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Fundamentals and Irrationalities in Norwegian Housing Prices

Master Thesis
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Abstract

A housing price model is built to analyze whether there is a housing bubble in the Norwegian housing market. The model is built based on the general definition of financial bubbles. Fundamentals in the family level are then introduced in order that empirical data in the household level can be used for analysis. Empirical data conducted by SSB in 2012 are investigated. No bubble is concluded in the current Norwegian housing market.

Preface

The thesis is submitted as a requirement for the degree MSc. at Norwegian University of Science and Technology (NTNU).

The data applied in the thesis are cross-sectional data conducted by the Statistics Norway (SSB). The original purpose of the data is to investigate the living condition of Norwegian inhabitants from 2001 to 2012. Anonymized data sets have been made available by the Norwegian Social Science Data Services (NSD). Statistics Norway (SSB) was responsible for sampling and interviewing. Neither NSD nor SSB are responsible for the analyzes/interpretation of data shown in the thesis.

I want to thank my supervisors Synne S. Almaas and Lars-Erik Borge who gave me useful guidance, helpful discussions and valuable suggestions.

I would also like to thank my husband whom supports me all the time. Finishing the thesis is not a easy task to me, but it became less painful with the understanding of my lovely family, my son Situo and my husband Ganpan.

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Chapter 1

Introduction

A commentary paper wrote by Gjerstad and Smith, 2009 in the Wall Street Journal describes the process of housing bubble inflating and bursting in the time period of 1997-2008 in US. The great similarities between the current Norwegian housing market and the early phase of the US housing bubble described in the paper makes the questions of whether we are in a housing bubble in Norway worth examining. To avoid the housing bubble is important, because the bursting of a housing bubble could hurt the financial system seriously and further affect the entire economy. Leamer (2007) states that the business cycles in the economy are largely driven by the housing investment. The great harmfulness has been evidenced from the 2008 subprime crisis in US. Housing bubbles can arise when some households buy not on fundamental value, but on price trend or momentum (Gjerstad and Smith, 2009, Stiglitz, 1990, Duus and Hjelmeland, 2013). Therefore, the existence of a housing bubble could be identified by either knowing the fundamental value of houses or the house prices supported by the momentum. However, both the fundamental value and the momentum driving house prices are difficult to know (McClure, 2015). Some in-

dicators like the Case-Shiller index (Karl and Shiller, 2003) were successfully used on identifying the existence of a housing bubble in US, yet can be easily defended by the Norwegian politicians by Norway being different (Solberg, 2014). Intuitively, an analogical comparison between a verified housing bubble period and the current housing market in Norway would be a good start for housing bubble investigation (The observations of the U.S. are taken from Gjerstad and Smith, 2009):

1. The largest housing bubble in the US history started in 1997. It was probably due to the rising of household income started in 1992 and the elimination of taxes on residential capital gains up to $\$500,000$ in 1997. In comparison, Norway experienced a great salary increasing started in 1996 (See Figure 1.1). And the yearly salary keeps on increasing stably and evenly for about 20 years.

2. The bubble could have been deflated during the 2001 recession. However, an expansionary monetary policy executed by the Federal Reserve (Fed) in order to counteract the downturn kept further developing or at least maintaining the bubble. As for Norway, the downturn was stimulated by the oil price decreasing in 2008 (see Figure 1.2) and counteracted by the Central Bank of Norway by applying an extreme low interest rate (see Figure 1.4).

3. The credit standards are eroded by rating agencies accepting the hypothesis of ever-rising home values combined with lenders using rising home prices to justify loans to buyers with limited assets and incomes. Meanwhile, Norwegian banks tend to lend a mortgage to house buyers that are more than five times of the family income. Young households

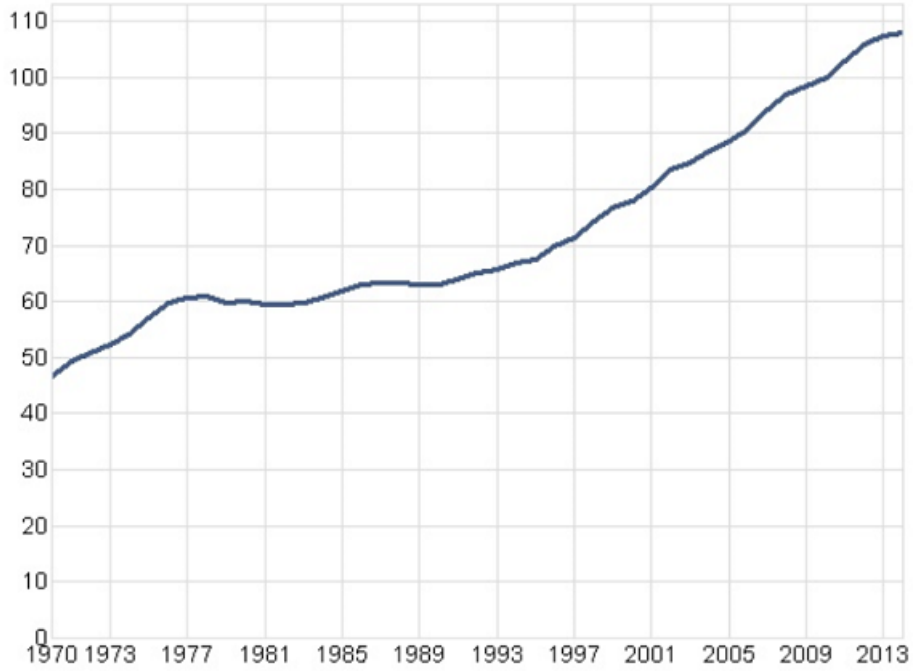

Figure 1.1: the index of nominal yearly salary in Norway from 1970 to 2014 (2010=100)

Sources: SSB

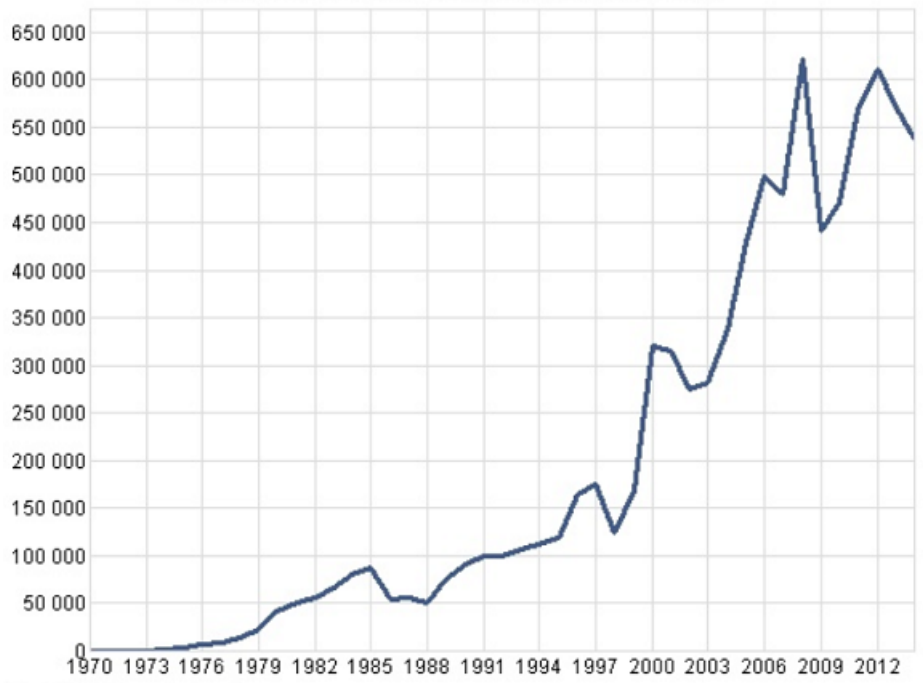

Figure 1.2: Yearly income (mNOK) from export of oil and nature gas in Norway from 1970-2013

Sources: SSB

are aggressively interested in buying big houses and strongly supported by banks and guaranteed by their parents (Norwegian-Central-Bank, 2014).

4. The house loan increased by an average of 56% per year for three years from $1.05 trillion in 2000 to $3.95 trillion in 2003. Analogically, the average remaining loan of each household in Norway is increasing from NOK250,000 to NOK1,000,000 from year 1997 to year 2012, with an average rate of 26% per year (see Figure 1.3).

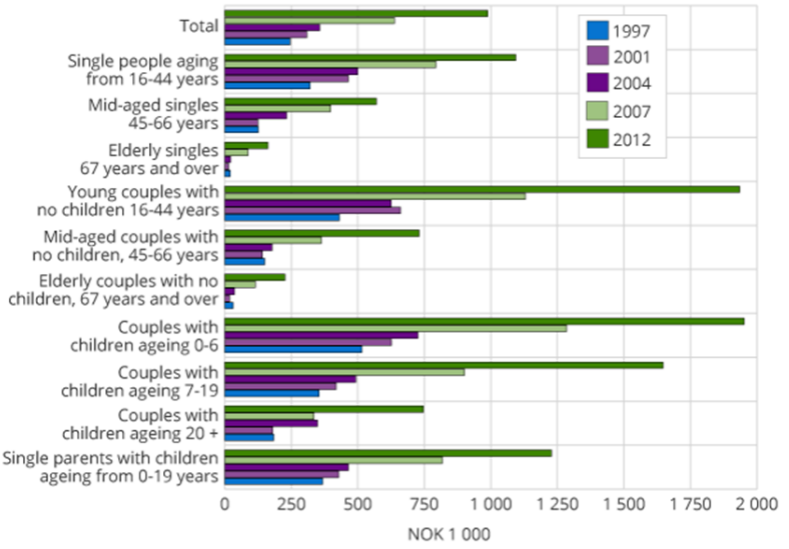

Figure 1.3: Average Remaining Loan (kNOK) for Households that own their dwelling, 1997-2012

Sources: Survey of level of living EU-SILC 1997-2012

5. The Case-Shiller 10 city index shows that the accumulated inflation in home-ownership costs between January 1999 and June 2006 was

151%, but the CPI measured only a 23% increase. At that time, Fed monitored inflation based on CPI, so they continued the lax monetary policy. Even after the Fed began to slowly raise the fed-funds rate in May 2004, the average rate was still low and the bubble continued to inflate for two more years. Not in coincidence, the probable reason for Norway to stay on a low key-policy-rate (1.4) is the fairly low CPI measured in Norway not considering the house inflating. And the globally low interest rates make Norway no more choices than keeping a low interest rate as well in order to stimulate its industrial exports.

