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**THE EFFECT OF OIL PRICES ON HOUSING PRICES IN THE  
NORWEGIAN MARKET**

by

Yu Yiqi

Supervisor: Wong Po Yin

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This thesis was written as a part of the master program at NHH. The institution, the supervisor, or the examiner are not - through the approval of this thesis - responsible for the theories and methods used, or results and conclusions drawn in this work.

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## ABSTRACT

The oil industry makes significant impact on Norway's economy. In 2016, the export value of crude oil, natural gas and condensate in Norway is around NOK 350 billion, which takes approximately 47 percent of the total value of Norway's exports of goods. The oil reserve has guaranteed long-term economic boom for the country, while the economic growth in turn has benefited the country's real estate market, where the house price in Norway has increased 8.3 percent in average in 2016, with hardly any price decline in the recent twenty years.

In this analysis, we try to estimate whether the oil prices have significant impact on the house prices in Norway, by using an empirical model that intends to explain fluctuation in house prices using various fundamental variables including oil prices. We also notice the recent decline in house price in Stavanger, the oil capital in Norway, is closely related to the consistent low oil price starting from July 2014. Therefore, regional differences in house prices possibly caused by oil industry distribution in the country is also investigated.

Conclusively, we find that oil prices have significant direct effect on the national house prices, and that the house prices in regions where the economy relies largely on oil industry are more sensitive to oil price fluctuations.

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## 1. Introduction

The main purpose of this thesis is to estimate whether the oil prices have significant influence on the housing prices in Norway. Oil and gas field has been the pillar industry in Norway, and the fluctuation in oil price has great impact on the country's economy. Meanwhile, the house price in Norway has raised tremendously in the recent decade, which ranks one of the top among other European countries in recent years (see Appendix 1). We want to investigate the fundamental factors that can explain the house price increase and to testify whether the energy sector is one of them. Regional differences in housing prices are also discussed in the analysis, for we believe that the regions with oil fields in Norway have different economic pattern with others.

### 1.1 Oil Prices and Housing Prices: Theoretical linkages

Some analysts suggest a role for rising energy prices in the 2008 financial crisis. Carr and Beese (2008), for instance, postulate that because of the oil price surge between 2004 and 2007, the Federal Reserve raised interest rates, which led to increase in payments for those with adjustable rate mortgages, and therefore resulted in the surge in foreclosures. But others also argue that the economy has become less susceptible to oil price shock because of the declining energy intensity of the US economy (Blanchard and Gali, 2008).

Although most of the countries in the world nowadays do not rely primarily on oil industry, and the fluctuation in crude oil prices does not make a dominant influence on the economy, there are some that still have similar economic structure as Norway does. Take Scotland as example, average house prices there in 2016 showed steady growth than the previous year, except for the biggest house price decrease in its oil capital Aberdeen, where price dropped by 8.7 percent, due to the oil price slump (Philip, 2016). Canada, for instance, is also a country abundant in oil

reserve and relies heavily in oil export as longtime economic engine. Whatever happens in the oil industry affects many aspects of Canada's business cores, one of which is the housing industry. After the oil price crash in 2014, the real estate sales in the major province for oil production in Canada, Alberta, slowed for 13 straight months and the housing prices in Calgary started to fall. It is no secret that Alberta's economy is closely linked to the peaks and craters of oil prices (Jason and Chris, 2016). And it has been testified that the combination of oil price, exchange rate, interest rate and employment levels can determine up to 98 percent of the changes in house market in Calgary (Padilla, 2005).

Because the oil industry plays crucial role in Norwegian economy, the oil prices can influence the country's housing prices through different mechanisms. Breitenfellner et al. (2014) discussed about different ways the energy price can influence the house prices: Firstly, the adverse effects of energy prices on economic activity and household income can reduce the demand for dwellings; Secondly, the energy price can have impact on construction and operation costs and thus influence the housing supply; thirdly, the fluctuation in energy price can lead to reaction of monetary policy on inflation withdrawing liquidity and further affect demand in the market; Fourthly, when the energy price surges, it may result in increased attractiveness of commodity versus housing investment in asset markets; Lastly, in the long term, the energy price can have a lagging impact of common factors on both variables, such as economic growth. Therefore, the oil market can affect the real estate market in both direct and indirect ways.

Meanwhile, the finding in Bjørnland and Jacobsen (2010) shows that house prices in Norway react fairly strongly to a monetary policy shock, and this is supported in later studies by Robstad (2014). Since the house prices are sensitive to policy changes, while the oil industry in Norway

has great influence in the economy, it is the authorities' responsibility to take the oil sector into account when making changes in regulations for the market.

The analysis implies that monitoring of oil price fluctuations should be considered as an important task for financial market regulators in Norway and central banks should include the energy sector in the framework of macro-financial risk assessment.



## 2. Housing Market in Norway

In this chapter, an overview of the housing prices in Norwegian market in the past decades is presented first, followed by regional differences in housing prices particularly in recent years, the brief introduction of housing policy and analysis on the demand and supply sides in Norwegian housing market.

### 2.1 Housing Prices Cycles

As Figure 1 shows, Norwegian property prices have witnessed strong and steady growth since the mid-1990s. The constant increase in house price in Norwegian market was partially due to low interest rate, easy access to cheap credit and tax reliefs for home owners, all of which guaranteed low costs for households to purchase dwellings. In Norway, nearly 85 percent of the population owns the place they live in, and most of them benefit from low borrowing cost from banks and mortgage companies. In the near two decades, according to Statistics Norway, the house price index for the whole country has steadily increased from 34.3 in 1992 to 195.5 in 2016, with the year 2005 as base (100). Annual price falls only happened three times in over 20 years, which were in 1993, 2003 and 2008 respectively. However, according to Figure 1, none of the three price falls actually interfered the overall growth in the market. The longest price decrease during the third quarter in 2008 to the second quarter in 2009, accounts for 7.2 percent of price decrease adjusted for inflation, and the market recovered steadily after that. Despite the fact that increase in housing price has been nothing new to Norway, the recent boom in the market is still well notable. In 2016, housing price in Norway increased by an average of 8.3 percent compared to the previous year, which is observed as the biggest annual increase ever. Even housing price for off season as in December witnessed the first increase of 1.1 percent since 2003. In comparison to this, as the most well-known website with good reputation in the market, Real Estate Norway predicted in the beginning of 2016 a mere 5.3 percent

increase in housing price, far lower than what really happened in the market. The continuous increase in house price and no sign of slowing down made people start to suspect if there is a bubble in the market. However, most researchers claim that so far there is no evidence for severe risk in the Norwegian real estate market (Duus and Hjelmeland, 2013).

It is predicted that the sharp increase in housing price will ease off as authorities are putting forward new regulations in order to control housing demand, but still there's no sign showing the potential price decline in the near future.

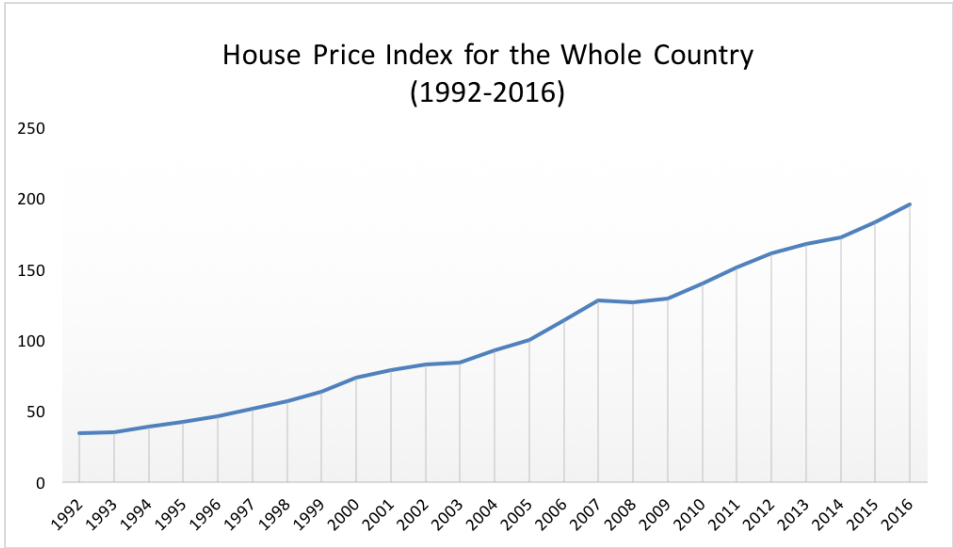


Figure 1: The development of house price index in Norway  
Source: Statistics Norway

## 2.2 Main Reasons for Strong House Price Increase

There are two main well-accepted reasons for the persistent increase in housing prices development in Norwegian market: strong economic growth and low interest rate. Both factors mainly boost the demand in the housing market and drive the housing prices up.

### 2.2.1 Strong Economic Growth

Except a slight downturn after the worldwide financial crisis in 2009, Norway has not experienced a recession since 1990. The country has enjoyed the benefits from its oil reserves

for decades. Its economy boosted by more than 5 percent annually from 1994 to 1997. Even during the economic slowdown in 2002 and 2003, annual GDP growth did not fall below one percent. And because of the constant oil field exploited in Norway, the mainstay of the country's economy makes its development relatively undisruptive. Mainland GDP growth in Norway is projected to continue increasing in 2017 and 2018 and then remain at just over 2 percent annually (Norges Bank, 2017).

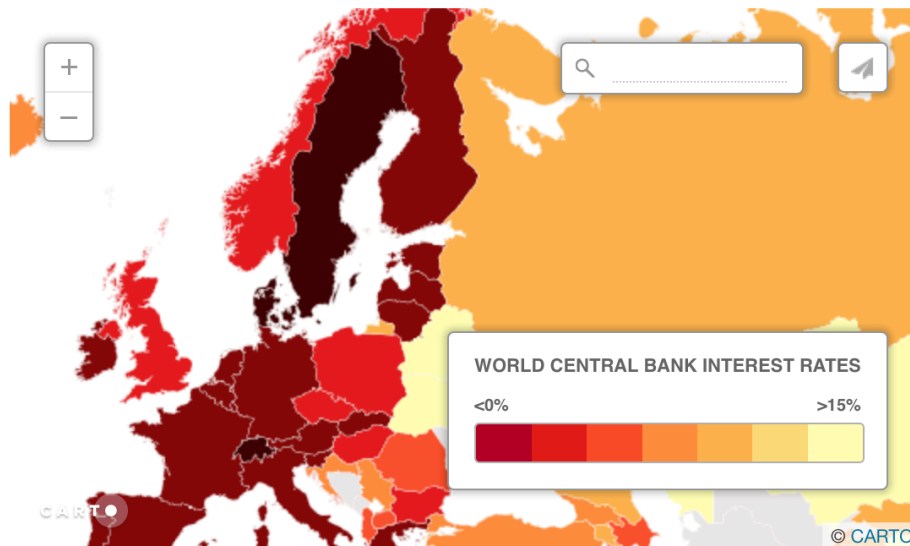
While other countries regard the oil and gas reserve as a free lunch, by contrast, Norway has always been continuing to invest all its profits from oil industry into a giant sovereign wealth fund (Treanor, 2014). In 1990, Norway set up its oil fund to guarantee that the oil reserve can benefit future generations. The government demanded as much as 78 percent tax from oil companies after profits and the costs of research and exploration. One hundred percent of those taxes were banked and used as original capital for various investment projects that are decided by Norges Bank Investment. Nowadays, according to Norges bank, the fund's market value already exceeds NOK 8000 billion. The government is only allowed to use as much as four percent of the fund to support governmental expenditure, yet so far they never used up the quota.

