive areas of Oslo, it attracts a higher number of people who wish to live in Oslo city. This area is predicted to have the highest population growth and has the highest number of constructions being developed. Therefore, it is safe to say that, if the unemployment rate would increase, and people are unwilling to move out of the city, Gamle Oslo will be the best alternative. This also, due to its proximity to the city center, increasing demand mostly due to population growth and higher supply because of the constructions being built, which ultimately leads to an increase in the overall housing prices. However, as this is considered a shadier part of town, there is nothing pointing towards that this area will exceed the prices of the most expensive areas. However, who

[13] The reason for this is, because there is more data available in the multiple regression model, than the simple linear, as well as the influence on the results of adding more variables to the model. Ow m

knows, if this area becomes even more attractive, it might exceed the housing prices of Grünerløkka? Based on this analysis I have come to the conclusion that I would recommend investing in residential real estate, especially in areas such as Gamle Oslo and Grünerløkka. This due to the fact that, these areas on average, according to my regression result, are the most positively influenced locations based on a change in any the fundamental factors analyzed.

After calculating the P/R-ratio and comparing it to the overall trend and average ratio over the analyzed period, I found several degrees of deviations from the trend-line. These deviations might prove that there exists a housing bubble tendency in Oslo. Moreover, in order to get more reliable results, I also used the HP-filter, with both quarterly and annual data. By determining the long-term underlying trend of the housing prices through the HP-filter, I also observed deviations from the trend during the same periods as in the P/R-method. Consequently, I concluded that there exist bubble tendencies in the housing market in Oslo.

From all of the analysis above, it is clear that there are many factors influencing the housing prices. However, as concluded in the market analysis, there are many reasons for why the housing prices have increased this much. First, there is a sociological reason, people thrive towards buying a home over their life and expect to never rent again when they have invested in housing. Thus, the demand is constantly higher than in other markets, putting even more pressure on the housing prices. Second, with a very low interest rate, people are in beginning able to gain more value for their money than previously. Then, when more people take up loans and start buying housing, the prices moves in the same direction, thus increasing prices. Third, speculators and media has pushed the prices even higher, by constantly discussing how the prices will "jump to the roof". As housing is considered, the largest investment over a person's life it is comprehensible that people are being precocious, by doing anything in their power to avoid losing money or even their home. Therefore, media and economists' influences are considerably higher than one could expect.

Consequently, I have managed to do several analyses in order to dig deeper into the topic of housing prices. For further detailed studies on the same topic, there could be included more variables, thus a longer time series. It could also, be interesting to look at peoples' perception by doing an extended interview to understand the underlying reasons behind homeowner's decision-making, linked to their housing. It would also, be interesting to include fundamental factors to the P/R-analysis in order to compare the fundamental and real P/R-ratio. Would this have given considerably different results from my variables and findings? Also, it could be beneficial to look at other geographical areas where the prices are more stable, in order to see the difference in the cycles and housing bubble predictions. Would there be distinct differences, presenting the potential housing bubble tendencies more clearly, than by comparing similar areas?

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