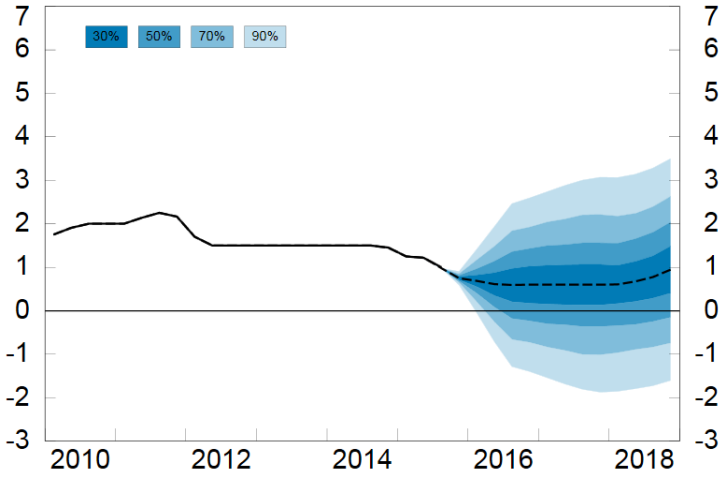

Figure 1.4: Key Policy Rate in Norway, 2010-2018
Sources: www.norges-bank.no/en/Monetary-policy/Key-policy-rate/

6. Between 1999 and 2006, the price-to-rent ratio in the U.S. has shot up from 20.8 to 32.3. In Norway, on February 16th, 2013, Dagens Nringsliv(DN) wrote that there is a downward pressure on rental prices in Oslo. The rental price was expected to be decreased by 20% for an

apartment located in Oslo. This is also supported by a study by Dagbladet, showing that rental prices flattened out during Q4/2012 and that more rental prices were decreased than increased. (Jokinen, 2013).

There are apparently some differences between observations from the U.S. in the largest housing bubble period and the current situation in Norway. A list of differences could be relative to the analysis of housing bubble are as following:
1. The homogeneity of population in Norway is high. In addition, the discrepancy of family income is relatively small compared to US. As a consequence, the economy of Norway is expected to be more stable than that of US.

2. As one of the richest countries in the world, Norwegian economy is capitalized by the government (Almaas et al., 2015). It seems sustainable for the government to support the well-established welfare system and create job opportunities in order to maintain a low unemployment rate. Whereas the U.S. is thought as a highly market-driven country where unemployment rate could fluctuate frequently.

3. Norway applies a full-recourse loan system, meaning that the house loan is connected to the household instead of the house itself. This could make the Norwegian households more conservative than households in other nations.

4. There is a saying in Norway that the value of having ones own house is not measurable in monetary terms at all. The stock market and some of other financial markets in Norway are less developed.

Houses are usually the main properties that the Norwegians invest on.

5. You can get tax deductions from the loans you have, which has even better returns than the interest you get from your saving. And in addition, you need pay tax for the earnings from your deposits.

6. Norway has a great amount of government pension fund. The yearly return of the fund is about 400,000 NOK for each family in Norway (Norwegian-Bank-Investment-Management, 2014).

These differences bring a great debate between foreigner economists and native politicians. Debates between economists and politicians are always endless because their concerns are different. First, economists intend to predict the future of the economy and have more focus on the sustainability, whereas politicians make most effort on the prosperity of the current economy in order to win the election for the next round. Second, economists dare not to speak out statements in order to draw eyeballs of their audiences. However, politicians are more responsible to their countries' development so that they are cautious on telling an even-existence truth to their people. Last but not the least, economists' statements are based on simplified economic models and strict statistical assumptions which might have been validated in one place (say US) but are not necessary to be correct in other place (say Norway). Whereas modern politicians have better practice on their national economy and get more supports from their native economists whom have access to investigate more informative data. So the native politicians should have a better overview of the real situation. Again, there is a matter of whether they wish to tell the truth openly. There-

fore, it is important to stay neutral between the foreigner economists and the native politicians before an investigation is conducted on the Norwegian housing markets.

The severe consequence of a housing bubble bursting drives many researchers working on it. Two major problems are investigated: how to distinguish a housing bubble and what is the mechanism of causing a housing bubble. Both are equally important. First, one should be able to distinguish a housing bubble and then second, one understands the mechanism and knows how to control the development of the bubble afterwards. In addition, if one understand the mechanism of the housing bubble, it will be helpful on finding correct indicator of the housing bubble. Numerous researches try to relate a housing bubble to different impacts, for instance, misguided monetary policy (Gjerstad and Smith, 2009), government policies stimulating house buying (Anundser and S., 2013, Dokko et al., 2011), irrational expectation of rising housing prices (Shiller, 2015), inelastic housing supply (Glaeser, Gyourko, and Saiz, 2008). Some others believe that it is the informational asymmetries between the financial institutions and the private-label mortgage-backed securities (PLS) investors (Levitin and Wachter, 2012). The mechanism of housing bubble is so complicated that to fully understand it is still long way to go. Instead, we are searching for the possibility of identifying it from statistical data. Karl and Shiller (2003) applied Cash-Shiller-index to predict the existence of housing bubble. However, based on our knowledge, most researcher apply time series data or panel data to study on the development of a housing bubble and further identify the bubble in a certain level. In this thesis, we try to use cross-sectional data instead. And we investigate only the current situa-

tion of the housing market without considering its dynamic developing.

We are interested in the existence of a housing bubble in Norway due to,
1. Such a housing bubble is risky for the economy of Norway.

2. It is interesting or at least a good training as a student to figure out who are correct, the foreigner economists staying out of Norway or the native politicians who may lie to their people.

3. It is good to stand independently, giving warning message or security information to the public on the situation of housing market in Norway.

4. If the house bubble is serious, it is possible to give suggestions to the government in order to have political adjustments for a soft landing of the economic down-shock.

In this thesis, we intend to apply the empirical data in 2012 in the household-level to investigate the existence of the housing bubble. To be able to do this, we first define fundamentals of house and household in the household-level. Then the price of each individual house can be split into the fundamental part of the house, the fundamental part of the household and the irrational part which inflates the housing bubble. The conclusion of the existence of housing bubble is then drawn by seeing how much percentage of the house price is caused by the irrational part.

The structure of the thesis is to build a house price model with variables indicating housing bubble based on the basic definition of a financial bubble in Chapter 2. Chapter 3 discusses what an ideal data survey should be applied for testing the model and how we could compromise to use an existence data survey that were not conducted for our purpose. Chapter 4 shows the analysis of regression results. And discussion and conclusion are given in Chapter 5 and Chapter 6, respectively.

Chapter 2

Conceptional Model

2.1 A House Price Model Stemmed from the Definition of a Financial Bubble

Different economists may have different views of what a financial bubble is. However, it will be generally acceptable by stating a financial bubble as the over-valued price part being unsupported by the fundamental of the economy. The over-valued part is in a sense supported by the irrational expectation of the price increase in the future.

Housing bubble is a type of financial bubble. Based on the general statement of a financial bubble, it is intuitive to divide the housing price into two parts, formally writing as Equation 2.1,

$$\text{CHP} = \text{CHP\_FUN} + \text{CHP\_IRR} \tag{2.1}$$

where,
CHP: the current housing price,
CHP_FUN: the part of housing price supported by the fundamental,
CHP_IRR: the part of housing price supported by irrational expectation of house price change in the future.

We see that Equation 2.1 is more general than being used for defining a housing bubble. A housing bubble exists only when the second term in the right-hand-side is positive. The equation applies also the opposite case where the housing price supported by irrational expectation is negative. Sequentially the market price of a house is then lower than the fundamental supported housing price. This equation gives also a clear picture of why government politicians prefer to state positive opinions whereas economists would like to give negative messages. Because the politicians are more cared about the boomed prices evidenced by their people and the economists are more interested in the real fundamental hiding behind the market.

2.2 The Fundamental Part of the Housing Price

The current house price (CHP) of an individual house or the average price of the entire housing market is easy to achieve. In Norway, the price of a house is known by the dealing price in a successful trade.

Even more, some agent companies charge households nothing for estimating the current prices of their houses. And you can obtain the average price of all sold houses annually from the Statistic of Norway (www.ssb.no). Seeing from Equation 2.1, one would be able to know whether there is a housing bubble or not, given that one knows either the current housing price supported by the fundamental (CHP_FUN) or the current housing price supported by the expectation of the change of future housing price (CHP_IRR),

Unfortunately, both the CHP_FUN and CHP_IRR are just formal terms. Their determinants could be fairly subtle and thus to measure them quantitatively is very difficult. Macroscopically, the average CHP_FUN is expected to be equal to the long term equilibrium of the housing price determined by the supply and demand of a purely free market (Duus and Hjelmeland, 2013). In reality, such an ideal market does not exist. Furthermore, the long term equilibrium tells the fundamental housing price in the past when all dynamic activities have settled down (Duus and Hjelmeland, 2013). It is not persuasive to apply the long term equilibrium in the current time. This is also one of the drawbacks by applying the HP-filter model in the housing market analysis (see end-points errors in (Duus and Hjelmeland, 2013)). To specify CHP_IRR is even more difficult because it is almost impossible to quantify the irrational expectation.

We are not going to make effort on the quantification of these two terms. Instead, we intend to build an econometric model relating the house price to its possible effects in terms of different explanatory variables. In these variables, we expect that some of them have a reflection

of the price part supported by fundamental and some others give us ideas of the irrational expectation. By testing the significance of these variables, we hope the econometric model will give us some indications of the existing of a housing bubble.

The pricing of a house is a combined reflection of the goodness of the house and the financial capability of the household family. These two factors in total give the fundamental part of the current house price.

We also realize that a house price could vary due to the preferences of different families. For example, the price of a house close to a good school will be thought higher for a family having school children than a family without school children. A house with large garden will be less valuable for pensionists than young couples, as the garden work could be hard and it is not affordable to rent the work out in Norway. In considering these preferences, we apply family a group of preference dummies on explaining the prices differences seen by different families. We write the fundamental part of current house price as Equation 2.2:

$$\text{CHP\_FUN} = \text{CHP\_HFUN} + \text{CHP\_CROSS} + \text{CHP\_TFUN} \tag{2.2}$$

where
CHP_CROSS: the house price affected by the interaction of the house and the household,
CHP_HFUN: the house price supported by the fundamental of the house,
CHP_TFUN: the house price supported by the fundamental of the

tenure economy.

By seeing Equation 2.2, it apparently shows that the fundamental part of the house price is an independent function of the individual house and household family. This is of cause not correct. The pricing of a house is determined by the entire housing market, even the macro-economy of the whole country. Therefore, one might expect that the fundamental part of the current housing price would be a function of macro-economic factors like GDP, CPI and so on.