The sustained economic growth with high stability has enabled the country to maintain a low level of unemployment rate and steady growth in wages. The economic booming, along with favourable government policies, has encouraged households in Norway to not only own their place of living, but also purchase houses as an investment instrument. According to Global Property Guide, approximately 10 percent of Norwegian households own their second dwellings, which is higher than only 2 percent in the UK and 6.5 percent in the US and Canada.

### 2.2.2 Low Interest Rate

Norges Bank sets the interest rate aiming at stabilising inflation at target - annual consumer price inflation of close to 2.5 percent - in the medium term. The horizon depends on disturbances to which the economy is exposed and the effects on prospects for inflation and the real economy (Norges Bank, 2017).

Though Norway is not part of the Eurozone, it mirrors the low key interest rates of the European Central Bank (ECB). Because of the unique currency and close trading connection with other EU countries, the key policy rate in Norway is inevitably influenced by that in other countries. It is obvious in the World Central Bank Interest Rates Map (Figure 2) that most of the countries in Europe are hitting rock bottom rates. As a matter of fact, Norway's closest neighbor Sweden and Denmark have already pushed their interest rates below zero (Khan, 2016), which poses intense pressure to Norway's key policy rate through trading and investing activities.



*Figure 2: World Central Bank Interest Rates Map  
Source: Mehreen*

Norges Bank started cutting key interest rates in the third quarter of 2008 in response to the global credit crunch, reducing the sight deposit rate from 5.75 percent to a historic low of 1.25

percent in the third quarter of 2009. And after that, as a ripple effect, the Norwegian mortgage interest rate reached its rock bottom.

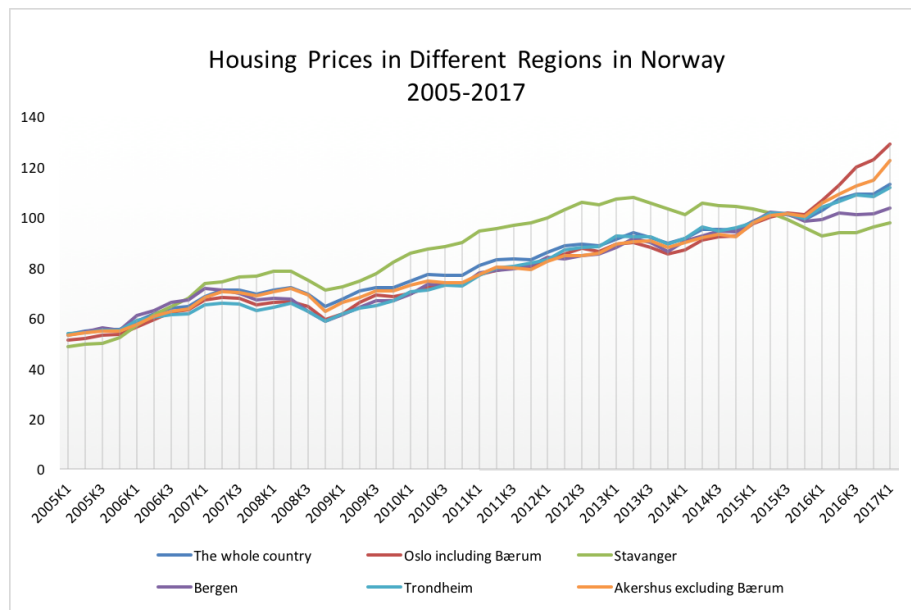
After the oil price crashed in June 2014, the central bank has been cutting rates to support the slowing economy and to prevent the possible downturn. However, the easy access to cheap credit accelerated the demand in housing market, which in turn forces the central bank to put forward regulations to tighten residential mortgage lending.

Early in 2017, Norges Bank decided to keep the key policy rate unchanged at 0.5 percent, the same as the rate since March 2016, in consideration of preventing the risk of a further imbalance in financial aspect and the uncertainties that low key policy rate has brought to the economy. It is predicted that the key policy rate in Norway will only increase gradually again from 2019.

### 2.3 Regional Differences in Recent Years

According to Statistics Norway, the country is divided in eleven geographical regions, of which four are cities – Oslo and Bærum, Stavanger, Bergen and Trondheim. Other regions include: Akershus without Bærum, South Eastern Norway, Hedmark and Oppland, Agder and Rogaland without Stavanger, Western Norway without Bergen, Trondelag without Trondheim.

Despite the fact that housing prices in Norway have witnessed general persistent rises, it still shows significant regional differences, especially for the cities with oil production.



*Figure 3: Regional differences in housing prices*  
*Source: Statistics Norway*

It can be observed from Figure 3 that until the end of 2015, most of the regional housing prices in Norway were following the similar trend since 2005, with the exception of that in oil capital Stavanger. And the growth in housing prices started to vary significantly among different regions since 2016, and Oslo is witnessing the most rapid growth in the country.

Note that the housing price in Stavanger stands out during the recent decade. As the oil price surged, the housing price in Stavanger went from relatively low compared to other regions in the country to the highest, and it kept its high speed of growth for years. After the slump in oil prices in 2014, as Norway's oil capital, Stavanger and its region account for 72 percent of the country's rise in unemployment over the year, despite the fact that it once had the lowest rate in the whole country. As a result, the tightening job situation hit local house prices, which decreased 1.2 percent over 12 months, while nationally they have risen 7.7 percent (Jacobsen and Fouche, 2015). It is obvious that cities dominating in oil field enjoy more economic benefits when the oil industry is in good year and suffer higher risks during downturns in oil industry.

In the empirical analysis presented later, we will discuss about the influence oil prices made on housing prices in one of the representative oil production cities in Norway, Stavanger, compared to regions in Norway that have no oil field.

## 2.4 Housing Policy

According to Husbanken, the Housing and Building Department in the Ministry of Local Government and Modernisation is responsible for implementing the government's housing and building policy in Norway, while the Norwegian State Housing Bank (NSHB) is the government's main implementing agency for housing policy, and it uses financial measures to facilitate the achievement of housing policy goals. Housing policy in Norway witnessed significant changes during the last forty years, and as a country with famous for its welfare system, Norway has always tried to guarantee adequate and secure housing for its residents. In order to fulfil its main objectives, the Norwegian government has been working on providing easy access to disadvantaged households using "packages" such as start-up loans, grants and housing allowances, as introduced by Husbanken. The policy results in a large portion of households in Norway buying their place of living with the help of loans.

Most banks offer mortgages to buy a house or an apartment in Norway. The repayment period for a mortgage is relatively long, usually between 20 and 30 years. According to the guidance for new residents in Norway, people who are purchasing their first housing unit can apply for a first-time buyer mortgage, which refers to a mortgage with the same interest rate for the entire amount, where households can borrow up to 100 percent of the purchase price.

Ever since the housing market started to surge, Norway's financial supervisory authority has been keeping an eagle eye on its ripple effects. It was announced by the Ministry of Finance

early in 2015 that Norwegian residential mortgage lending regulations would be tightened. However, it takes time before the new regulations come into effects.

In late 2016, the Norwegian government claims to impose further restrictions on banks' mortgage lending from 2017. Among the new rules, they put a cap on the amount that households are allowed to borrow from banks proportional to the household income, which aims at restricting the household debt level. The constraints in Oslo is even more tightened, with a particular limit on second home purchase.

## 2.5 Demand and Supply

Housing prices are determined by the demand and supply sides in the market. The increase in prices normally reveals the demand surplus, and vice versa. In this part, both housing demand and supply as well as the equilibrium in the Norwegian market will be discussed.

### 2.5.1 Housing Demand

Housing demand consists of two components: household demand for owner-occupied dwellings and demand for dwellings as a pure investment instrument (Jacobson and Naug, 2004). As discussed before, the majority of Norwegians choose to buy their own place to live, therefore the house rental price is not included in this analysis.

In the short term, demand can be decided by, for example, the interest rate level, credit standards, expectations of house prices in the future and the situation in labor market (Molden, 2011). In the long term, household income can be a deal breaker when people decide on whether to purchase a dwelling or not. Other factors that influence population can also effect the overall demand for dwellings, and therefore the migration pattern also matters.

### 2.5.2 Housing Supply



As a matter of fact, it takes a certain period of time to build houses. Thus the housing supply in the short term is considered relatively inelastic. That is to say, the housing prices in the short term is mostly determined by the fluctuation from demand side. In the long run, as shown in the following figure, between 2000 to 2014, Norway has kept a relatively high level of residential construction among Nordic countries. The housing constructions were sharply cutoff in most of countries after the financial crisis in 2008, as the global economy was in recession. But shortly after that there were upswing especially in Norway and Sweden, which brought the construction level to a new peak.

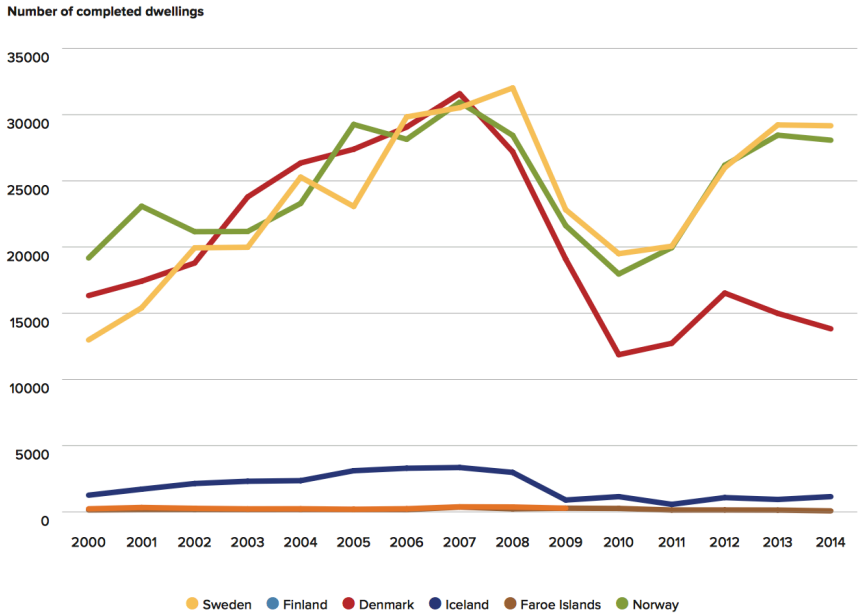


Figure 4: Development of residential construction in Nordic countries, 2000-2014  
 Source: Nordregio Report

2.5.3 The Balance

Molden from Norges Bank (2011) has provided a way to calculate the changes in the housing surplus through a period, which is shown as follows:

**Need for housing (demand) =**

- Changes in number of households
- + Changes in number of unoccupied dwellings

+ Housing stock losses in the period

**-Supply of new dwellings =**

New dwellings completed

+ Sectioning of other buildings into dwellings

**= Change in housing surplus**

Using that method, the housing surplus gap in Norwegian market narrowed between 2002 and 2006, and turned to negative after that. Up till 2010, the demand in dwellings has surpassed the supply with the surplus gap as large as -13062. It is obvious that the mismatch between demand and supply in the market results in the long term housing price increase in Norway.

### 3. Fundamental Factors in Norwegian Housing Market

#### 3.1 Demand factors

##### 3.1.1 Population

Changes in population can be regarded as one of the most direct factors that influences housing demand. It is obvious that if the population grows fast, the new households' demand for housing can raise rapidly.

It can be observed from Figure 5 and Table 1 that both high population growth and fewer members per household contribute to the increase in the number of households in the past decades (Molden, 2011). Also Figure 5 tells us that at first the population growth in Norway is mainly due to excess births, while in more recent years, immigration has been the major reason for the boost in population. It is reasonable to assume that growth in net immigration has more relatively short term effects on demands in houses than births do, since households need a place to live in after immigrating, whereas households are more likely to already own a dwelling before they give births.