We agree on this. However, we also realize that formulating the fundamenta in the country level is more complicated than Equation 2.2. Communications between different countries, financial markets, business units, imports, exports and macro-economic policies make the fundamental value so difficult to be tracked such that Burton Malkiel suggest that fundamental analysis is useless in outperforming the markets. Instead, if we define a fundamental in the family level similar to the fundamental in the country level, meaning that each individual family has its own fundamental, the determinants of such family fundamental will be much less than that of the country fundamental. Being no buys and sales in an individual family, we can simply relate the family fundamental to limit terms of family-scale economic factors like family income, debt, properties and so on. By doing so, we have implicitly assumed that the observation of the housing market in the country level is the summed effect of housing strategy in each individual family. This is similar to the so-called bottom-up approach in the area of fundamental analysis. Imagine, it is fair to claim a housing bubble if there is housing bubble in each family. In a most complicated

case, there are both housing bubble inflation and deflation in different families. To draw a conclusion in such situation can be difficult. We hope the housing market of Norway is not in this case.

Another reason we can define such a family fundamental is that most of individual economic indexes such as personal salary, family debts are products of the current macro-economy. So an individual decision or pricing on housing made by each independent family has already reflected the fundamental of the economy in the country level.

In summary, the reasons we would like to define such a fundamental in the family level is four-folds. First, it is doable to use the concept of family fundamental to capture the entire housing market by applying a bottom-up method, at least in some cases. Second, by introducing the family fundamental we state that the entire housing market is formed and behaved by each individual family, meaning all decisions of housing trading are made by households. It is therefore not necessary to consider the fundamental value in the country level, which could cover markets not just housing. This makes the investigation of housing market much simpler. Third, the communications between different financial units and activities are not included in the family level. So dynamics disappears automatically. We do not need to conduct the family fundamental after a long-term equilibrium. Therefore, current factors determine current fundamental. In the end, the channels from a family fundamental to the country level could be multiple depending on the financial behaviors of the family members, while the channel from the country fundamental to the family level is simply being the job opportunity. Once stable jobs are given to a family, family mem-

bers have right to make any decision they want. Therefore, to draw conclusions of housing markets from the country fundamental is more ambiguous than from the family fundamental. A schematic figure illustrating the relation between the country fundamental and the family fundamental is shown in Figure 2.1.

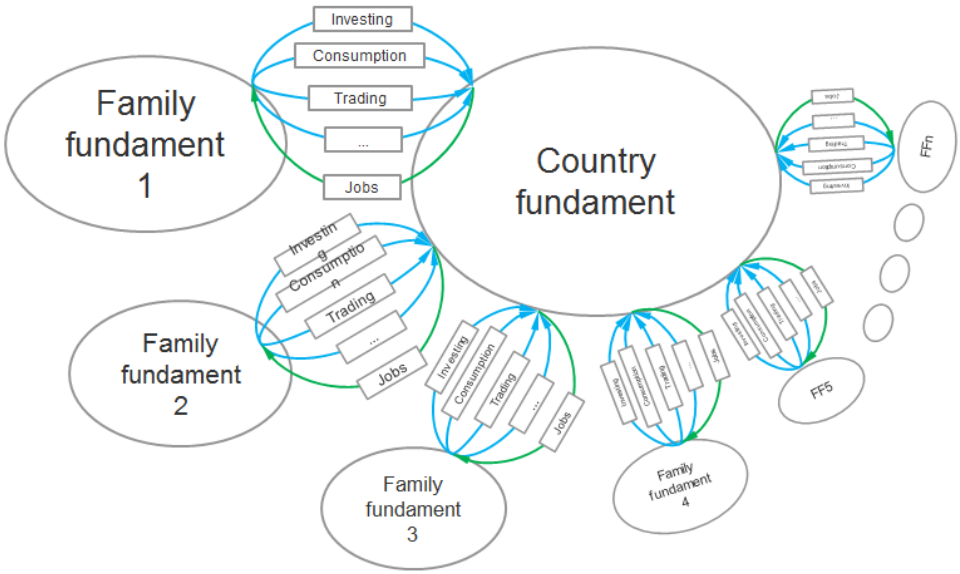

Figure 2.1: schematic figure of communications between country fundamental and family fundamental

However, it is worth to mention that we do not consider the houses being used for investing. It could be risky if there are houses existing in the market for only investing purpose. But due to limits of our model, we are not able to cover these events.

2.3 Irrational Part of the House Price

From the previous section we say that the rational part of the price of a house is supported by the goodness or quality of the house, the preference of the family to the house and the financial capability of the family. Whereas the irrational part of the house price is more subtle to be defined.

Based on the definition of a housing bubble, a bubble is inflated if there is irrational expectation of the price increase in the housing market. However, part of the price increase of a house for the future should be expected rationally. For example in Norway, the current economy is good; the interest rate is low and stable and the unemployment rate is low as well. So it is hard to blame that most Norwegian are expecting a house increase in the future. In addition, it is a psychological phenomenon that all decision makers in different families always believe themselves to be rational, based on what they observe from market. If they have already realized that they are irrational, they would of course not take an obvious risk. Just like a drunk person never telling himself being drunk, it is also impossible to get the correct answer on asking each decision maker whether he/she is irrational. Furthermore, each family, especially the decision-maker of the family, has its expectation of the direction of the house price change of the future. The amount of the expected price change is partly dependent on the fundamental of the macro-economy, but is also psychologically dependent on the characteristics of the decision-maker. For instance, by seeing the same

high house price in the current market, different persons could have different opinion. Some optimists might think the future house price will be even higher because the house market is going to bring more interests. Whereas some pessimists might think the house price will experience a downturn because they think the house price has reached a historical high point.

We don't claim that we are more clever than all decision makers. We have even less information than each decision maker on his/her own family. Therefore, we don't think we can get an idea of irrational expectation based only on information from an individual family. We only assume that we have more information from the inferences of statistical observations than individual decision makers. We also assume that we could conduct all data we want in order to spot the irrational expectation.

If we are able to carry a thought experiment where there is a family whom owns a house. The decision maker in this family has an expected price of the house in two years time. He asks an agent company to estimate the house price after two years and gets an advised price of the house. And he sales the house afterwards with a selling price. In this experiment, we have obtained three prices: the expected price, the advised price and the selling price. We also assume that there is another price which is exactly the fundamental value of the house. From these four prices, we could obtain the bubble value of the house to be the subtraction of the selling price and the fundamental price. This is the real irrational part we would like to obtain, yet unknown due to missing fundamental value of the house. We could also

get the subtraction of expected price and the selling price. We call it the super-irrational part of the house price. Even though this part is not the real irrational part of the house price, it tells at least some information about the irrational expectation of the decision maker on the current house. We call it a super-irrational part because it is the irrational part exceeding the real irrational part the house price. While the real irrational part has been taken by the next household. Next, we define the subtraction of the selling price and the advised price to be a pseudo-irrational part. We expect that the advised price from an agent company should be more close to the fundamental value of the house than the expected price and the selling price. Therefore, the pseudo-irrational part of the house should approximately equals the irrational part of the house price. There is another irrational part which is the subtraction of the advised price and the fundamental value of the house. This part tells the irrational expectation of the agent company, which is very hard to be distinguished.

Based on the above experiment, if we define the current house price as the selling price of the house, then the term CHP_IRR should be formally expressed as:

$$\text{CHP\_IRR} = \text{CHP\_PSUDO} + \text{CHP\_AGENT} \tag{2.3}$$

where,
CHP_PSUDO: The pseudo-irrational part of the house price,
CHP_AGENT: The irrational part of the house price from the agent company.
The super-irrational part is missing in Equation 2.3, because it is not a

part of the selling price. It tells the irrational expectation of the household, but does not take effect on the current housing trade. However, this part could affect the movement of house prices statistically.
The irrational part of the house price from the agent company is difficult to conduct, as the exact value of the fundamental part of the house price is yet unknown.
Remember that what we would like to have on the irrational part of the house price are indicators instead of exact values. So we can rewrite Equation 2.3 as:

$$\text{CHP\_IRR} = \beta_1 \text{CHP\_PSUDO} + \beta_2 \text{AP} + \beta_3 \text{CHP\_SUPER} + \alpha \qquad (2.4)$$

where,
AP is the advised price,
CHP_SUPER is the super-irrational part of the house price,
β_1, β_2 and β_3 are under-estimated coefficients of the dependent variables. α is the intercept of the model.

2.4 Model the House Price

We sum the fundamental part and the irrational part together to obtain the model for the current house price. Combining Equation 2.1, 2.2 and 2.4 we have the house price model writing as following equation:

$$\begin{aligned} \text{CHP} = {} & \text{CHP\_HFUN} + \text{CHP\_CROSS} + \text{CHP\_TFUN} \\ & + \beta_1 \text{CHP\_PSUDO} + \beta_2 \text{AP} + \beta_3 \text{CHP\_SUPER} + \alpha \end{aligned} \tag{2.5}$$

where

$$\text{CHP\_HFUN} = \sum_{i=1}^{\text{NH}} \alpha_{g1i} \text{vHF}_i \tag{2.6}$$

$$\text{CHP\_CROSS} = \sum_{i=1}^{\text{NC}} \alpha_{g2i} \text{vFP}_i \tag{2.7}$$

$$\text{CHP\_TFUN} = \sum_{i=1}^{\text{NT}} \alpha_{g3i} \text{vTF}_i \tag{2.8}$$

vHF, vFP and vTF are independent variables that determine CHP_HFUN, CHP_CROSS and CHP_TFUN, respectively. The numbers of them are NH, NC and NT, respectively. These variables will be discussed in the next chapter.

Chapter 3

Data

3.1 Econometrics: A Data-driven Method or A Model-driven Method

Econometrics has been applied widely in different disciplines, especially in social sciences where a general rule like Newton's law in Physics in not applicable. Econometrics supplies a statistical tool to extract ideas, infer hypotheses, summarize regulations from complicated data where variables in the data are fully-communicated, humbly-related and of implicitly-causality. By using a software like $STATA$ every people can run OLS (ordinary least-square) regressions and test hypotheses easily by typing in short commands.

Therefore, it is reasonable to believe that the data are the most important for econometric analysis. We may treat the Econometrics as a data-driven method. It is understandable to highlight the importance of data, because a comprehensive setting of data is the premise of a

meaningful investigation. In addition, the deficit of robust mathematical tools for analyzing more complex models than linear relationship prefers researchers a model the simplest (one could of cause have models with high order terms and/or logarithm terms, still, the basic theory is linear regression).

We think that data are over-emphasized whereas the importance of models is ignored in many researches. Oppositely, we believe that a proper model is more important than or at least as important as data. And data are only valuable when they are conducted properly by a model. For example, in order to obtain a $BLUE$ (Best Linear Unbiased Estimate), the data should fulfill Gauss-Markov assumptions. One of the assumptions is that all the data variables should be Gaussian distributed, which means, in order to make an OLS regression meaningful, all data variables should be tailored in a shape of "Gaussian distribution". If we speak of the Gaussian distribution as a model, we are saying that the playing of all data should be in a specific frame of the "Gaussian" model. In addition, we know that an estimate will have a risk of biasness if there are one or more variables omitted. One would obtain biased estimates as well when there is collinearity or incorrect causality in the model. The decision of including variables in the model and clarifying the collinearity and causality is not told by the data but by a carefully selected model. Therefore, we conclude that building a proper model is more critical than regressing data blindingly.