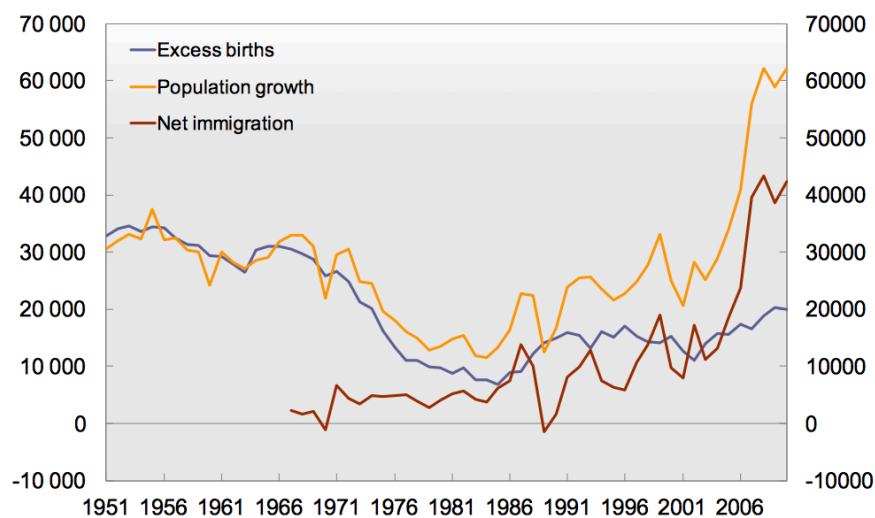


Figure 5: Excess births, population growth and net immigration in Norway, 1951-2010  
Source: Norges Bank

	1970	1980	1990	2001	2010
<i>Population</i>	3 888 305	4 092 340	4 249 830	4 503 436	4 920 305
<i>Households</i>	1 296 734	1 523 508	1 751 363	1 961 548	2 170 893
<i>Household size</i>	3.00	2.69	2.43	2.30	2.27

*Table 1: Changes in population, households and household size in recent decades  
Source: Statistics Norway*

Late in 2016, the Confederation of Norwegian Enterprise (NHO) described the Norwegian real estate market as "out of balance" for the fact that its population is much higher than the rate of new residences. Take Norway's capital city Oslo for example, the population there has increased by 130,000 since 2000. However, the construction of houses did not follow the rapid growth in households and their need for dwellings. Therefore, the rapid growth in population and the lack of new residences has been a key reason for the excess demand in the market.

### 3.1.2 Geographical preferences

As stated in chapter 2, there are regional differences in housing demand, and one of the major driven factor is household geographical preferences. The population growth in Norway is not evenly distributed, and the geographical preferences especially for internal migration households can make the housing demand various in different regions. Most internal migrations would prefer buying dwellings in places with better social conditions, and that makes big cities become priorities for new households to consider moving in.

According to Statistics Norway, in 2016, among all the regions in Norway, Oslo has the most significant population growth, closely followed by Akershus. According to the housing prices in 2016 in Figure 3, those two regions happen to be among the highest housing prices in Norway. Therefore, it is reasonable to assume that geographical preferences contribute to the regional differences in demand for dwellings.

### 3.1.3 Unemployment

The unemployment rate has been a common lagging indicator in business cycle, for the number of unemployed people rises mostly after an economic downturn or even recession. When the unemployment rate goes up, it can affect many aspects of the market. For instance, consumer's expectation for future market growth is pushed down when there is a persistent high unemployment rate, and thus investment activities decrease and people tend to save their money. In this case, the government authorities have to put forward policies to boost the economy by creating more job positions and encouraging investments. Household demand for dwellings decline when the family members fail to have a stable income, whereas for the households expecting their second dwelling, the lack of confidence in the market can postpone their purchase plan.

In Norway, because of the steady economic growth, the country's unemployment rate has always been lower than other countries in Europe thanks to the blessing of its oil reserve. Even at the height of the financial crisis in 2009, unemployment rate in Norway only reached 2.7 percent. As mentioned before, because of the investment they made using the oil revenue, the Norwegian government can still rely on the oil fund while other countries have to cut their expenditure in welfare system.

However, since the domestic economy relies so much on the oil sector, the fluctuation in oil market can make great influence on the regions where oil industry is the engine for local economy. In 2015, for instance, because of the sudden drop in oil price and the consistent over supply in the global market, companies in Stavanger and its surrounding region had to layoff workers to prevent loss, which contributed to 72 percent of the country's rise in unemployment. The housing prices in Stavanger were down 1.2 percent within the year 2015,

while nationally they have risen 7.7 percent and most of other regions in Norway also witnessed continuous growth in housing prices.

#### 3.1.4 Consumer confidence

In some papers, the consumer's expectation is a key factor included in the model as an explanatory variable for housing price (Jensen and Quach, 2015). It is claimed that people's opinions about the future can determine how they make decisions on their saving and investing plans. For example, if people believe the economy is going through a downturn, they would prefer not to take the risk and take out loans from banks, otherwise, they would consider investing in instruments such as dwellings to make profits. There is an expectation Survey conducted by TNS Gallup in Norway, which is a telephone interview made every quarter, and the result of the survey is calculated as the consumer expectation of the country's economy, known as the "Consumer Confidence Index (CCI)".

The CCI for the fourth quarter in 2016 is 0.3, it has gone up from the third quarter where the figure was -5.5. It is reported that the decline from the third to fourth quarter is primarily due to a decline in the sub-indicators related to the country's economic development in the future and less confidence in whether it is a good time for major acquisitions. The overall expectation on the country's economy for the year 2016 is strengthened than the year before, and researchers has found that personal financial plan is more related to the expectation of the country's economic developments for more recent period. However, in the long term, the assessment of consumer's own financial status and the country's economy are relatively independent of each other.

### 3.1.5 Interest rate

As discussed in Chapter 2, the interest rates, specifically the mortgage rates, relate closely to consumer's decision of purchasing (owner-occupied dwelling) as well as investing (second dwelling). When the interest rate is in a relatively low level, it attracts consumers to borrow money from the bank at a low cost and therefore they can afford to buy houses, which boosts the demand in housing market. When the bank's lending rate is high, households would rather choose saving instead of borrowing money. Therefore, the persistent low interest rate can boost the demand in residential buildings and thus pull up the price.

### 3.1.6 Income for households

Income can directly decide household's housing affordability. With increasing household income, people will be able to spend more on dwellings and thus the demand for houses rises and house price goes up. Demand for housing is often treated as income elastic as a luxury good, for the rise in income normally results in a bigger portion of it being spent on dwellings. When households make less money, they have less ability to pay for the bank loan and thus have less demand for purchasing houses, no matter if it is for living or for investment.

According to Statistics Norway, Norwegian households generally had a weak growth in income from 2014 to 2015. Those that even experienced reduction in income are mainly young households. Even in the two previous years households experienced a slow income growth. Overall, the estimated income after tax for Norwegian households has been growing steadily with an increased rate of 10.1 percent from 2010-2015. Privately owned dwellings is the most important wealth component for most households in Norway.

### 3.1.7 Inflation

When households consider purchasing houses as investment, the inflation rate can make great impact on their decision. Inflation is defined as a sustained increase in the general prices for goods and services. Houses that appear to appreciate in value over time may actually remain the same value when the effect of inflation is taken into account.

The common measure of inflation is Consumer Price Index (CPI), an index that describes the development in consumer prices for goods and services purchased by households in Norway. The inflation rate in Norway has been relatively low in recent years (see historical CPI in Appendix 3.1.7), which has given Norges Bank a lot of room for interest rate adjustment.

## 3.2 Supply factors

### 3.2.1 Housing stock

Housing stock reveals the supply side of real estate market, over supply leads to drop in house prices, while short in supply results in house price increase, which is the current situation in most regions in Norway. While the demand in Norwegian real estate market has surged, the building stock is not increasing accordingly. According to the Confederation of Norwegian Enterprise (NHO), even if residents in Oslo can maintain the size of their current residence, the growth in population requires that 66 000 new homes should have been built since 2000. On the contrary, only 37000 homes are built during this period. In 2016, the building stock in national level increased 0.7 percent by fewer than 28 000 buildings, which is the lowest net growth in percentage since 1997. One of the reasons for the slow growth in housing supply is the new building standards that raises the cost of construction material and the wages in labour. Also the demand in residential buildings has gone up beyond expectation in recent years, while



it takes time for building dwellings. Local authorities are not prepared to increase housing stock quickly.

### 3.2.2 Construction cost

The monthly construction cost in Norway has been increasing stably at more than 2 percent than the previous year since 2010. The wage raise in labour is also included in the index. Therefore, the increase in construction cost consists of both material and labour cost. Prices for material indices for timber, concrete and steel almost experienced no decrease since 2010 (see Appendix 3.2.2). The index for labour cost is shown below, which also shows consistent growth in recent years.

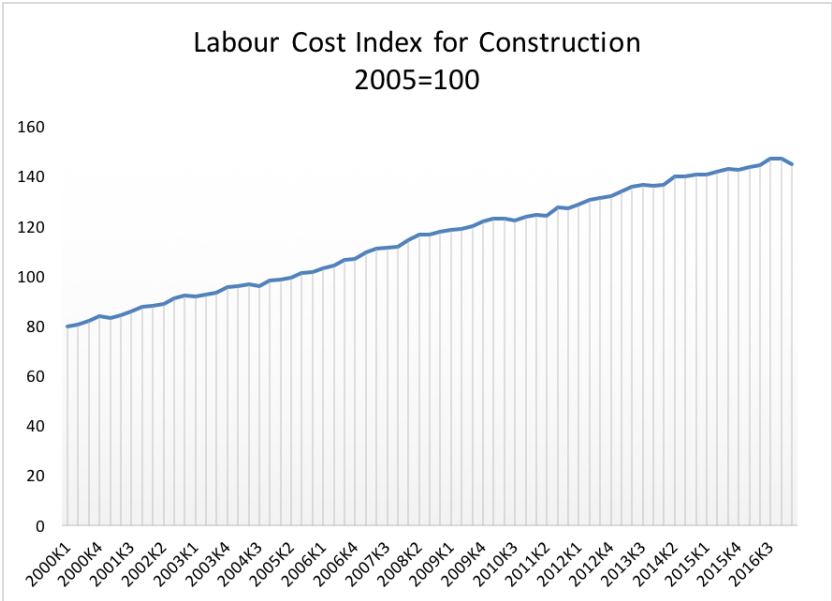


Figure 6: Labour cost index for construction, 2000Q1-2016Q3  
Source: Statistics Norway

### 3.2.3 Building standards

Norwegian authorities have always been holding high standards for residences. The first version of the Energy Performance of Buildings Directive (EPBD) has been fully implemented in Norway since 2010, while by the end of 2015, approximately 570,000 Energy Performance

Certificates (EPCs) had been issued. In November 2015, new version of residential building requirement was published and is mandatory from January 2017 (Isachsen and Strand, 2015).

One of the major focus on the building standards in Norway is the energy sector. There are specific energy limitations regarding different dwelling types (see Appendix 3.2.3). Another aspect of the restrictions includes different components of the building envelope, as well as technical installations and solutions. As the energy and technology requirements get tightened, both the cost of materials and the cost of certain skilled labours increase, and thus the construction cost raises, which results in higher cost for dwellings.

## 4. Oil Market in Norway

Norway is European largest petroleum liquids producer and the world's third-largest natural gas exporter, according to EIA. In this chapter, an overview of the oil market and Norway's petroleum history is introduced and the close connection between the oil industry and domestic economy in Norway is presented.

### 4.1 Oil market overview

Just like petrol, diesel, lubricants and industrial chemicals, crude oil and natural gas have been refined to serve as fuels since the 1850s. The discovery of the Spindletop geyser in 1901 drove huge growth in the oil industry. After that, companies started to enter the business and the industry quickly expanded, and that was when oil started to become the dominant fuel of the 20th century and contribute to an integral part of many countries' economy.