Instead of using a data-driven procedure, we start with a model and use the model to drive the usage of the data. In the next section, we are going to carefully investigate all possible impacts that could affect

the current house price of each family. We propose an ideal data survey which include all variables that are possible impacts.

3.2 Model-driven Data: An Ideal Survey

Based on the analysis of the previous chapter, we conclude that the current price of a house is determined by the four parts: the goodness of the house, the preference of the household to the house, the economical fundamental of the household family and the irrational part which is supported by the unrealistic expectation of the house price increasing in the future. In this section, we are going to convert these four parts into steerable variables that could be conducted by data.

3.2.1 Determinants of the Goodness of Houses

We define "the location of a house" ($zone\_house$) as the first explanatory variable. It is easy to imagine that a house located in the city center of Oslo is more expensive than a house with the same quality in some remote areas in Norway. This variable could also be treated as preference of the household to the house. However, since it is a common-sense of almost all households, we attribute the variable as the inner property of all houses. In addition, the zone of a house is a qualitative variable, which means, hard to be quantified by the values

of this variable. For example, if we give the value of the house zone in the city center of Oslo as 10 and 1 for another house locating at some remote area, it does not say that the value of the house in the Oslo center is 10 times larger than the other. Therefore, when we include this variable in the equation, it should be defined as dummies, or alternatively, the samples should be divided into different zone groups.

The age of a house (*age_house*) is another variable. New built houses are usually more popular than house with ages, as a result of modern design and advanced construction materials applied. Beside, there could be some special relations between the house and the age of the house. For instance in Trondheim, people are unwilling of buying houses built in the 1980s, Because they know that the quality of the house in this period is relatively bad. In addition, a linear relationship between the house price and the age of house is not necessarily correct. For example, it is hardly understandable that a house built in 2001 should be cheaper than a house built in 2002. Because the age difference of these two houses are so small that people usually have no sense of the difference on the price. Therefore, it is at least worth to try regressions by dividing the houses into different age groups as well. The age of the renovation of a house (*age_renov*) has similar characteristics as the variable *age_house*. Ideally, we should discrete the age of renovation into several different variables: the renovation age of bathrooms (*age_renov_bath*), the renovation age of kitchen (*age_renov_kit*), the renovation age of living room (*age_renov_liv*), the renovation age of bedrooms (*age_renov_bed*) and so on.

It is intuitive to relate the size of a house (*size_house*) to the price

of a house linearly, as well as for the size of the garden of a house (*size_garden*). We could also take the size of the house more precisely into the size and number of bathrooms, bedrooms, living rooms, kitchens and so on. However, when we use the more detailed sizes, we should not apply the size of a house simultaneously as a variable in order to avoid collinearity.

One variable of a house which is fairly important specifically for the Norwegian housing market is the amount of common debts (*amount_cdebt*) of a house. The reason is that the common debts usually have a much higher interest rates compared to the interest rates of house loans one borrows from the bank. Therefore, with the same price of houses, people pay more for the houses with heavier common debts.

Some of the side effects could be the existence of garages, balcony, basements, attics, fireplaces/air-conditions and so on.
Below is a table (Table 3.1) of all explanatory variables we should ideally have for regressing the fundamental of houses.

3.2.2 Determinants of Preferences of Households to Houses

Different families have different preferences of their houses. We consider the determinants that are reasonable in general-sense. Households with some special preferences from very few populations of house-

Table 3.1: The ideal explanatory variables for regressing the fundamental of houses

variable	type	label
zone_house	dummy/group	the location of house
age_house	linear/group	the age of house
age_renov_bath	linear/group	the age of renovation of bathrooms
age_renov_liv	linear/group	the age of renovation of living rooms
age_renov_bed	linear/group	the age of renovation of bedrooms
age_renov_kit	linear/group	the age of renovation of kitchens
age_renov_bath	linear/group	the age of renovation of bathrooms
qua_renov_bath	dummy	the quality of renovation of bathrooms
qua_renov_liv	dummy	the quality of renovation of living rooms
qua_renov_bed	dummy	the quality of renovation of bedrooms
qua_renov_kit	dummy	the quality of renovation of kitchens
num_bath	linear	the number of bathrooms
size_bath	linear	the size of bathrooms
num_liv	linear	the number of living rooms
size_liv	linear	the size of living rooms
num_bed	linear	the number of bedrooms
size_bed	linear	the size of bedrooms
num_kit	linear	the number of kitchens
size_kit	linear	the size of kitchens
num_garage	linear	the number of garages
size_garage	linear	the size of garages
num_bas	linear	the number of basements
size_bas	linear	the size of basements
num_attic	linear	the number of attics
size_attic	linear	the size of attics
amount_cdebt	linear	amount of common debt of the house
is_balcony	dummy	existence of balconies
is_fire	dummy	existence of fireplace or aircondition

holds are treated as outliers. For instance, most people prefer to have their house in a quiet environment. Whereas there could exist some families who would prefer to live in a noisy environment. Such families having a special preference are far different from statistics and are considered to be outliers.
Table 3.2 give a comprehensive list of variables as the determinants of the preference of the household to the house:

Table 3.2: The ideal explanatory variables for representing the preference of the household to the house

variable	type	label
good_school	dummy	have good school nearby for family with small kids
good_enter	dummy	have good entertainment places nearby for youngs
good_view	dummy	have good view (close to nature or sea) for olds
good_park	dummy	have good parking area for guest for youngs
good_care	dummy	close to healthy center for olds or unhealthy people
good_shop	dummy	close to shopping center for youngs and olds
good_traffic	dummy	convient public traffic system nearby for youngs

3.2.3 Determinants of the Economical Fundamental of the Households

A house price is affected by the situation of each household's economy in two ways. First, the pricing of houses in the entire housing market is determined the average affordability of the people living in the market. Second, the price of each individual house is determined by

the economical situation of the household. In a word, the average and the deviation of house prices are both determined by the economical fundamental of households, which highlight the importance of the economical fundamental.

The work type is an important factor for a family involving in the housing market. For example, the students are fairly difficult to buy an apartment in Norway. They have no jobs or only work temporarily. Banks credit them lowly and don't want to lend money to them. In other hand, Banks prefer to lend more money to the family who has stable jobs. We divide the work type into two groups: stable group and unstable group. So it is a dummy variable. We treat all self-employed jobs as unstable jobs, which could be arbitrary. However, we think that it make sense. Because if the self-employed personnel have good incomes, their economical situation should be able to distinguished by some other variables liking saving.

The salary from jobs are the main supports for most families. Besides, one could have income from renting out part of his/her house. These two types of incomes are different so that we treat them separately. The main difference we believe is that the latter part of income is more related to the house market.

loans are a groups of variables that affect the economical fundamental negatively. We use two variables to describe the loans: the house loan and other loans. The reason is the same as we split incomes into two variables.

The payments are described by following variables: payment for kids, payment for daily consumptions, payment for vacations and payment for paying debts. Together with some other variables, we list them in Table 3.3

Table 3.3: The ideal explanatory variables for representing the economical fundament of households

variable	type	label
work_typ	dummy	two groups: stable(1) and unstable(0)
inco_job	linear	incomes from jobs
inco_ren	linear	incomes from renting
inco_oth	linear	incomes from other sources
loan_hus	linear	house loan
loan_oth	linear	other loans
paym_kid	linear	payment for kids consumption
paym_deb	linear	payment for debts
paym_dai	linear	daily payments
paym_vac	linear	payments for vacations
valu_oth	linear	values of other properties
valu_sav	linear	savings
rate_hus	linear	interest rate of house loans
rate_oth	linear	interest rate of cars etc
year_edu	linear	years of education for job member
num_imm	linear	number of immigants in family

3.2.4 Determinants of irrational expectation of the future house price

As discussed in the previous chapter, we use three constructed variables, the CHP_PSUDO, the CHP_SUPER and the AP, by giving three prices of the houses: the expected price, the advised price and

the saling price. We believe three three prices determine the irrational part of the house prices, listing them in Table 3.4

We believe that we are able to draw the conclusion of whether there

Table 3.4: The ideal explanatory variables for representing the irrational part of the house price

variable	type	label
pris_exp	linear	expected price from household
pris_adv	linear	advised price from agent
pris_sal	linear	saling price

is housing bubble by giving a data survey with all variables described above. We thus such a data survey an ideal data survey. It would be great if we have an ideal survey for investigation. However, most time we have to face the reality of high expense of conducting data in Norway. Compromisingly, we have data conducted from SSB which are not designed for our purpose. By comparing the data with the ideal survey and after some data pre-processing, we hope that we can do a similar econometric analysis. The real data survey is described in next section.

3.3 An Applicable Data Survey: the Real World and Its Limits

The data we use is a 2012 survey conducted by the Statistics of Norway (SSB). The questions of the data are designed for investigating the living condition of the Norwegian residents. The survey was conducted mainly through telephone interviews. Whereas in some cases personal interviews are also performed. The criteria for family sample selection are based on evenly distribution of gender, age, education, family size and region. The survey covers information of both house members and house situation itself. The variables for house members consist of age, gender, number of kids, education, employment situation, income, debt and so on. The variable for house situation consist of house bought price, house bought year, house size, house loans, predicted current house price and so on. After eliminating identification information, the data are made available to researchers through the Norwegian Social Science Data Archives (NSD).

Since the data are mainly focused on the living condition of residents, questions are heavily distributed on the feeling and convenience of the residents. Limit information of their houses is described. There are no detailed information about the numbers, sizes and quality of bedrooms, living rooms, bathrooms, kitchens, balconies, basements and attics. However, they have carefully invested on some items like upwarming system in houses. What we can obtain from the data about the fundamental of houses are information about:

The preferences of the household to the house are comprehensively

Table 3.5: The real explanatory variables for regressing the fundamental of houses

variable	label
county	which country is the house belong to (in total 7 counties).
urban	is the house in the urban area (1) or the city area (0).
size_hus	the size of the house
new_renov	the house have been renoved in the recent 5 years.
amount_renov	the amout of money has spent on renovation.
warmup	the main up-warning system for the house.
drainage	the goodness of drainage system
cooling	the goodness of cooling system
decay	the existence of decay problem of the house.
moisture	the existence of moisture problem of the house.
light	the existence of light problem of the house.
noise	the existence of noise problem of the house.
air	the existence of air quality problem of the house.
violence	the existence of violence risk of the house.

covered by the data. In addition to the variables we list in the previous section, some more variables are supplied by the data which are,
The economic fundamental of households is also well described by the

Table 3.6: The real explanatory variables for regressing the interactions of the house and the household

variable	label
good_bank	convenient bank system nearby (for olds)
good_post	convenient post office nearby (for olds)
good_hus	general feeling of the house.
good_env	general feeling of the surrounding environment.

data, except some consumption terms are not collected, i.e., the yearly payment for vacation.