For decades, the oil price has witnessed numerous peak and troughs, and the following graph shows an overview of the historic fluctuation in oil prices and the various causes that led to the business cycles.

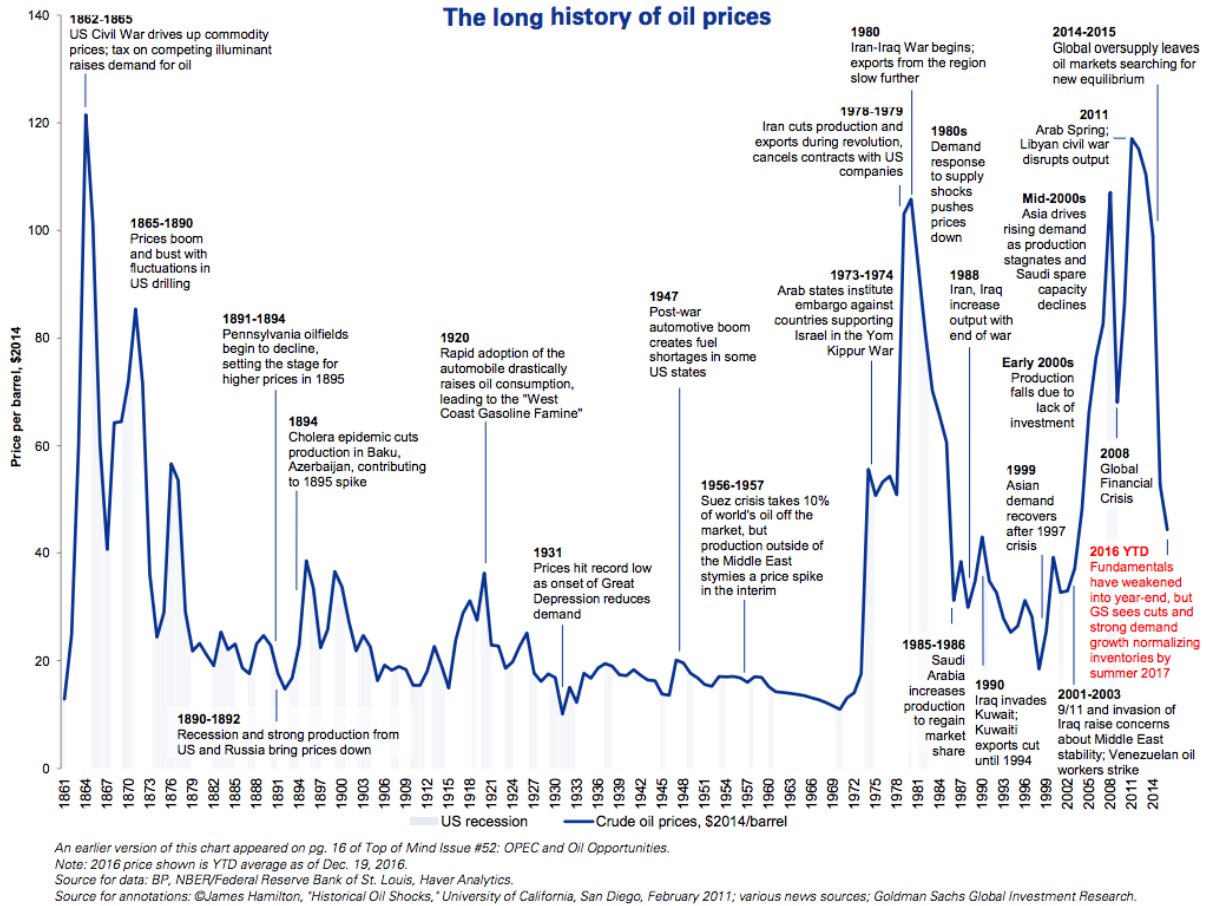


Figure 7: The history of oil price

In more recent years, the big event in the oil market should be the crash in oil price since July 2014. From 2000 to 2008, the oil market saw an unprecedented increase in oil price, which went from under \$25 per barrel to almost \$150 per barrel. The 2008 financial crisis had ripple effects on the oil market, when the oil price dropped to around \$40 per barrel. Shortly after that, the oil price recovered to over \$100 per barrel because of the globally short in supply, until it sharply fell to around \$50 per barrel in the end of 2014. Strong production in the United States and Russia led to over supply in the global market, and OPEC's decision later in 2014 not to put any extra constraint on production further damaged the market.

Although the production in the oil industry has slowed down in many countries since 2015, the decrease in the global demand is not enough to soak up the gusher of over supply. Earlier this year, the International Energy Agency (IEA) claims that the global oil market is reaching its

rebalance soon, provided that the supply cut for OPEC is not extended (Meredith, 2017). However, the market is suspicious about whether the oil price can recover anytime soon.

### 4.2 Norway’s petroleum history

The Norwegian oil industry began with the discovery of Ekofisk oil field in 1969. Production from the field started on June 1971, and in the following years a number of major discoveries were made. The following figure shows the historic major oil fields that were discovered in Norway and the amount of oil reserve that has been explored so far.

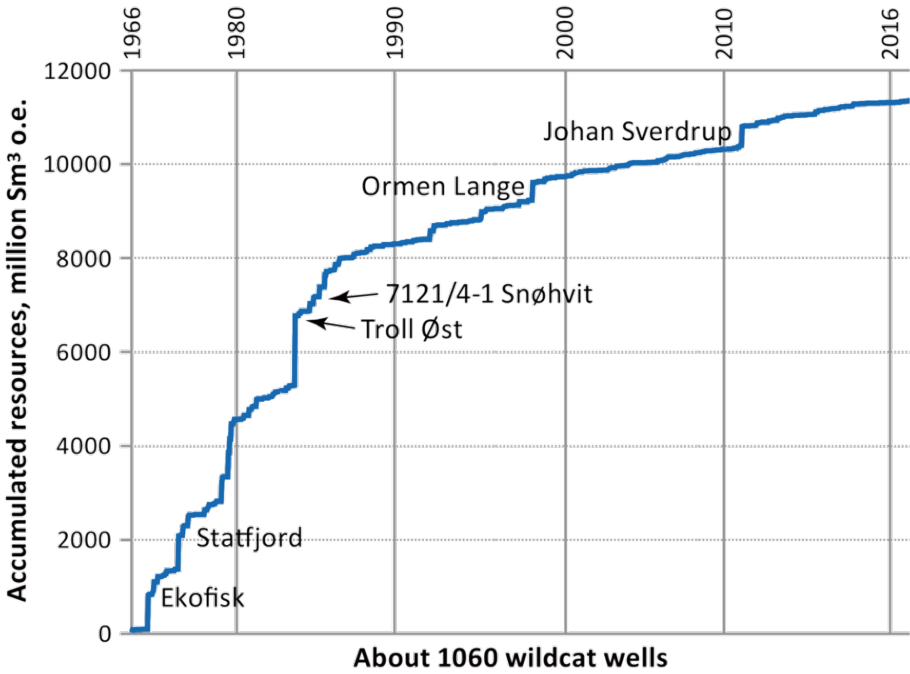


Figure 8: Accumulated resources on the Norwegian continental shelf, 1966-2016  
 Source: The Norwegian Petroleum Directorate

In the early days, the Norwegian government hired foreign companies to conduct the petroleum activities. It took some time before local Norwegian participation gradually developed. Statoil was established in 1972 as a fully state-owned company. Regulation was set after to give the State a 50 percent ownership interest in each production licence. This principle was changed in 1993 so that an assessment is made for the authority to decide whether to participate in the

ownership of the companies as well as the ratio of the ownership. In 2001, Statoil was partially privatised, which led to the establishment of Petoro. Petoro took over administration of the State's Direct Financial Interest (SDFI), established in 1985, from Statoil. According to the facts published by Ministry of petroleum and energy, up till today, about 50 Norwegian and foreign companies are active on the continental shelf.

#### 4.3 Oil industry and economy

Company and government revenues in the oil and gas industry have played a crucial role in creating the modern society in Norway. The country holds the largest oil and gas reserve in Europe and it is a major supplier to other European countries. According to the Oil & Gas Journal, until the beginning of 2016, Norway has 5.14 billion barrels of already proved crude oil reserve, all of which are located offshore on the Norwegian continental shelf (NCS).

Based on the information in Norwegian Petroleum, the oil production in Norway peaked in 2001, with a total liquid production of 3.4 million barrels of oil equivalents a day, and then it decreased till 2013. The oil production on the Norwegian shelf has been increasing again since 2014, and Norway now supplies around 2 percent of global oil consumption.

In 2016, the total export value of crude oil, natural gas and condensate was approximately NOK 350 billion, or 47 percent of the total value of the nation's exports of goods. The substantial decrease in the portion of total export revenues in the recent years is due to lower average oil and gas prices.

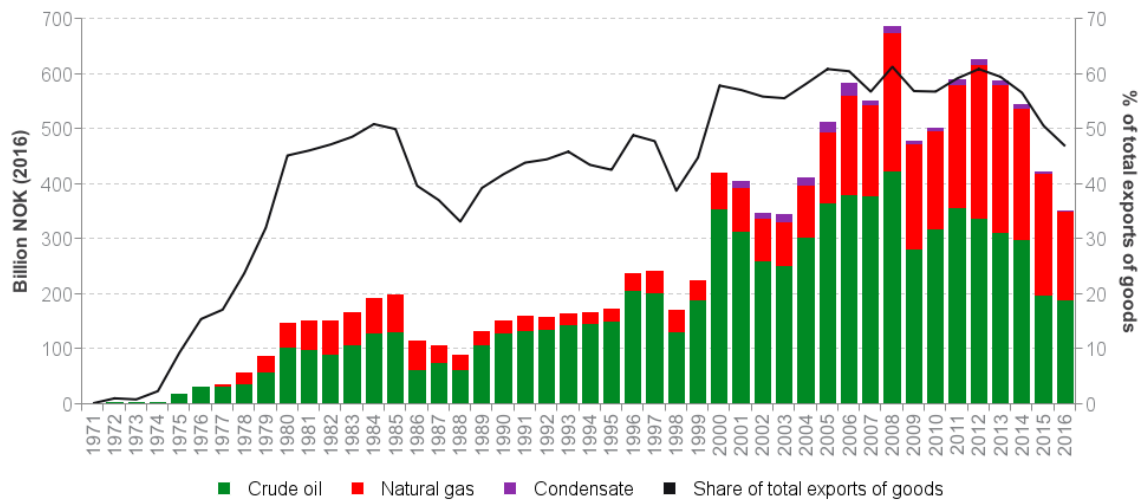


Figure 9: Export value of Norwegian petroleum, 1971-2016  
 Source: Statistics Norway

The oil industry has contributed significantly to the economic growth in Norway, as well as to the financing of the Norwegian welfare system. Through more than 40 years of operations, the industry has created values in excess of NOK 12 000 billion in current terms. In 2012, the petroleum sector accounted for 23 percent of value creation in the country, which is more than twice than that in the manufacturing industry and approximately fifteen times the total value creation of other major industries, provided by Norwegian government.

In spite of over 40 years of production, merely around 42 percent of the total expected resources on the NCS have been produced. Therefore, the oil and gas industry is going to continue supporting Norway's economy in the years ahead.

## 5. Empirical methods

In this chapter, the main empirical models used in this analysis is introduced. The analysis tries to answer the question whether oil price fluctuation makes an impact on housing prices in Norway. In order to answer this, firstly we run a simple regression to test fundamental factors that determines housing prices using the method that is developed by Jacobsen and Naug in 2004. Then we add the oil price into explanatory variables and test if it helps to better describe the fluctuation in housing prices. After that, in order to directly test the relationship between oil prices and housing prices, a simple linear regression between the two variables is conducted. Last but not least, in order to further illustrate the role of oil prices in regional housing prices differences, a differences-in-differences test is introduced to specifically testify the significant influence that oil prices make on the real estate market in Norway's oil capital Stavanger.