However, the variables from Equation 2.3 could be difficult to obtain. First, to ask all families in one or multiple regions to sell their houses at the same time is impossible and as well betray the regulation of market. Second, it is usually not easy to ask households to tell you their expected house prices due to privacy issue. Therefore, we called the experiment a thought experiment.

In a more realistic case, we should find some indicators for identifying the irrational part of the house price. First, two extreme groups of families should be much easier to be distinguished whether they are irrational or not. One group is the families having no debts but savings in banks. This group should be defined as a non-irrational group. The other extreme group is the families having no stable incomes but buying unnecessary consumptions. The latter group of families are

usually rejected by banks on housing loan. Therefore, this group is not affecting the current house price.

Second, the families who have both extreme high debt-to-income ratio and debt-to-value ratio should be treated as irrational. They have relatively heavier part of irrational value on their house prices.

We take the families without debts as the base group and create a series of dummies by sorting the debt-to-income ratio from low to high, writing it in Equation 3.1

$$\text{CHP\_IRR} = \beta_1 Dummy_1 + \beta_2 Dummy_2 + \beta_3 Dummy_3 + ... \qquad (3.1)$$

where,
$Dummy_1$: 1 if debt-to-income ratio >0 and <1 and 0 otherwise,
$Dummy_2$: 1 if debt-to-income ratio >1 and <2 and 0 otherwise,
$Dummy_3$: 1 if debt-to-income ratio >2 and <3 and 0 otherwise,
β_i are the coefficients of different dummies. The drawback of Equation 3.1 is that it is impossible to figure out which dummy parts represent the irrational part of the house price.

3.4 Data-driven Model: An Adjusted Model

A compromise of the ideal model and the real data gives us a more realistic model, written in Equation 3.2 :

$$\text{CHP} = \sum \alpha_{1i}\text{HF}_i + \sum \alpha_{2i}\text{FP}_i + \sum \alpha_{3i}\text{TF}_i + \sum \alpha_{4i}\text{IR}_i \tag{3.2}$$

where
HF_i is the ith variable of the house fundamental listed in Table 3.5,
FP_i is the ith variable of the family preference listed in Table 3.6,
TF_i is the ith variable of the family fundamental,
IR_i is the ith dummy which splitting families into different irrational groups.

3.5 Data background

In order to have a better understanding of the housing market in Norway, it is necessary to have a brief introduction of the historical background of the Norwegian housing market. We take the description of the historical background from Almaas et al. (2015):

A low credit default rate for the house mortgage has been applied for quite long time after the Nordic financial crisis in the early 1990s. Together with great successes in the petroleum production along the Norwegian continental shelf, the Norwegian house price index increased fast and steadily in the last 20 years.

Appreciated by the prosperity of the house market, many Norwegians invested and earned more money from their homes than they earned

from work. The increasing rate of houses is overheating. The total value of houses is also historically high. According to SSB, the total value of Norwegian houses is almost equal to the value of the pension fund in 2014 (Almaas et al., 2015).

We believe that it is the credit relaxation making high climbing of the house prices and debt-to-income ratio. The Norwegian credit market was strictly regulated in the 1970s. The housing market was inactive at that time. The government started to relax the credit in 1980s. The liberalization process boomed the housing market and led to a sharp increase in loan-to- income ratio. The collapse of stock market in 1987 was followed by increases of credit defaults. Many of the commercial banks had to close down or merge with larger banks due to the loss of loans . Not in coincidence, the housing price experienced a sharp drop after over a decade of increase. The Norwegian economy experienced a national crisis with the unemployment rate peaked at 6%. After the 1990 crisis, the housing price started to increase again. Although new rules were introduced to limit market risk, the housing market continued increasing and so did the demand for credit. In 1998, the government raised the risk weight from 50% to 100% for mortgages with loan to value (LTV) between 60% and 80% (Almaas et al., 2015). After 2001, the country entered another credit boom. The Norwegian housing prices are entering a fast increase period.

3.6 Data statistics

The data originally have 6186 samples, including both house-owners and renters. The renters are not of our interest. So 1055 renters are deleted, left with 5131 samples. We do not find any indication from the data that houses under-investigated are used for investing. Therefore, we assume that all house-owners need at least one house each for living. The extra properties owned by house-owners are not considered in the investigation. Then we find that some people predict their houses prices too expensively, so that either the prices are not realistic or these samples will be treated as outliers because they stay far away from the data distribution. We cut the predicted prices by more than 20 million or less than 0.1 million . Another 505 samples are dropped from the pool. Bought price of the house is an important variable in our regression. Omitting the bought price of the house will bias the estimate of other parameters. Therefore, we drop 150 more samples where the bought prices of the houses are not supplied. In addition, we delete 1138 samples which have negative loan-to-income ratio. We end up 3338 samples. The statistics of data variables are listed in Table 3.7. Some other variables are dummies or less important. Their statistics are not listed.

Table 3.7: Statistics of data

variable	label	average	standard deviation	min	max
HPPrice	predicted house price	3.28mNOK	1.95mNOK	0.1mNOK	20mNOK
own_year	house own year	15	10	3	60
HSize	house size	160m2	103m2	11m2	999m2
HBPrice	bougt house price	1.67mNOK	2.24mNOK	0mNOK	100mNOK
HRenov	house renovation	35kNOK	75kNOK	0kNOK	40kNOK
TTI	total family income	891kNOK	386kNOK	-460kNOK	1780kNOK
TFC	financial capital	0.56mNOK	1.67mNOK	0	54.6mNOK
LTI	loan-to-income-ratio	8.02	50.13	-25.5	1667
AGE	main member age	43	15	12	90
num_property	number of properties	1.14	0.44	1	4

Chapter 4

Data Analysis

In most empirical analysis, an econometric model is interpreted as relating the dependent variable by some specific independent variables of interest in order to infer the statistical significances of these variables. Our purpose is a little different. Instead of looking for the relationship between expected house price and its determinant factors, we intent to compare the distribution of different determinant factors to the house price. Such purpose requires us being cautious on almost all independent variables. Therefore, we play many round of regression in order to ideally make the coefficients of all related variables unbiased.

4.1 The Skewness

Initially, we plan to interpret our model (the expected house price) as four portions of determinants, the fundamentals of houses, the fundamentals of households, the interaction between houses and households and the irrational part of households. This is a rather easy and intu-

itive way. However, the reality of the data forces us to do some changes on our model, and further, changing our way of interpretation.

One important issue is the skewness of the data. Table 4.1 illustrates the importance. In Table 4.1, we regress the expected house price by single variable loan-to-income ratio (LTI) at the first column. We expect to see a positive correlation. Because if we assume there exist irrational moments on the Norwegian housing markets, the loan should contribute positively to the house price. However, we obtain a negative correlation from regression with a fairly low T-value.

After investigation, we find that this is due to the skewness of the data, both for the expected house price and the loan-to-income ratio. The second column shows the regression result by taking the log transform of both the expected house price and the loan-to-income ratio. Now we obtain a positive correlation with a much higher confidence from the T-value. Here, we have thrown the part of samples having negative loan-to-income ratio (it is not applicable to take the logarithm of a negative value). We think it is plausible because we can not blame any irrational momentum from the households without any loans. In addition, the regressions in column 3 and column 4 tell that the log transform does not affect the model inference if the correlation is already clearly seen from the original model, but rather gives an even higher T-value due to the improvement of skewness of the data.

The improvement of the skewness by taking a log transform can be seen from Figure 4.1. At the left panel of Figure 4.1 we see that the original predicted price is right-lagged, whereas after taking the log

transform, the skewness problem becomes much better (seen from the right panel of Figure 4.1). We see similar improvement of the skewness by applying the log transform to some other variables. Thereafter, the log forms are taken for the variables when we see their skewness is improved by taking log transform.

Table 4.1: Simplified house price model for illustrating the importance of applying log transform for some data variables. Column 1: single-variable model where the dependent and independent variables are predicted price and loan-to-income ratio (LTI), respectively; Column 2: single-variable model where the dependent and independent variables are the logarithm of predicted price and the logarithm of LTI, respectively; Column 3: single-variable model where the dependent and independent variables are predicted price and the house size, respectively; Column 4: single-variable model where the dependent and independent variables are the logarithm of predicted price and the logarithm of the house size.

	(1) pred_price	(2) log_HPPrice	(3) pred_price	(4) log_HPPrice
LTI	-828.740			
	(-1.24)			
log_LTI		0.047***		
		(6.13)		
size_hus			5002.167***	
			(19.23)	
log_HSize				0.477***
				(28.62)
N	4443	3312	4443	4440
R^2	0.000	0.011	0.077	0.156
adj. R^2	0.000	0.011	0.077	0.156
pseudo R^2				

Marginal effects; t statistics in parentheses
* p<.1, ** p<0.05, *** p<0.01

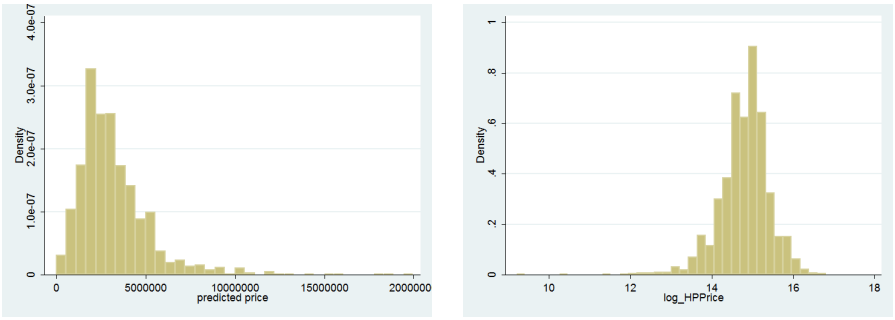

Figure 4.1: Improvement of skewness after log transform. Left: histogram of the predicted price; Right: Histogram of the logarithm of the predicted price.

4.2 House Price with Different Concerns

The first group of variables is the fundamentals of houses. The variables describing the fundamentals of houses can be divided into two groups. The first group gives quantitative information of the house, i.e., the size of the house, the amount of money invested on the renovation of the house, the bought price of the house, how many years the household owning the house. The other group gives dummy information of the house, i.e., whether the house is in the urban (a variable called urban), whether the house has a parking slot, whether the house attaches a good kid playground. It is intuitive and also seen from initial regression tests that the first group of variables have more effect on the predicted house price. One exception is the dummy variable urban. It is plausible that a house located in the urban area is much expensive than a house with the same quality out of the urban area.

Therefore, we expect the variable urban to be an important factor of the predicted house price. We include it in the first group. The regressions of the predicted house price on the first group is shown in Table 4.2.

First, one can see that the adjust goodness of fit (adj. R^2) is becoming larger and larger from Column 1 to Column 4, by adding more and more relative variables in the equation. Secondly, all 4 regression tests infer statistical significance of the considered variables. Their coefficients are slightly decreased after more variables being involved. Their high T-values give us no chances to reject the significance of any variables in this group. In the end, by seeing the coefficients of different variables, we conclude that the size of the house, the bought price of the house and existing of the house in the urban area give the most contribution of the predicted house price. In the regression shown in Column 4, One percentage increase of house size will increase 0.294 percentage of the house price. When the bought price of the house increases by 1%, the house price increases by 0.297%. When the house is located in the urban area, the house price will be 11.3% more expensive than the house located other area with the same quality. The renovation of the house and the own year of the house are also positively affecting the house price, but their effects are relatively smaller compared to the former three variables.

The second group of fundamentals of the houses are dummy variables that are most concerned by tenures in common sense (Table 4.3).
It consist of the existing of playground for kids, existing of parking position for guests, existing of house problems on warming up, drainage,

Table 4.2: The house price model concerning on the fundamentals of the house. In Column 1, the model is not controlled by any other variables. In Column 2, the model is controlled by some dummy variables describing the general quality of the house (House_Fund2). In Column 3, the model is controlled by both the general quality of the house (House_Fund2) and the fundamentals of the household (Household_Fund). In Column 4, the model is controlled by the general quality of the house (House_Fund2), the fundamentals of the household (Household_Fund), the interactions between the house and the household (HHInter) and the irrational indicator of the household (log_LTI)

	(1) log_HPPrice	(2) log_HPPrice	(3) log_HPPrice	(4) log_HPPrice
log_HSize	0.388***	0.390***	0.340***	0.294***
	(18.59)	(17.69)	(14.43)	(11.74)
log_HRenov	0.028***	0.027***	0.024***	0.019***
	(4.57)	(4.43)	(3.90)	(2.99)
log_HBPrice	0.313***	0.306***	0.277***	0.297***
	(22.57)	(21.76)	(19.53)	(17.85)
own_year	0.018***	0.018***	0.015***	0.020***
	(16.16)	(15.23)	(12.85)	(14.39)
urban	0.199***	0.192***	0.178***	0.113***
	(8.17)	(7.78)	(7.30)	(3.94)
House_Fund2	N	Y	Y	Y
Household_Fund	N	N	Y	Y
HHInter	N	N	N	Y
log_LTI	N	N	N	Y
N	2166	2142	2139	1686
R^2	0.514	0.518	0.538	0.573
adj. R^2	0.511	0.513	0.532	0.563
pseudo R^2				

Marginal effects; t statistics in parentheses
* p<.1, ** p<0.05, *** p<0.01

cooling, decay, moisture, light, noise and air. Seen from goodness-of-fit (adjusted R^2) of the first column, the correlation between the

Table 4.3: The house price model concerning on the fundamental dummies of the house. In Column 1, the model is not controlled by any other variables. In Column 2, the model is controlled by some other house fundamentals (House_Fund1). In Column 3, the model is controlled by both the fundamentals of the house and household (House_Fund1, Household_Fund). In Column 4, the model is controlled by some other house fundamentals of the house (House_Fund1), the fundamentals of the household (Household_Fund), the interactions between the house and the household (HHInter) and the irrational indicator of the household (log_LTI)

	(1) log_HPPrice	(2) log_HPPrice	(3) log_HPPrice	(4) log_HPPrice
kid_playground	0.017	-0.015	-0.022	-0.015
	(0.81)	(-0.70)	(-1.04)	(-0.65)
parking_position	0.283***	-0.010	-0.018	0.008
	(8.17)	(-0.24)	(-0.43)	(0.19)
warmup	0.158***	0.025	0.011	-0.001
	(8.62)	(1.27)	(0.57)	(-0.06)
drainage	0.136***	0.053	0.045	0.017
	(3.09)	(1.13)	(0.98)	(0.35)
cooling	0.018	-0.038	-0.042	-0.054**
	(0.71)	(-1.44)	(-1.64)	(-2.02)
decay	-0.093*	-0.078	-0.052	-0.061
	(-1.88)	(-1.61)	(-1.09)	(-1.28)
moisture	-0.001	-0.012	-0.002	0.031
	(-0.02)	(-0.28)	(-0.05)	(0.73)
light	-0.193***	-0.161***	-0.131**	-0.162***
	(-3.94)	(-3.14)	(-2.57)	(-3.01)
noise	-0.094***	-0.022	-0.017	-0.032
	(-3.07)	(-0.69)	(-0.54)	(-0.96)
air	-0.003	0.034	0.048	0.039
	(-0.10)	(1.11)	(1.61)	(1.24)
House_Fund1	N	Y	Y	Y
Household_Fund	N	N	Y	Y
HHInter	N	N	N	Y
log_LTI	N	N	N	Y
N	4393	2142	2139	1686
R^2	0.169	0.518	0.538	0.573
adj. R^2	0.166	0.513	0.532	0.563
pseudo R^2				

Marginal effects; t statistics in parentheses
* p<.1, ** p<0.05, *** p<0.01

predicted house price and the group of dummies are not very high. And the goodness-of-fit gets apparently improved by adding more related variables in the first group of house fundamentals. High T-values in the first column for the existing of parking position, warm-up problem, drainage problem and noise problem could be due to important variable omitting. Their statistical significance vanishes after including more relative variables. The insignificance of these variables are understandable, because most Norwegian are industrial and good at house-work. Their houses are normally very well maintained so that these basic problems like warm-up, drainage, moisture, decay will be fixed by households if they have been discovered. One variable standouts from the regression is the existing of light problem. The high-T values for all four columns of regression on this variable shows clear relation between predicted house price and the light problem. This observation is very interesting and easily interpretable. Norway is a North-European country. The light is extremely precious for Norwegian habitants. Therefore, we see that a house having poor light condition is about 16% cheaper than with good light condition. A surprising find is that it seems that households in Norway are statistically more concerned on the cooling than the warming up of the house.

Even though Norway is a country of having relatively small economical discrepancy between families, where High incomes families are heavily taxed and low income families are governmentally supported, unevenness of family economy is still very common. As a consequence, the families with better economy are expected to live in houses with larger size, better location and/or better quality. Additionally, the households having better economical situation should have better expecta-

tion of the future house price so that they will predict their house price more optimistically. Therefore, we should naturally see links between house price and the economical fundamentals of the household.

Table 4.4 displays the regression of house price on the fundamentals of the household.
Before we interpret the data, we would like to make a clear definition of variable job_stability. It is the total working hours of the major workers in a family. By doing this, the self-employed workers are excluded from the analysis, because we observed that those samples have unrealistic working hours every week. From 3 columns of regression, we see that 3 most significant variables affecting the predicted house price are the total income of the family, the existing of vacation house and the total financial capital. The total income of the family is a most important index for the economical situation both in the past and future. So we see from the Column 3 that 1 percentage change of total income change will induce 0.186 percentage change of the predicted house price. This is about 2.5 times higher than the effect of owning vacation house and about 7.5 times higher than the effect of total financial capital. We see a decrease of effects from Column 1 to Column 3. We believe the regression in Column 3 best describing the model because all considered variables are included. This can also be seen from the increase of adjusted goodness-of-fit from from the left to the right. Based on this, we conclude that the decrease of coefficients is due to variable omitting in Column 1 and Column 2. It is interesting to see that the net debt of the family (mkr_TND) is initially significant to the predicted house price and disappear it significance in Column 3. A carefully investigation shows that there is a collinearity between loan-to-income ratio

Table 4.4: The house price model concerning on the fundamentals of the household. In Column 1, the model is not controlled by any other variables. In Column 2, the model is controlled by house fundamentals (House_Fund). In Column 3, the model is controlled by house fundamentals of the house (House_Fund), the interactions between the house and the household (HHInter) and the irrational indicator of the household (log_LTI)

	(1) log_HPPrice	(2) log_HPPrice	(3) log_HPPrice
log_TFC	0.052***	0.025***	0.026***
	(8.43)	(3.53)	(3.28)
log_TTI	0.299***	0.119***	0.186***
	(14.57)	(4.70)	(6.26)
mkr_TND	0.017***	0.008**	0.011
	(4.62)	(2.02)	(1.58)
num_property	0.059***	0.022	0.010
	(3.34)	(1.15)	(0.49)
have_vacation_house	0.106***	0.077***	0.076***
	(6.54)	(4.28)	(4.01)
job_stability	0.001	-0.005	-0.007
	(0.11)	(-0.38)	(-0.55)
sick	-0.022	-0.004	0.056*
	(-0.92)	(-0.16)	(1.89)
num_member	0.029***	-0.011	-0.012
	(3.85)	(-1.22)	(-1.34)
years_adult_edu	0.007	0.002	-0.000
	(1.57)	(0.37)	(-0.02)
House_Fund	N	Y	Y
Household_Fund	N	Y	Y
HHInter	N	N	Y
log_LTI	N	N	Y
N	4431	2139	1686
R^2	0.302	0.538	0.573
adj. R^2	0.300	0.532	0.563
pseudo R^2			

Marginal effects; t statistics in parentheses
* p<.1, ** p<0.05, *** p<0.01

and the net debt: $log\_LTI = log\_TND - log\_TTI$. Therefore, in order to avoid collinearity problem, the net loan should be excluded from the regression when the loan-to-income ratio is included. In fact, the net loan is excluded in the regression of other tables. The regression of Table 4.4 is only for illustrating the effect of collinearity. We see also that the number of member becomes insignificant in Column 2 and Column 3. This could also be due to the collinearity between house size and the number of members.

Table 4.5 shows the effects of the interactions between the house and the household on the predicted house price.

Generally speaking, the significance of this group of variables are less significant than the variables in the upper three fundamental groups. It is plausible because the variables in this group are all subjective variables. Compared to those objective variables like house size, the subjective variables are more random and noisy. We see that the most significant variables are good_env, good_traffic and good_care. A house having a good environment is 18.6 percentage more expensive based on the regression of all samples. A house having good traffic is 8.1 percentage more expensive based on the regression of all samples. A house having good care system nearby is 7.8 percentage more expensive based on the regression of all samples. In order to check the difference of preference in different groups, we arrange two specific groups of samples for regression. The first group (see Column 4) consists of samples in which the ages of the house adults are above 58 years old. The second group (see Column 5) consists of samples in which the ages of the house adults are below 25. Our first expectation is that the coeffi-

Table 4.5: The house price model concerning on the interactions between the house and the household. In Column 1, the model is not controlled by any other variables. In Column 2, the model is controlled by both house fundamentals (House_Fund) and household fundamentals (Household_Fund) and the irrational indicator of the household (log_LTI). In Column 3, the control variables are the same as in Column 2 but the data are conditioned by the ages of the house adults above 58. In Column 4, the control variables are the same as in Column 2 but the data are conditioned by the ages of the house adults below 25.