### 5.1 Empirical models

#### 5.1.1 Introduction to the house price model

In their study in 2004, Jacobsen and Naug found that interest rates, dwelling construction, unemployment rate and household income are the most vital explanatory factors to illustrate house prices in Norwegian market. Their models have been used and further testified by later studies. In their empirical models, they tested the effects of multiple explanatory variables for housing prices, including households' total (nominal) wage income, CPI, after-tax interest rate, housing stock, unemployment rate, historical housing prices, household debt, total population, households' expectation on the country's economy, etc. They estimated a proper model that can to a great extent interpret the house price fluctuation. The model is listed below:



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

In the model, they used difference operator for most of the variables to convert them into stationary data series. Also they took the logarithm of the variables that is in lower case in the model. The estimation period is from 1990 Q2 to 2004 Q1. In the result, most variables turn out to be significant at 5 percent level, the  $R^2$  is 0.8773, which indicates that the explanatory variables explain the dependent variable well.

The model includes impacts of total wage income, unemployment rate, bank's after-tax lending rate, unemployment rate and adjusted consumer confidence index. Also it contains both short and long term effects of the explanatory variables. They discovered that bank's lending rate has a significant impact in all the sample regressions, which reveals its great importance to house price fluctuation. The long term effects are included in the square brackets, which contains lagging factors of interest rates, unemployment, household income and housing stock. It is not surprising that in the long term the house price in the past can influence that in the next period. Also the housing stock and construction cost can vary over time, which contribute to the long term effects.

Overall, the model developed by Jacobsen and Naug is feasible in explaining the estimation data and it has a solid theoretical foundation. It is also frequently mentioned by later studies that discuss about housing prices in Norway. Therefore, in this analysis, more recent data is used to testify the original model and we further estimate whether oil price, along with other fundamental factors, makes significant influence on the housing price in Norway.

### 5.1.2 Revised house price model

In this analysis, a new house price model is presented based on the existing house price model with some adjustment.

Firstly, because seasonal adjusted data are used in this analysis, the seasonal dummy variables are not included in the revised model. Secondly, in the original model, they attempted to emphasize on the effects of consumer confidence in the market, i.e. consumer's expectation for the country's future economy. The indicator they used, TNS's Gallup's indicator of households' expectations, as mentioned in chapter 3, is an index estimated based on a survey with five equally weighted questions for consumers. Jacobsen's paper claimed that consumer's expectation index has a strong impact on the house prices, while it is also correlated with both interest rates and unemployment rates. Therefore, they created another model to adjust the consumer expectation index and eliminate its correlation with other explanatory variables. Then they used the adjusted index in their final house price model.

In the revised model, we choose not to use the consumer confidence index based on the following consideration. Firstly, the consumer expectation barometer is a survey that measures quarterly households' expectations for their own and the country's economy. The survey is conducted by Kantar TNS and is a collaboration between Finans Norge and Kantar TNS. It is a quarterly survey where a cross section of the Norwegian population (about 1000 people in the telephone interview) is being asked about expectations for own and the country's economy. The survey consists of only 6 questions (see Appendix 5.1.2), and the first 5 only requires the interviewees to answer yes/no, which can be a hasty decision in the short phone call. Secondly, since the population in Norway is more than five million, the result of a telephone interview of one thousand people seems to be not convincing enough to represent the opinions of the whole population. Also as mentioned in the original model, the index is closely correlated to interest

rate and unemployment rate. In the final regression result, the magnitude for consumer expectation is 0.04, which is relatively not one of the vital indicators in the model. All things considered, we think that using the consumer expectation index is neither convincing nor reasonable enough and most of its effect on the house price can be covered by interest rate and unemployment rate.

As for the long term effects, the quarterly data for housing stock is not available (only annual data). It is obvious that constructions of different kinds of residences can take various time period, and it is not feasible to divide the annual data into quarterly data based on the existing information. therefore, the housing stock variable is replaced by construction cost which also reflects the effect from supply side.

Also the main purpose of this analysis is to estimate whether the oil prices have impact on the fluctuation in housing prices, therefore, oil price is included in the model as an explanatory variable. However, noted that the impact of oil price on house price can be underestimated in the model because oil industry influences multiple aspects of the economy in Norway, and oil price can have indirect effects on house market through other mechanism. Therefore, it is possible to have over controlling problem in the multiple regression model.

Finally, because we use more recent data in the model, it is inevitable that the original combination of other explanatory variables is not best fitted for new data, so we also make some permutations of the possible indicators in sample regression to get the final revised version which is presented in Chapter 7.

### 5.1.3 Housing prices and oil prices

In order to testify whether or not oil prices have influence on housing prices in Norwegian market, a simple regression model is made as follows:

$$\Delta houseprice = \alpha \Delta oilprice + \beta$$

In this equation, although only one explanatory variable is included, the main purpose is to reveal the correlation between oil price and house price. Because no other variables are included, we are able to include the data in relatively longer period and thus estimate if the two variables are related over long period. The simple regression using only oil price as explanatory variable can at least testify whether there is a relationship between the two variables, holding other factors fixed.

### 5.1.4 Testify regional differences

One of the main features of the housing prices in Norway as analyzed before is the regional differences. As we can see from Figure 3, while the development of house prices in other regions in Norway are following the similar trends, the house prices in Stavanger stand out, as it boosts to the highest from 2007 and sharply drops to the lowest in the nation late in 2015. By plotting the house price in different regions, we found a parallel trend for the development in house prices in the country's oil capital Stavanger and another region named Akershus, a county close to Oslo with traditional agriculture as the main local industry. It is a typical set of panel data that is suitable for testing the potential trigger, i.e. oil price fluctuation here, that causes the difference between the house prices in the two different regions.

#### 5.1.4.1 The choice of compared regions

It is obvious that the house prices are influenced by multiple aspects in the market. It is optimal to measure the regional oil price impact while controlling for almost identical condition in other

aspects of the economy. This can be solved by finding another region in Norway that does not have oil field and thus the local economy is much less influenced by the oil industry. And because it is a region in Norway, it still has the same banks lending rate, consumer price index, financial policies as the oil capital Stavanger. In that case, it is reasonable to assume that a large portion of the differences in house price in the two regions come from the impact of oil industry. In consideration of that, we choose Akershus as a comparative region to estimate the regional differences.

Except for the major local business, Akershus resembles Stavanger in many ways. Stavanger is the third-largest urban zone and the administrative center of Rogaland county, while Akershus is the second largest county by population with more than half a million inhabitants. The population and economy boost in the late 20<sup>th</sup> century in Stavanger is primarily due to Norway's booming offshore oil industry. Meanwhile, Akershus is neighbour to the district of Oslo, which is the capital of Norway and the main economic center. Unlike Stavanger, Akershus is not on the western coast of Norway (See major oil field map in Appendix), and it is away from the oil production fields. As the biggest difference, the main industry in Akershus is agriculture, and the total area of Akershus county is 4918  $km^2$  with agricultural area covering about 900  $km^2$ . The local economy indicates that the house price in Akershus is much less likely to be directly affected by the oil price fluctuation.

When we plot the house prices in Stavanger and Akershus, it is observed that housing price in Akershus has the exactly identical trend as in Stavanger before oil price started to consistently go above \$60/bbl late in 2005, and after that the house price in Stavanger surges, while still keeping a parallel trend with that in Akershus.

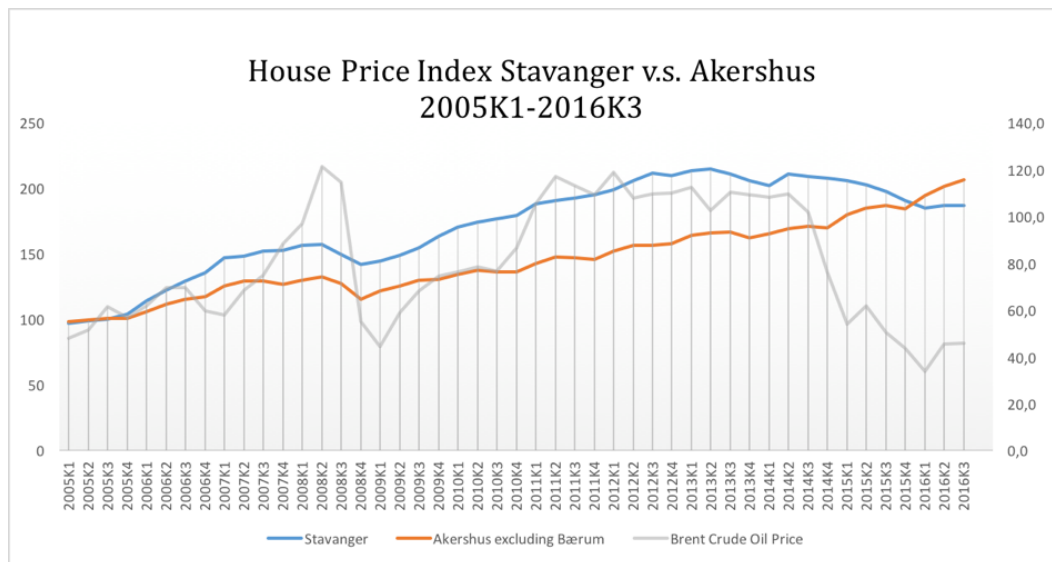


Figure 11: House prices (left axis) in Stavanger and Akershus, oil price (right axis)  
 Source: Statistics Norway

It is observable that after the oil price has gone above 60 USD/bbl since the fourth quarter in 2005, although the house price index in Stavanger increases significantly more rapidly than in Akershus, the two lines still show an underlying parallel trend. For instance, we notice that the downturn in 2008 dragged both lines down and the house price in both regions recovers again shortly after the financial crisis in a clearly parallel trend. Although the fluctuations for most of the time are not as significant as in 2008, we can still observe the parallel trend even during minor fluctuations.

The parallel trends, together with the different local industry in the two regions while assemble in every other aspect, provides us the basic condition to do a differences-in-differences (DID) regression to investigate the impact of the treatment, i.e. when price constantly goes above \$60/bbl.

#### 5.1.4.2 DID regression model

To testify the effect of persistent high oil price on house price in Stavanger, a DID regression is run. The control group here is the housing price in Akershus, where its economy is not built

on oil industry. The treatment group is the house price in Stavanger when the oil price starts to persistently go above 60 USD/bbl. The regression model for this estimation is:

$$Y_{ist} = \alpha + \gamma Stv_s + \lambda post_t + \delta(Stv_s * post_t) + \varepsilon_{ist}$$

Where *post* is a dummy variable that equals 1 when the Brent crude oil price is above \$60 bbl, and it equals 0 when the oil price is below \$60 bbl. *Stv* is the other dummy variable that *Stv*=1 represents the data series for Stavanger, and when the data is from Akershus, *Stv*=0.

## 6. Data Overview

### 6.1 Data for house price model

#### 6.1.1 Data selection

The housing prices in Norway used in this model is the national house price index, which is published quarterly by Statistics Norway. The data is produced by Norwegian Association of Real Estate Agents (NEF), the authority that monitors the national and regional prices in Norway on a monthly basis. The original house price information is from the sales in FINN.no, which is the major online trading website for Norwegian real estate market. Sub-indices for three housing classes and eleven regions are calculated by using the hedonic method, while the weights are measured by the estimated total value of housing stock of each housing class and in every region. The final house price index provided by Statistics Norway is seasonal adjusted. In this analysis, we use the house price index of the existing dwellings sold in the market.