	(1) log_HPPrice	(2) log_HPPrice	(3) log_HPPrice	(4) log_HPPrice
good_hus	0.233***	0.143*	0.174	0.010
	(3.21)	(1.76)	(1.21)	(0.07)
good_env	0.277***	0.186**	0.291*	0.123
	(3.61)	(2.34)	(1.92)	(1.05)
good_shop	0.082**	0.006	-0.058	-0.020
	(2.13)	(0.15)	(-0.76)	(-0.21)
good_bank	0.063	-0.045	-0.003	-0.084
	(1.60)	(-1.01)	(-0.04)	(-0.82)
good_post	-0.058	-0.033	-0.075	0.043
	(-1.48)	(-0.79)	(-1.13)	(0.44)
good_traffic	0.137***	0.081***	0.109**	0.098*
	(6.59)	(3.37)	(2.52)	(1.95)
good_care	0.118***	0.078**	0.019	0.028
	(3.84)	(2.36)	(0.30)	(0.39)
good_space	0.000	0.000	0.000	0.000
	(.)	(.)	(.)	(.)
House_Fund	N	Y	Y	Y
Household_Fund	N	Y	Y	Y
log_LTI	N	Y	Y	Y
N	4396	1686	566	341
R^2	0.152	0.573	0.577	0.625
adj. R^2	0.150	0.563	0.546	0.578
pseudo R^2				

Marginal effects; t statistics in parentheses
* p<.1, ** p<0.05, *** p<0.01

cient of good_care should be higher in the 58 years group than the 25 years group. And the significance of good_care should also be higher in the 58 years group. Because we expect that the old people would like to ease the hospital. However, we dont́ see this from the regression results. This is interesting, as we do see that the good_care affect the predict house price. So there must another group of people who are more concerned about this. Our initial guess is then the families having small kids. However, it is still insignificant when we regress in the group of families having kids less than 3 years old. After testing many groups, we find that the good_care is only significant when there is no small kids and no olds in a family. This is not easy to be understood.

Table 4.6 illustrates the effect of irrational indicator of the household (loan-to-income ratio) on the predicted house price.
All 3 columns shows clear significance of the loan-to-income ratio effect. The difference between Column 2 and Column 3 tells the biasness caused by the collinearity between loan-to-income ratio and the net loan. By giving 1% change of the loan-to-income ratio, we see that the predicted house price is increased by 0.047%, which is 0.004% larger than the model the net loan is included. In addition, we see the goodness-of-fit is initially small (0.140) when only the loan-to-income ratio is regressed (Column 1), and is greatly improved by having both fundamentals of house and household in the model, which indicates that the predicted house price relies more on the fundamentals than the irrational momentums.

Table 4.6: The house price model concerning on the irrational indicator of the household (log_LTI). In Column 1, the model is not controlled by any other variables. In Column 2, the model is controlled by both house fundamentals (House_Fund) and household fundamentals (Household_Fund) and the interactions between the house and the household (HHInter). In Column 3, the control variables are the same as in Column 2 but the variable net_debt (mkr_TND) is deselected in the model.

	(1) log_HPPrice	(2) log_HPPrice	(3) log_HPPrice
log_LTI	0.037***	0.043***	0.047***
	(5.05)	(4.87)	(5.37)
House_Fund	N	Y	Y
Household_Fund	N	Y	Y
HHInter	N	Y	Y
N	3312	1686	1686
R^2	0.142	0.573	0.572
adj. R^2	0.140	0.563	0.563
pseudo R^2			

Marginal effects; t statistics in parentheses
* p<.1, ** p<0.05, *** p<0.01

4.3 House Price Model within Different Groups

In the previous section we have generally discussed the effects on the predicted house price for all available samples. It would be interesting to specifically investigate the effects in different groups. For examples, there might be housing bubble in some specific cities like Stavanger, where the housing price is highly determined by the oil price. In 2015, we evident the decreasing of house price due to the sharp downturn

of oil price. However, in some other cities, like Trondheim, the house price may be affected by the long-term change of oil price. Because Trondheim is a high-technology, high-education dominated city and therefore people are linked to oil price not as directly as the people living in Stavanger. To investigate the group differences is the task of this section.

Table 4.7 has 4 columns regression.
In the first two columns, the samples are grouped based on the location of the house, mainly whether the house is located in the urban area or not. In the next two columns, the samples are separated by the number of properties owned by the households. The households having more than one properties are selected in Column 3 and the left are selected in Column 4. Though we see differences of both significance and estimated value of coefficients in different groups, the results are fairly consistent. The consistency in some sense give us confidence on the model. The largest differences for the urban and non-urban groups on significance are variables renovation and total financial capital. They could be due to the large difference of the number of samples in these two groups. The largest differences for the urban and non-urban groups on estimated values are loan-to-income ratio and house size. The predicted house price is almost tripled when the same percentage of loan-to-income ratio change existed in the non-urban group than in the urban group.

We then divide the samples into 5 age groups based on the average age of the house adults. From Table 4.8 we see that house size has the largest effect to the age group of 50-60 years old. 1% change of house

Table 4.7: The house price model within different groups: Column 1: the house group in the urban area; Column 2: the house group out of the urban area; Column 3: the house group in which households having more than 1 properties; Column 4: the house group in which households having only 1 property. All columns are regressed by controlling other variables (All_Others).

	(1) log_HPPrice	(2) log_HPPrice	(3) log_HPPrice	(4) log_HPPrice
urban	0.000	0.000	0.318***	0.073**
	(.)	(.)	(3.07)	(2.47)
num_property	0.019	-0.002	0.015	0.000
	(0.90)	(-0.04)	(0.23)	(.)
log_HSize	0.284***	0.346***	0.194**	0.301***
	(11.28)	(3.74)	(2.09)	(11.75)
log_HRenov	0.019***	0.021	0.044*	0.020***
	(3.01)	(0.95)	(1.68)	(3.07)
log_HBPrice	0.300***	0.275***	0.314***	0.301***
	(17.35)	(5.29)	(5.15)	(17.48)
own_year	0.020***	0.019***	0.022***	0.020***
	(13.70)	(4.54)	(4.26)	(14.06)
log_TFC	0.029***	-0.018	0.011	0.021***
	(4.12)	(-0.81)	(0.40)	(3.01)
log_TTI	0.188***	0.216**	0.184*	0.196***
	(6.44)	(2.15)	(1.72)	(6.58)
log_LTI	0.037***	0.101***	0.046	0.048***
	(4.19)	(3.38)	(1.30)	(5.51)
All_Others	Y	Y	Y	Y
N	1403	283	198	1488
R^2	0.584	0.457	0.606	0.591
adj. R^2	0.573	0.378	0.515	0.581
pseudo R^2				

Marginal effects; t statistics in parentheses
(d) for discrete change of dummy variable from 0 to 1
* p<.1, ** p<0.05, *** p<0.01

size induces the predicted house price to be changed by 0.388%. The renovation of the house is affecting the most for the youngest group. However, the effect of renovation is relatively much smaller compared to the house size. The bought price is most related to the predicted house price for the youngest group, which is fairly easy to be understood. Because the youngest group own their houses the shortest. The bought price is thus the closest to the predicted house price. The most important, we see that the coefficient of the loan-to-income ratio is the highest for the youngest group, which could explain that the youngest group have the highest irrational momentums in the Norwegian housing market.

It is also interesting to investigate the discrepancy of housing market in different region of Norway. In the data, samples are selected from 7 different counties. Therefore we naturally separate the samples into 7 groups. Each group contains samples in one county. Table 4.9 lists the first 4 groups and Table 4.10 lists the next 3 groups, being County Akerhus and Oslo, Hedmark and Oppland, Out of the country, Agder and Rogaland, Vestland, Trondelag and Nord-Norge sequentially. We are not so sure about the regression because number of samples in some groups are small (114 for Group 2, 152 for Group 7). One important observation is that the predicted house prices in all these 7 groups depend mainly on several critical variables like the house size, the bought price, the family total income and the loan-to-income ratio. To pay more attention on the irrational indicator, the loan-to-income ratio contributes not too much on the predicted house price. the largest value of the coefficient of loan-to-income ratio is 0.083 for the Nord-Norge group, which could be interpreted as 1% change

Table 4.8: The house price model within different age groups: Column 1: the group in which the average age of house adults is less than 30 years old; Column 2: the group in which the average age of the house adults is between 30 and 40 years old; Column 3: the group in which the average age of the house adults is between 40 and 50; Column 4: the group in which the average age of the house adults is between 50 and 60; Column 5: the group in which the average age of the house adults is above 60 year old. All columns are regressed by controlling other variables (All_Others).

	(1)	(2)	(3)	(4)	(5)
	log_HPPrice	log_HPPrice	log_HPPrice	log_HPPrice	log_HPPrice
log_HSize	0.100	0.244***	0.118	0.388***	0.286***
	(1.55)	(5.14)	(1.62)	(4.90)	(6.15)
log_HRenov	0.049**	0.026**	0.028	0.018	-0.004
	(2.52)	(2.34)	(1.53)	(1.01)	(-0.30)
log_HBPrice	0.638***	0.507***	0.365***	0.136***	0.292***
	(11.78)	(14.51)	(8.05)	(2.90)	(10.05)
own_year	0.050***	0.035***	0.018***	0.003	0.020***
	(6.79)	(10.54)	(3.77)	(0.84)	(8.59)
urban	0.001	0.143***	0.066	0.168**	0.175***
	(0.01)	(2.83)	(0.86)	(2.09)	(3.00)
log_TFC	0.027	0.020	0.019	0.037*	0.046***
	(1.38)	(1.60)	(1.01)	(1.90)	(3.37)
log_TTI	0.275***	0.135**	0.377***	0.197*	0.220***
	(2.64)	(2.08)	(3.92)	(1.96)	(4.39)
log_LTI	0.134***	0.093***	0.042**	0.064***	0.052***
	(3.03)	(4.66)	(1.99)	(2.81)	(3.23)
All_Others	Y	Y	Y	Y	Y
N	194	434	359	257	442
R^2	0.708	0.635	0.412	0.504	0.569
adj. R^2	0.652	0.607	0.357	0.435	0.537
pseudo R^2					

Marginal effects; t statistics in parentheses
(d) for discrete change of dummy variable from 0 to 1
* p<.1, ** p<0.05, *** p<0.01

of loan-to-income ratio causes 0.083% change of predicted house price.