Based on previous research, apart from oil price, the following explanatory variables are tested in sample analysis to explain house price fluctuation:

- Disposable income for households
- After-tax interest rates for banks and mortgage companies
- Unemployment rate, 15-74 years, seasonal adjusted
- Construction cost index for residential buildings, 2000=100
- Consumer Price Index, 2015=100
- Population for the whole country
- Brent crude oil price

When choosing the data for analysis, we take into consideration that it is households that take loans from banks and mortgage companies to purchase houses. Therefore, for income sector,



the quarterly data of disposable income for households is chosen. We use after-tax interest rates in line with the original model, and the marginal tax rate on capital income and expenses is constant value of 0.28. As for unemployment rate, the Norwegian Labour Force Survey defines unemployed person as those who were not employed in the reference week, but who had been seeking work during the preceding four weeks, and were available for work in the reference week or within the next two weeks. The data series are seasonal adjusted and calculated by three month moving average in order to reduce uncertainty. The construction cost uses 2000 as the base year and it measures the monthly cost development of residential building construction. The index reveals the changes in the prices of input factors to the construction process of residential buildings, while changes in productivity and profit margins are not included in the index. The cost is calculated based on actual sales prices in the country's construction industry. Consumer Price Index is published monthly by Statistics Norway that measures the actual changes in the prices for household goods and services including charges and fees. As for population, note that the data series also include people from other countries who stay in Norway for more than 6 months, even though it is still a temporary stay. Because it is highly unlikely for these people to purchase dwellings in Norway, it is possible that the effect of increase in population is exaggerated. Last but not least, for oil prices, we use Brent crude oil price, which is the most widely used benchmarks in the world, averaged from daily data, and the unit is dollars per barrel.

Because both short-term and long-term effects are considered in the analysis, possible lagging factors are also considered during the sample period. Also different forms of the data are tested, including using the logarithmic form and taking first difference, based on the previous research by Jacobsen and Naug. Apart from the explanatory factors in previous studies, we paid special attention to the role of oil price when trying to explain house price fluctuation in this model. In the end, not all the possible explanatory variables are included into the model, the final result

presented in Chapter 7.1 is a combination of both best fitted and relatively most reasonable model.

### 6.1.2 Data description

In Appendix 6.1.2, we list the descriptive statistics of the original data series for the variables we test in sample regression. However, because there is large variance in most of the data series especially for population and households' income, we need to transform the data to reduce variance and thus get stationary data series and reduce multicollinearity. We did log transformation to house price, income for house holds, population, construction cost and oil price. Also we take the first difference of the series including house price, income and interest rate in order to avoid non-stationary data, which is in line with the house price model in Jacobson's paper. After the data transformation, we still find time trend in income for households, interest rate, population and construction cost. Therefore, we use Stata to remove the time trend from the problematic data series to avoid spurious results. The table below shows the description of the data series we use in final regression, while  $\Delta X_t = X_t - X_{t-1}$ , and the variables in lower case are measured on logarithmic scale.

Variables	Sample	Minimum	Maximum	Mean	Standard Deviation
<i>Dependent Variables</i>					
$\Delta houseprice$	60	-0.0730	0.0707	0.0154	0.0263
<i>Independent Variables</i>					
$\Delta income$	60	-0.0986	0.0760	0.0122	0.0229
$\Delta INTEREST(1 - \tau)$	60	-1.4976	0.3889	-0.0061	0.3112
$\Delta population$	60	0.0010	0.0041	0.0025	0.0008
$\Delta CPI$	60	-1.3667	2.2667	0.4417	0.6016
<i>unemployment</i>	60	0.8755	1.5892	1.2764	0.1942

$\Delta construction$	60	-0.2858	0.3004	0.0086	0.0747
$\Delta oilprice$	60	-0.7344	0.2976	0.0155	0.1634

*Table 2: Data description for house price model*

As compared to the non-stationary original data series, the transformed data shows small variance from their mean value. Because we take the first difference for most of the data series, the minimum value for those are shown as negative. Also it is obvious that the logarithmic transformation further centralizes the data and thus results in smaller standard deviation than the data series in levels.

## 6.2 Data for relationship between house price and oil price

In the simple regression model using only housing prices and oil prices, we used the Brent crude oil price from the first quarter in 1992 to the first quarter in 2017. For housing prices estimation, firstly we did the regression using the national house price index data series which is between 1992 Q1 and 2017Q1. Then when we further estimate the regional differences, we selected four major regions in Norway, which are Oslo, Bergen, Stavanger and Trondheim. The housing price index for those four regions are quarterly data from 2005 Q1 to 2017 Q1. Following is the overview of the data series used in the simple regression model:

Variables	Sample	Minimum	Maximum	Mean	Standard Deviation
$\Delta houseprice$	100	-0.0730	0.0779	0.0180	0.0269
$\Delta oilprice$	100	-0.7344	0.3086	0.0109	0.1481

*Table 3: Data description for national house price and oil price*

Because we use only national house prices and oil prices in the regression model, we have data in longer time period than in the previous house price model. It is obvious from the data description that oil price fluctuates much more than house price does in the past twenty-five years.

Variables	Oslo		Bergen		Stavanger		Trondheim	
	Mean	Std.	Mean	Std.	Mean	Std.	Mean	Std.
$\Delta houseprice$	0.0192	0.0297	0.0139	0.0325	0.0146	0.0307	0.0152	0.0275
$\Delta oilprice$	0.0024	0.1744	0.0024	0.1744	0.0024	0.1744	0.0024	0.1744

*Table 4: Data description for regional house price and oil price*

The regional data is less sufficient than national data, with only 48 observations for each variable. As we can observe from the table, Oslo has the highest average house price among the four regions for its persistent excess in housing demand, while house price in Bergen fluctuates the most. The relatively low average house price in Stavanger is mainly due to the sharp drop after the oil price crash in 2014.

### 6.3 Data for regional differences

In the DID regression model, the house prices in Stavanger and Akershus are used. It is quarterly house price index from Statistics Norway. The time period is 2005 Q1-2016 Q3, during which the house prices in Stavanger stand out among all other regions in Norway because of the persistent high oil prices and the sudden crash later (see Appendix 6.3 for data description). The data is not sufficient enough to cover a long period, but it has been proposed that for DID regression, the smaller the time period is tested, the more likely the assumption is to hold.

From the data, although the average house price in Stavanger is higher than that in Akershus, the variance is also larger for data in Stavanger, with both larger maximum value and smaller minimum value. Overall, the house price in Stavanger fluctuates more than that in Akershus during the time period.

## 7. Results and Analysis

In this chapter, the final results of the three models are presented, as well as analysis based on the results. Also the differences between the revised models and the models by previous researchers are discussed, and the possible causes of bias in the empirical research is provided.

### 7.1 House price model

In this analysis, we try to estimate a model of house price using quarterly data in the recent 15 years and we specifically try to include the oil price as one of the explanatory variables. Firstly, the original house price model created by Jacobsen and Naug is tested using data series in more recent time period, i.e. between 2002 Q1 to 2017 Q1 (see result in Appendix 7.1). However, it seems that the original model does not apply properly to the recent data, for the coefficient for income factors and interest rate factors in the result are highly insignificant, and only the coefficient for long-term effect in income turns out to be significant at 5 percent level. The R-square is only 0.427 after adjusting for time trend and autocorrelation problems, which confirms that the old model is problematic explaining the recent market. It is reasonable to assume that the determinant factors for housing price fluctuation may change in different period of time because of the economic environment, therefore certain adjustment in the explanatory variables is made according to the demand and supply analysis in chapter 3. The revised house price model is listed below:

$$\begin{aligned}\Delta houseprice_t = & \beta_1 \Delta income_t + \beta_2 \Delta (\text{INTEREST} \cdot (1 - \tau))_t + \beta_3 \Delta (\text{INTEREST} \cdot (1 - \tau))_{t-1} \\ & + \beta_4 \Delta population_t + \beta_5 \Delta oilprice_t \\ & + \lambda [houseprice_{t-1} + \theta_1 \Delta income_{t-1} + \theta_2 unemployment_t \\ & + \theta_3 \Delta construction_{t-1}] + \alpha\end{aligned}$$

The result of the regression model is as follows:

*Table 5: Estimated parameters and their standard errors*

Independent Variables	Parameter	t-Statistics
$\Delta oilprice_t$	0.0415 (0.0799)	0.52
$\Delta income_t$	-0.1160 (0.0778)	1.49
$\Delta population_t$	-0.6561*** (0.1080)	6.08
$\Delta(INTEREST(1 - \tau))_t$	0.3312*** (0.1181)	2.80
$\Delta(INTEREST(1 - \tau))_{t-1}$	-0.2242* (0.1218)	1.84
$houseprice_{t-1}$	-3.8500*** (0.6249)	6.16
$income_{t-1}$	0.4698 (0.7964)	0.59
$unemployment_t$	-0.6724** (0.3160)	2.13
$\Delta construction_t$	0.3748*** (0.0924)	4.06
Constant	35.7803*** (4.6418)	7.71

$R^2 = 0.7331, DW = 1.9348$

Estimation period: 2002Q1 - 2017Q1

Estimation method: Least squares method

Standard errors are given in the parenthesis under the estimates.

$\Delta$  is a difference operator:  $\Delta X_t = X_t - X_{t-1}$

The variables in lower case are measured on logarithmic scale.

\*\*\*Significant at 1 percent level.

\*\*Significant at 5 percent level.

\*Significant at 1 percent level.

The model contains effects of household disposable income, population, interest rates, unemployment, construction cost and oil price. In order to control for possible bias, time trend is tested for all the variables and we remove the time trend in the biased data series. Also the Durbin Watson test result is close to 2, which reveals that there is little autocorrelation problem in the model. The R square is 0.73 in the result, which indicates that the independent variables can explain the major trend in dependent variable.

In the short term, changes in population is the most significant factor that decide house price. The sign of the coefficient is confusing at first, but it actually can be explained by the analysis from Chapter 3.1.1. It has been proved that for recent decades, the main source of significant increase in Norwegian population comes from net immigration, whereas the excess births in Norway has been relatively low. And because the new immigrants usually have less purchasing power when they first come to Norway, the demand for purchasing dwellings basically falls because of the slowing down of excess birth.

The model also implies that the house price increase by 0.33 percent when the interest rate raise by one percentage point, whereas it decreases by 0.22 percent when the interest rate from the previous period increases by one percentage point, other things equal. It can be comprehended that the raise in interest rate in the short term can attract people to purchase dwellings as a investment instrument, while in longer period the increase in bank's lending rate raises the cost for loans and thus households have less demand for purchasing houses.

On the contrary, the changes in income only makes positive effects on house prices in the long term, which is in line with the research by Statistics Norway (Economic Survey, 2013). It is understandable that purchasing dwellings is a long-term process, and only when the households have a stable increased income that they can afford to borrow from banks and mortgage

companies. According to the model, an increase in the interest rate can lead to 0.47 percent raise in house price in the long run, with other factors unchanged.

For the effect of oil price, we find no evidence that it can influence the house price in the long term, and it is not as significant as other indicators as explanatory variable. However, we believe that the effect of oil price on house price is underestimated in the model, and it is indirectly transformed through other factors. We also did correlation test for oil price and other explanatory variables, while it reveals a relatively strong correlation between oil price and construction cost with the correlation coefficient of 0.34. Also the oil price has a weak correlation with interest rate by the correlation coefficient of 0.27. Combined with the finding from 8.2, we insist on including oil price into the model. And according to the model, house price will increase by 0.04 percent if the oil price increase by one percent *ceteris paribus*. Taken the recent persistent low oil price into consideration, the impact of oil price on house price is not trivial at all.

In the long term, the model implies that one percent increase in unemployment rate can result in 0.67 percent decrease in house price, other things being equal. It verifies that when the economy is in the downturn and people are losing jobs, their demand for houses declines and thus house price goes down. On the other hand, when the construction cost gets one percent higher, as a result, the house prices goes up by 0.37 percent, with other factors fixed. The coefficient for the lagging variable of house price shows that house prices can rise (fall) by 3.85 percent in quarter  $t$  if house prices are 1 per cent lower (higher) than the estimated long-term relationship in quarter  $(t - 1)$ , all else being equal.



## 7.2 Relationship between house price and oil price

In order to further illustrate the direct effect of oil prices on housing prices in Norway, the following simple linear regression model is conducted. The following table reveals the simple regression result about how the changes in oil price can explain housing price fluctuation.

<b>Method:</b> <b>Estimation period:</b> <b>Observations for each variable:</b> <b>Standard errors are given in the parenthesis under the estimates.</b>	<b>Least Squared</b> <b>1992Q1-2017Q1</b> <b>100</b>	
<i><math>\Delta</math>houseprice</i>	Norway	
Variable	<b>Coefficient</b>	<b>t-Statistic</b>
<i><math>\Delta</math>oilprice</i>	0.2460*** (0.0932)	2.64
<i>Constant</i>	35.0981*** (5.4233)	6.47
R-square	0.066	
Durbin Watson test	1.801	
P-value	***Significant at 1 percent level **Significant at 5 percent level *Significant at 10 percent level	

*Table 6: Relationship between Norwegian housing price and oil price*

From the result we can observe that the oil price fluctuation has a significant effect on the country's housing price fluctuation over the past 25 years, and it can explain almost 7 percent of the changes in housing price. The Durbin Watson test result is close to 2, which shows a weak positive autocorrelation in the residuals. After we corrected autocorrelation, the result becomes:

Method:	Least Squared (After correction for autocorrelation)	
Estimation period:	1992Q1-2017Q1	
Observations for each variable:	100	
<b><i>Δhouseprice</i></b>	Norway	
<b>Variable</b>	<b>Coefficient</b>	<b>t-Statistic</b>
<b><i>Δoilprice</i></b>	0.272***	2.73
<i>Constant</i>	34.132***	5.88
<b>R-square</b>	0.071	
<b>Durbin Watson test</b>	1.904	
<b>P-value</b>	***Significant at 1 percent level **Significant at 5 percent level *Significant at 10 percent level	

*Table 7: Relationship between Norwegian housing price and oil price after correction for autocorrelation*

With the correction for autocorrelation, the Durbin Watson result is closer to 2 and the magnitude of coefficient for oil price slightly increased with no changes in sign. Therefore, it is reasonable to conclude that the increase (decrease) in oil price has a significant positive (negative) effect on the country's housing prices during the past 25 years.

After we tested the housing price for the whole nation, we specifically tested the housing prices in different regions to observe the regional differences, i.e. whether the oil price make various direct effects on housing prices in different regions in Norway. The results are as follows:

Method:	Least Squared			
Estimation period:	2005Q1-2017Q1			
Observations for each variable:	48			
Standard errors are given in the parenthesis under the estimates.				
<b><i>Δhouseprice</i></b>	Oslo	Bergen	Stavanger	Trondheim
<b>Variable</b>	<b>Coeff</b>	<b>Coeff</b>	<b>Coeff</b>	<b>Coeff</b>
<b><i>Δoilprice</i></b>	0.196 (0.1446)	0.135 (0.1461)	0.234* (0.1433)	0.177 (0.1451)

<i>Constant</i>	19.691***	21.194***	18.755***	20.173***
<b>R-square</b>	0.039	0.018	0.055	0.031
<b>Durbin Watson test</b>	1.727	1.979	1.151	2.222
<b>P-value</b>	***: 1% significant    **: 5% significant    *: 10% significant			

*Table 8: Relationship between regional housing prices and oil prices*

The result is relatively less convincing than the previous model using national data. Of the four regions that are chosen here, almost none of the coefficient for oil price fluctuation is significant except that the model for Stavanger is significant in 10 percent level. The result does not get any better after correction for autocorrelation. However, we can still observe that of the four representative regions in Norway, the oil price fluctuation makes relatively more significant influence on the housing price changes in Stavanger, with the coefficient for oil price much larger than that for other regions. Also according to the value of R-square, the oil price fluctuation explains the most for housing prices in Stavanger. Bergen, on the other hand, is least affected by oil price changes according to the result.

### 7.3 Regional oil price effect

In order to isolate the oil effect, we run a DID regression to testify the oil price effect by comparing the house prices in regions with and without oil industry in Norway. The result of the regression is shown below (Table 9), the coefficient ( $\delta$ ) of the interaction term shows the effect of oil price. From the result we can see that  $\delta$  has a positive sign with the magnitude of 19.64, and it is significant at 10 percent level. This indicates that when oil price reaches 60 or higher, there is a distinct positive impact on house price in Stavanger, where oil is the main local industry.

Variable	Regions		
	Aks	Stv	Difference, Stv-Aks
1. House price before high oil price	51.13 (6.77)	55.38 (7.33)	4.25 (0.40)
2. House price after high oil price	28.33 (7.96)	52.22 (14.67)	23.89 (4.75)
3. Change	-22,79 (-2.73)	-3,15 (-0.38)	19.64 (1.66)

*Table 9: Regional effect - Result for DID regression*

#### 7.4 Concerns and criticism

Overall, the three models have shown that the oil prices to some degree make impact on the house prices in Norwegian market. However, there are some concerns regarding the results of the models.

First and foremost, data limitation is a big problem for the credibility of the models. For the house price model, only 60 observations are used which contains the quarterly data for 15 years. The other two model use even less data to estimate the result. Especially the case for regional differences, because of the method the authorities use to collect data, the house price for Stavanger alone is not available before 2005. However, we prefer not to use the data for the region that include Stavanger because we would not want to intervene the specific effect of oil industry on Stavanger's economy. Based on these facts, the results from the empirical models can only explain the most recent trend, and it may be biased because of the lack of data.

Secondly, one of the disappointment in the results is that we did not find statistically significant result for oil price in the house price model. However, we suspect that the coefficient for oil price variable is not significant only because it is correlated with other variables such as construction cost and interest rate. Nevertheless, there can be multicollinearity problem in the

regression that makes the final result biased. Also the statistical significance for income factor in the house price model is not satisfying as well. We still include the variable into the model because theoretically it is an important fundamental factor and it is proved in the original model by Jacobsen and Naug. Also the magnitude for the two variables are relatively big and it contributes to how much the model can explain the changes in house price.

Thirdly, we suspect that there could be endogeneity problem especially in the house price model. The R square is 0.73, and it is possible that there are omitted variables in the model, and whatever is left in the error term can be correlated to the explanatory variables we are using. Also measurement error can also influence the result while it is not observable in the analysis.

Overall, there are concerns that the models we present in the analysis can be in some way misleading due to various possible bias. However, we still believe that it to some extent can reflect the influence oil prices make on housing prices in Norway.

## CONCLUSION

In this thesis, we try to investigate whether the oil prices have a significant impact on the housing prices in Norway. We find that oil price can make direct positive influence on the Norwegian real estate market. Oil price, together with interest rate, household income, unemployment rate, population and construction cost can explain the major fluctuations in house prices in recent 15 years. Also we find that the oil industry differentiates the economic pattern in specific regions that have oil fields and the local economy depends largely on oil revenue. For those regions, the housing market benefits more during the period with high oil price and takes more risks during the consistent low oil price period.

As Stavanger's mayor, Christine Sagen Helgo said in one of his speech, 'the key word in Norway nowadays is change'. In order to prevent the risks for the oil-dominated regions as well as the whole nation, not only should authorities concern more about the oil market when deciding on financial policies, but also the regions that rely too much on oil sector should look for new fields to develop their economy in order to prevent the risks they may take during downturns of the oil market.

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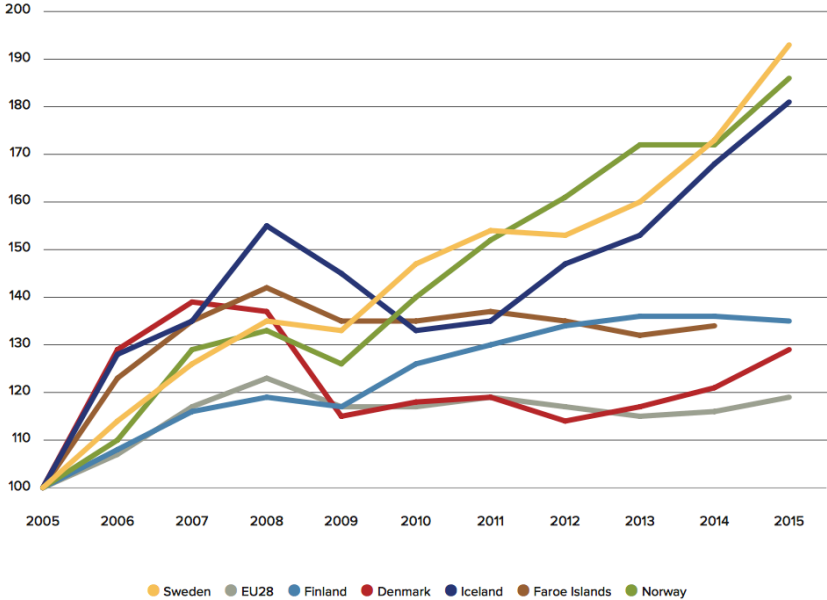
[https://www.regjeringen.no/globalassets/upload/oed/pdf\\_filer\\_2/faktaheftet/fakta2014og/facts\\_2014\\_netts.pdf](https://www.regjeringen.no/globalassets/upload/oed/pdf_filer_2/faktaheftet/fakta2014og/facts_2014_netts.pdf)

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# Appendix 1

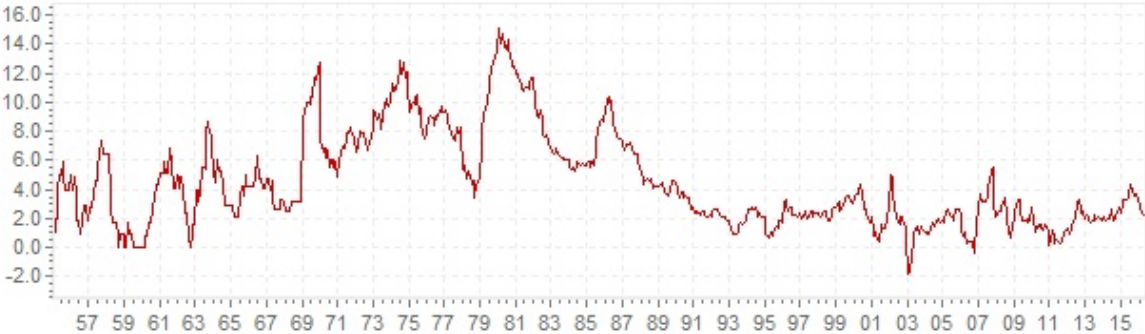
Figure: National House Price Index in Europe, 2005-2015  
Source: Nordregio Report



# Appendix 3.1.7

Graph: Historic inflation rate in Norway

Source: <http://www.inflation.eu/inflation-rates/norway/historic-inflation/cpi-inflation-norway.aspx>