Table 4.9: The house price model within different county group: Column 1: the group of houses located in Akerhus and Oslo; Column 2: the group of houses located in Hedmark and Oppland; Column 3: the group of houses located in out of the country. Column 4: the group of houses located in Agder and Rogaland. All columns are regressed by controlling other variables (All_Others).

	(1) log_HPPrice	(2) log_HPPrice	(3) log_HPPrice	(4) log_HPPrice
log_HSize	0.346***	0.328***	0.307***	0.301***
	(8.44)	(3.14)	(5.25)	(3.95)
log_HRenov	0.010	0.044	0.030**	0.024
	(0.93)	(1.66)	(2.19)	(1.19)
log_HBPrice	0.270***	0.231***	0.262***	0.368***
	(9.76)	(3.75)	(6.76)	(6.83)
own_year	0.024***	0.011**	0.018***	0.024***
	(9.02)	(2.42)	(6.08)	(5.34)
urban	-0.041	-0.201**	0.126*	0.035
	(-0.52)	(-2.16)	(1.73)	(0.43)
log_TFC	0.045***	0.054*	0.016	0.014
	(3.60)	(1.77)	(1.12)	(0.63)
log_TTI	0.256***	0.119	0.237***	0.128
	(5.49)	(1.11)	(3.43)	(1.49)
log_LTI	0.061***	0.077**	0.060***	0.009
	(4.09)	(2.53)	(3.04)	(0.32)
All_Others	Y	Y	Y	Y
N	436	114	327	220
R^2	0.673	0.722	0.484	0.587
adj. R^2	0.648	0.617	0.430	0.519
pseudo R^2				

Marginal effects; t statistics in parentheses
(d) for discrete change of dummy variable from 0 to 1
* p<.1, ** p<0.05, *** p<0.01

To blame all the households having positive loan-to-income ratio to be

Table 4.10: The house price model within different county group (continue): Column 1: the group of houses located in Vestland ; Column 2: the group of houses located in Trondelag; Column 3: the group of houses located Nord-Norge. All columns are regressed by controlling other variables (All_Others).

	(1) log_HPPrice	(2) log_HPPrice	(3) log_HPPrice
log_HSize	0.218***	0.118	0.282***
	(2.85)	(1.25)	(3.19)
log_HRenov	0.005	0.010	0.024
	(0.25)	(0.47)	(1.04)
log_HBPrice	0.262***	0.512***	0.342***
	(5.26)	(7.85)	(5.81)
own_year	0.015***	0.030***	0.019***
	(3.82)	(6.11)	(4.22)
urban	0.155**	0.038	0.184**
	(2.17)	(0.40)	(2.12)
log_TFC	-0.038*	0.038*	0.049**
	(-1.86)	(1.71)	(2.08)
log_TTI	0.256***	0.024	0.121
	(2.87)	(0.23)	(0.97)
log_LTI	-0.000	0.007	0.083**
	(-0.01)	(0.29)	(2.29)
All_Others	Y	Y	Y
N	274	163	152
R^2	0.380	0.655	0.640
adj. R^2	0.300	0.573	0.547
pseudo R^2			

Marginal effects; t statistics in parentheses
(d) for discrete change of dummy variable from 0 to 1
* p<.1, ** p<0.05, *** p<0.01

irrational is of cause unrealistic. In Norway, most families buy houses by borrowing money from banks and paying back the loans through their whole life. Therefore in our model, only the households having

high loan-to-income ratio should be treated as irrational households. Table 4.11 divides samples into 4 different groups based on the value of loan-to-income ratio. From Group 1 to Group 3, we see that the coefficient of loan-to-income ratio increases significantly from 0.043 to 0.417. It tells that the predicted house prices are affected by the loan-to-income much more for the high loan-to-income group than for the low loan-to-income group. However, it is not statistical significance for the group with loan-to-income ratio higher than 3. The reason is ambiguous. In the end, instead of interpreting how much percentage of predicted house price change due to unit percentage change of independent variables, we try to normalize the change of predicted house price to be unity and to see that such a unit change is contributed by how much percentage of important independent variables. Table 4.12 shows the results. 4.69% contribution of the LTI to the housing price for all samples in Column 4 infers a minor housing bubble in the Norwegian housing market.

Table 4.11: The house price model with in different loan-to-income ratio (LTI) group: Column 1: the house group in which the LTI is between 0 and 1; Column 2: the house group in which the LTI is between 1 and 2; Column 3: the house group in which the LTI is between 2 and 3; Column 4: the house group in which the LTI is larger than 3. All columns are regressed by controlling other variables (All_Others).

	(1) log_HPPrice	(2) log_HPPrice	(3) log_HPPrice	(4) log_HPPrice
log_HSize	0.342***	0.368***	0.218***	0.006
	(7.60)	(7.91)	(4.80)	(0.07)
log_HRenov	0.002	0.011	0.028***	0.052**
	(0.15)	(1.14)	(2.66)	(2.21)
log_HBPrice	0.268***	0.224***	0.279***	0.490***
	(9.24)	(8.12)	(8.07)	(7.60)
own_year	0.019***	0.018***	0.024***	0.037***
	(8.77)	(7.74)	(7.74)	(5.63)
urban	0.130**	0.157***	0.052	-0.109
	(2.53)	(3.50)	(0.97)	(-0.96)
log_TFC	0.025*	0.024**	0.020*	0.022
	(1.81)	(1.98)	(1.95)	(1.05)
log_TTI	0.179***	0.297***	0.363***	0.130*
	(2.83)	(5.74)	(5.82)	(1.76)
log_LTI	0.043**	0.253***	0.417***	-0.042
	(2.36)	(3.24)	(2.80)	(-1.53)
All_Others	Y	Y	Y	Y
N	539	604	327	216
R^2	0.596	0.611	0.719	0.609
adj. R^2	0.566	0.585	0.684	0.528
pseudo R^2				

Marginal effects; t statistics in parentheses
(d) for discrete change of dummy variable from 0 to 1
* p<.1, ** p<0.05, *** p<0.01

Table 4.12: One unit change of house price is contributed by how much percentage changes of different variables in different LTI group: Column 1: the house group in which the LTI is between 0 and 1; Column 2: the house group in which the LTI is between 1 and 2; Column 3: the house group in which the LTI is between 2 and 3; Column 4: all samples.

	(1) 100%_HPPrice	(2) 100%_HPPrice	(3) 100%_HPPrice	(4) 100%_HPPrice
log_HSize	33.93%	25.34%	15.56%	29.34%
log_HRenov	0.20%	0.76%	2.00%	1.90%
log_HBPrice	26.59%	15.43%	19.91%	29.64%
own_year	1.88%	8.13%	1.71%	2.00%
urban	12.90%	10.81%	3.71%	11.28%
log_TFC	2.48%	1.65%	1.43%	2.59%
log_TTI	17.76%	20.45%	25.91%	18.56%
log_LTI	4.27%	17.42%	29.76%	4.69%

Chapter 5

Discussion

We have performed several regressions of the house prices in Norway based on the empirical data gathered in 2012. Those regressions are logically understandable and interpretable for most variables. The major find from the regression is that there is little housing bubble in the Norwegian housing market.

However, our conclusion could bias from the real house market due to following issues that are not easily captured by our model.

The first one is the use of loan-to-income ratio as the indicator of the irrational part of house prices. It is reasonable to consider that the households with high loan-to-income ratio have higher irrational moment than the households with low loan-to-income ratio. The former accepts to take higher risk. However, there is no hint of determining a proper loan-to-income ratio so that if the loan-to-income ratio is higher than the proper ratio, the household becomes irrational. Therefore, we really have no idea to identify the irrational part of housing price. We can only conclude a non-housing-bubble when all groups of loan-to-income ratios are not affecting the house prices. Actually, this is not the case in our data. We observed high sensitivity of loan-to-income

ratios to the house prices in the group where the loan-to-income ratios are located between 2 and 3. The observation from this group could possibly indicate a housing bubble in this group. Then the next question is whether the housing bubble in one specific group means a housing bubble in the whole housing market. I believe it is nature that people have different risk-preference. It should also be acceptable to have a small group of people inflating bubble of their houses, while on the other hand, there are another group of people who could contribute more on the housing market. It is then hard to say whether a bubble created by a group of people can be absorbed by the entire housing market.

In addition, we have stated that the houses used for investing are not included in our model. We could of cause define similar variables, i.e., house fundamentals, household fundamentals and loan-to-income ratio. The problem is that the predicted prices from the households of this part of houses do not rely on the fundamentals any more. The main ambition of the household for holding those houses is just waiting for price increasing in the future. In fact, we should expect this part of houses as full bubbles in the housing market. However, we are not able to capture it and to sum the bubbles up to the houses used for living. Some oral interviews done by the author to the Norwegians indicate that there exist a few amounts of houses for investing. A large amount of investing houses could shake our conclusion of non-housing bubble in the Norwegian housing market. Further research and proper model should be done for this.

In the end, we say that households can make free decision of buying or selling houses. This is an important reason of defining family fundamental in our model. However, one should remember that this

is given by the assumption that households have been given jobs by the market. If the macro-economy is becoming worse in Norway and people are becoming unemployed, a stable housing market could be easily destroyed without financial support. Unfortunately, we are experiencing this now. The sharp decrease of crude oil price worldwide makes the unemployment rate climbing up in 2015. Prediction shows that the low oil price will keep steady until the end of 2016. This will seriously affect the housing market in Norway. We are evidencing changes in Stavanger now. It would be interesting to investigate on the possibility of housing bubble caused by this and if does, how fast it will spread out of the whole country. Such type of bubble stimulated by the external and global economy is not able to be captured by our model. Further works should be done to handle the above issues.

Chapter 6

Conclusion

We build a housing price model for investigating the existing of housing bubble in Norway. The model is based on the definition of a financial bubble. We also define fundamentals in the family level. We find that the analysis becomes much simpler compared to investigating fundamental in the country level. The housing price is split into four part, the fundamental of the house, the fundamental of the household, the fundamental of the interactions of the house and the household, and the bubble part which is supported by the irrational expectation of housing increase in the future.

The 2012 data survey conducted by SSB is not necessary to be ideal, but good enough for our analysis. We have regressed the housing prices controlled by different variables and into different groups. The dependency of housing price change due to changes of different variables varies in different experiments, yet the results are stable and interpretable.We use loan-to-income ratio as the indicator of the bubble term, which could be misleading because a normal loan-to-income ratio may not inflate any bubble. The limit of the real data makes us no other choice on the bubble reflection.

Based on our analysis, we conclude that there is no housing bubble in the entire Norwegian housing market. This is consistent with the conclusion from Duus's thesis (Duus and Hjelmeland, 2013), where she investing the Norwegian housing bubble based on statistical data. However, we also find that there exist some groups (groups with high loan-to-income ratios) where the bubble indicator remarkably affects the housing price, which might indicate bubbles in these specific groups.

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