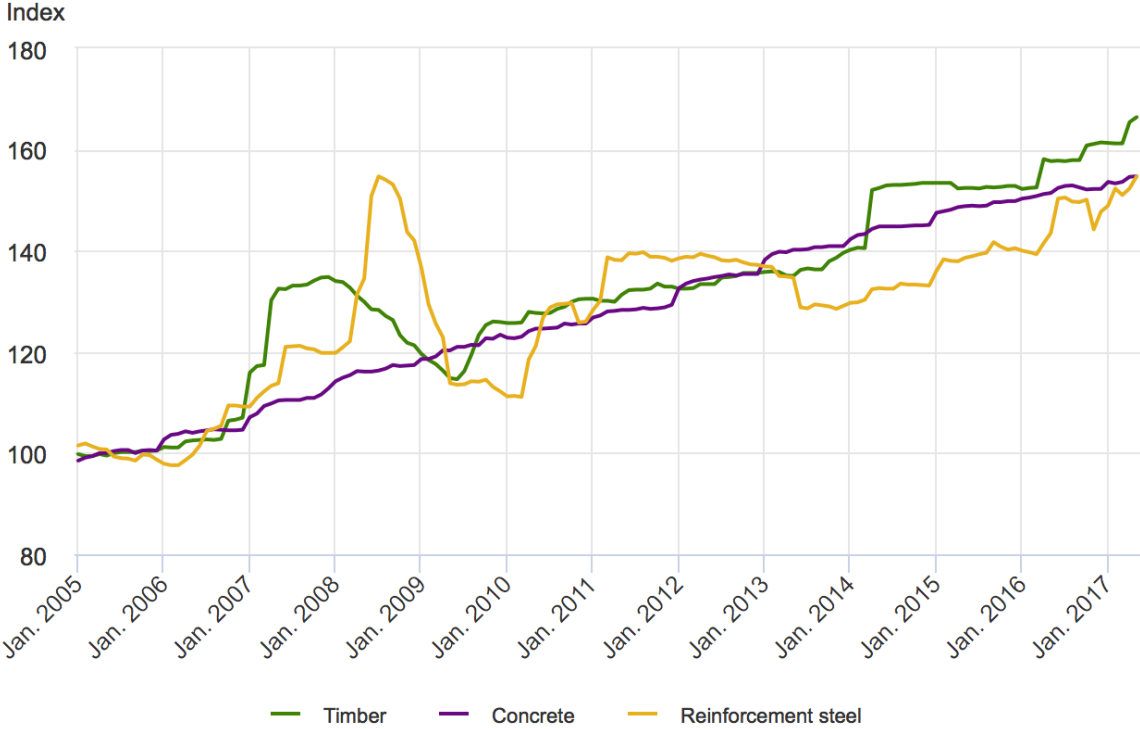


### Appendix 3.2.2

Figure: Construction cost index for residential buildings. Material indices for timber, concrete and steel. 2005=100

Source: Statistics Norway.

Available at: <https://www.ssb.no/en/priser-og-prisindekser/artikler-og-publikasjoner/increase-in-construction-costs--311866>



## Appendix 3.2.3

Table: Minimum energy requirements for buildings in Norway

Source: <http://www.buildup.eu/sites/default/files/content/ca3-2016-national-norway-web.pdf>

Requirement	1997	2007	2010 (after EPBD Directive 2002/91/EC)	2015
Net energy demand kWh/m <sup>2</sup> .year	-	Single-family house: 125 + 1,600/m <sup>2</sup> heated floor area Apartment: 120 Commercial building: 165	Single-family house: 120 + 1,600/m <sup>2</sup> heated floor area Apartment: 115 Commercial building: 150	Single-family house: 100 + 1,600/m <sup>2</sup> heated floor area Apartment: 95 Commercial building: 115
Maximum area of glass plus doors	20% of heated floor area	20% of heated floor area	20% of heated floor area	25% of heated floor area
Max U-value: exterior wall W/m <sup>2</sup> .K	0.22	0.18	0.18	0.18
Max U-value: roof W/m <sup>2</sup> .K	0.15	0.13	0.13	0.13
Max U-value: exposed floors W/m <sup>2</sup> .K	0.15	0.15	0.15	0.1
Max U-value: glass/doors W/m <sup>2</sup> .K	1.6	1.2	1.2	0.8
Thermal bridges (normalised U-value) W/m <sup>2</sup> .K	-	Single-family house: 0.03 Other buildings: 0.06	Single-family house: 0.03 Other buildings: 0.06	Single-family house: 0.05 Other buildings: not defined
Minimum efficiency of heat recovery in ventilation air	60%	70%	Dwellings: 70% Commercial building: 80%	80%
Minimum airtightness (Max air changes/hour at 50 Pa pressure difference)	Single-family house: 4.0 Other buildings (with more than two floors):	Single-family house: 2.5 Other buildings (with more than two floors): 1.5	Single-family house: 2.5 Other buildings (with more than two floors): 1.5	1.5
Max SFP factor kW/(m <sup>3</sup> /s)	-	Dwellings: 2.5 Commercial building: 2.0	Dwellings: 2.5 Commercial building: 2.0	Dwellings: 1.5
Max screening factor for glass/window (gt)	-	-	0.15 (all buildings)	

## Appendix 5.1.2

Source: TNS GALLUP

Available at: <http://www.tns-gallup.no/kantar-tns-innsikt/forventningsbarometeret-1-kv-2016/>

The consumer expectation survey consists of 6 questions listed as follows (Google translated from Norwegian), the first 5 questions are included as the Trend Indicator:

1. Do you agree that the economy in your household is better or worse than a year ago or is there no difference?
2. Do you think the economy in your household will be better or worse in a year or there will not be any difference?
3. If we look at the economic situation for Norway as a whole, would you say that the economy in the country is generally better or worse than a year ago or is there no difference?
4. Do you think that the financial situation in Norway will be better or worse in a year or there will not be any difference?
5. Do you think it's a good time for the general public to buy bigger household items or do you think it's a bad time?

The trend indicator = the difference between the percentage of optimistic and pessimistic answers for each question is summed up and divided into 5.

The trend indicator is supplemented with a 6th question called the industry indicator:

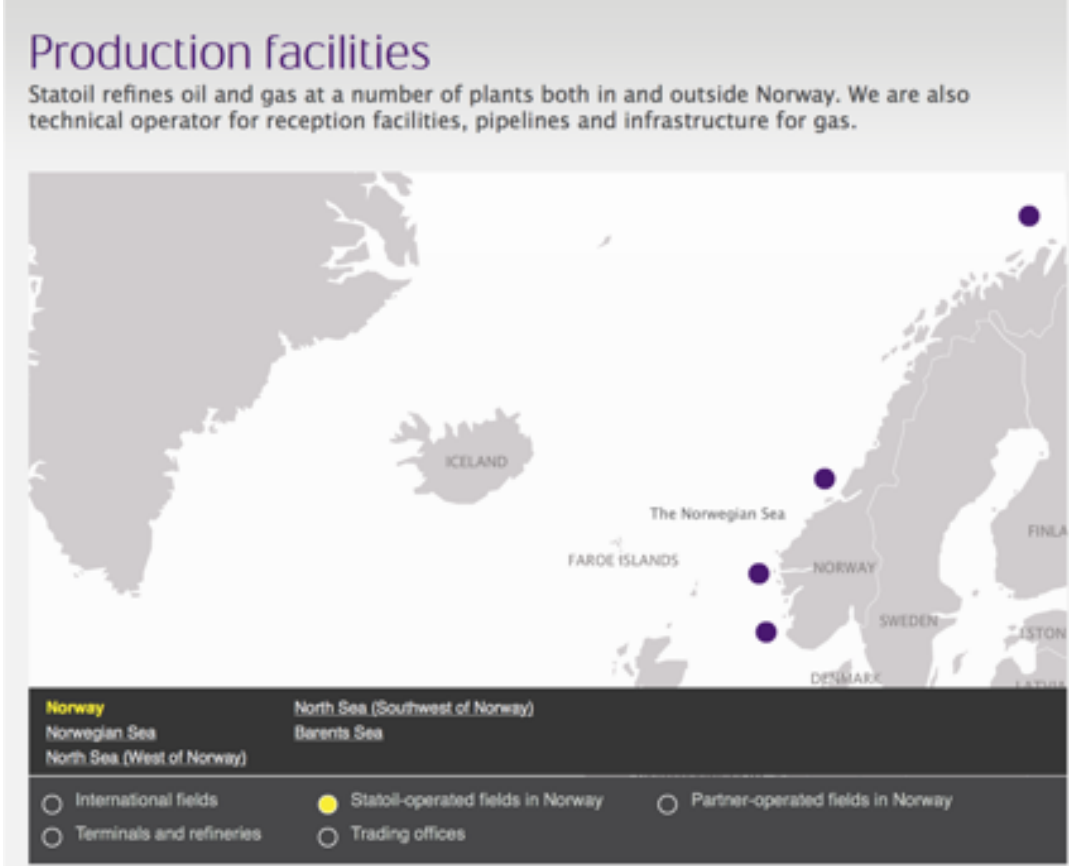
6. If the economy of your household improved, what would you spend the money for?



# Appendix 5.2.4.1

Graph: Major oil fields in Norway

Source: Statoil



## Appendix 6 DATA SOURCES

House price index

Source: Statistics Norway - Table 07221

<https://www.ssb.no/statistikkbanken/selectvarval/saveselections.asp>

Oil price (Brent crude oil price)

Source: <https://fred.stlouisfed.org/series/DCOILBRENTU>

Disposable income for households

Source: Statistics Norway - Table 11020

<https://www.ssb.no/statistikkbanken/selectvarval/saveselections.asp>

Interest rate for banks and mortgage companies

Source: Statistics Norway - Table 07200

<https://www.ssb.no/statistikkbanken/selectvarval/saveselections.asp>

Consumer Price Index

Source: Statistics Norway - Table 03013

<https://www.ssb.no/statistikkbanken/selectvarval/saveselections.asp>

Unemployment rate

Source: Statistics Norway - Table 07458

<https://www.ssb.no/statistikkbanken/selectvarval/saveselections.asp>

Population in the whole country

Source: Statistics Norway - Table 01222

<https://www.ssb.no/statistikkbanken/selectvarval/saveselections.asp>

Construction cost index

Source: Statistics Norway - Table 08651

<https://www.ssb.no/statistikkbanken/selectvarval/saveselections.asp>

## Appendix 6.1.2 DATA DESCRIPTION

Descriptive statistics for original data:

Variables	Sample	Minimum	Maximum	Mean	Standard Deviation
<i>Dependent Variables</i>					
House price	61	44.6	113.2	74.59	19.69
<i>Independent Variables</i>					
Income for households	61	166148	346805	251202.25	54625.12
Interest rate	61	3.02	8.53	4.75	1.44
Population	61	4524066	5258317	4853291.43	234898.58
Consumer Price Index	61	78.17	104.67	89.99	7.64
Unemployment rate	61	2.4	4.9	3.65	0.67
Construction cost	61	106.68	179.17	140.82	23.70
Brent crude oil price	61	21.12	121.2	69.64	30.35

## Appendix 6.3 DATA DESCRIPTION

Descriptive statistics for house price data in DID regression:

Variables	Sample	Minimum	Maximum	Mean	Standard Deviation
House price in Stavanger	47	48.5	107.8	85.80	17.43
House price in Akershus	47	53.3	112.3	78.56	15.20

## Appendix 7.1

The original model by Jacobsen and Naug, using recent data:

<i>Estimated parameters and their standard errors</i>		
Independent Variables	Parameter	t-Statistics
$\Delta income_t$	-0.1614 (0.1103)	1.46
$\Delta(INTEREST(1 - \tau))_t$	0.1904 (0.1793)	1.06
$\Delta(INTEREST(1 - \tau))_{t-1}$	-0.1850 (0.1744)	1.06
$houseprice_{t-1}$	-4.4283*** (0.8910)	4.97
$income_{t-1}$	-1.6407 (1.0815)	1.52
$INTEREST_{t-1}$	-0.4849** (0.2212)	2.19
$unemployment_t$	-0.5103 (0.4606)	1.11
Constant	68.5030*** (19.0536)	3.60

---


$$R^2 = 0.4274$$

Estimation period: 2002Q1 - 2017Q1

Estimation method: Least squares method

Standard errors are given in the parenthesis under the estimates.

$\Delta$  is a difference operator:  $\Delta X_t = X_t - X_{t-1}$

The variables in lower case are measured on logarithmic scale.

\*\*\*Significant at 1 percent level.

\*\*Significant at 5 percent level.

\*Significant at 1 percent level.