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What is the impact of the down payment requirement on the housing market in Oslo?

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Abstract

On March 1st 2010 the Norwegian government implemented a down payment requirement of 10%, later increased to 15% on December 1st 2011. The down payment requirement states the amount of equity needed to be applicable for a mortgage. In this thesis, we investigate how the down payment requirement has affected the housing prices in Oslo with the goal of increasing knowledge on how governmental actions impact the housing market. By monitoring the buying and rental market in the timespan between 2008 and 2015, we investigate how housing prices have developed using quantitative methodology. Governmental intervention on the housing market is a topic considered to be of high interest, however, we find the research done on down payment requirements in Norway to be insufficient. Through our research, we argue that the down payment requirement had no impact on the housing market in Oslo.

Acknowledgements

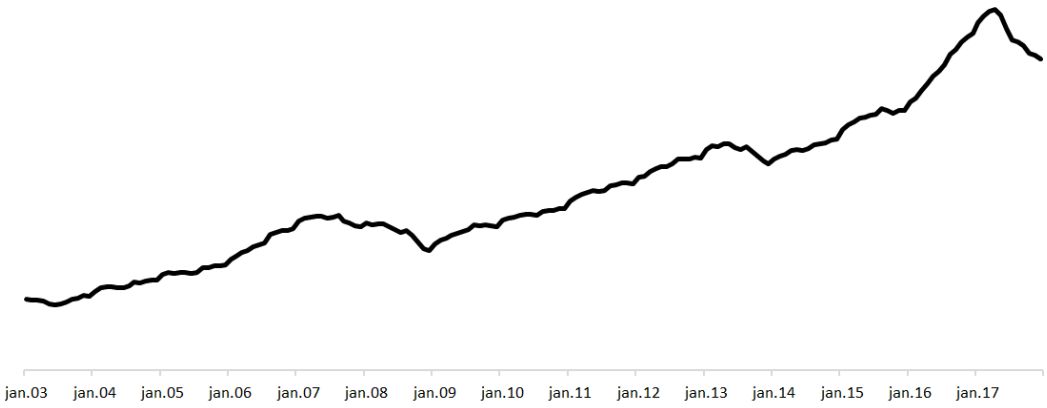
We would like to thank our supervisor Ignacio Garcia de Olalla Lopez for his great contributions and eager interest on the subject. Further, we want to express our gratitude to Eiendomsverdi and Erling Røed Larsen, head of research at Eiendomsverdi, for providing data used in this thesis. Without their contribution, this thesis would not be feasible. In addition, we would like to thank Husbanken for their support and contribution to this thesis.

Table of content

1 Introduction

The Norwegian housing market experienced significant growth from 1993 until 2016 (SSB, 2018), and Oslo has seen a major boom in the later years. See figure 1 for housing price development in Oslo between 2003 and 2017.

Figure 1
Housing price index Oslo



The figure shows the development of housing prices in the 15 city districts of Oslo from 2003 to 2017. The numbers are based on an index with 100 as the base in 2003. Source: Eiendomsverdi. Area transaction report.

The rapid development lead to the Norwegian government introducing limitations in the housing market to stabilise the growth and secure financial stability. In 2010 the first down payment requirement of 10% was introduced, a requirement that later increased to 15% in 2011. The down payment requirement depicts the amount of equity needed to be applicable for a mortgage, with security in housing. Previous research by Engelhardt (1996) and Campbell & Hercowitz (2005) states that down payment requirements induce risk sharing but comes at the cost of the homeowners.

In this paper, we investigate how the down payment requirement has influenced the housing market in Oslo. Research is done on the population level, analysing how the down payment has affected different geographical areas based on their level of wealth. Studies by Astrup, Medby and Johannessen (2013) show that the down payment requirement has affected individuals in the lower parts of the financial ladder and first-time buyers. We argue through our extensive research that the down payment requirement had no significant impact on the Oslo housing market.

Larsen and Sommervoll (2004, p. 10) argue that the development in real estate prices can be explained through demographic factors such as urbanisation and centralisation, and macroeconomic factors such as interest rates, access to liquidity, tax incentives and real wages. Another decisive factor according to Lamont & Stein (1997, p. 1) is credit availability, where high leveraged households are sensitive to shocks and changes. Borrowers tend to use their house as collateral, and cities with a high loan-to-value ratio are more vulnerable to fluctuation in housing prices relative to cities with a low loan-to-value ratio (Stein & Jeremy, 1995). House purchase often requires a significant down payment, where the demand for housing is strongly affected by the buyer's liquidity (Stein & Jeremy, 1995). Noted by Khan and Reza (2017, p 1254), private consumption can be affected by government actions through liquidity access influencing real estate prices and the aggregate demand in the market. Actions by central authorities is a decisive factor in the development of housing prices for a given country or region.

Homeownership, wealth distribution and accessing the housing market is a well-researched topic, especially in the US. Research shows that there is a clear correlation between homeownership and wealth. Herbert & Tsen (2005, p. 1) states that wealth is among the most decisive factors for a household to become a homeowner.

The escalation in prices may have a speculative component, that investors seek to monetise on short-term gains in the housing market. However, these arguments have limited empirical support. Surveys conducted by Shiller (1990, p 64) reveals that speculative considerations when investing in large city housing in the US was the primary motive for private actors. They considered small or no risk investing in housing and had the impression that if they did not invest in housing now, they would not be able to enter the market at a later stage. Shiller noted that the psychological factor of investing in real estate can be a significant factor in the development of housing prices. The psychological factor in the housing market has been further recognised by Mayer and Sinai (2007, p. 26) concluding in their research paper that housing price growth has a positive effect from behavioural components when looking on current price to rent ratios. Renting is an alternative to buying and an essential part of any well-functioning housing market. Changes

in housing prices might lead to a demand shift in the rental market. Studies done by Case et al. (2001) show that higher housing prices make it harder for renters to enter the housing market due to increasing equity demands.

The worldwide financial crisis in 2008 was partly induced by the sub-prime crisis rooted in the rapid decline of housing prices in the US according to Reinhart & Rogoff (2008, p. 4). Complex bundling of obligations was packed together in non-transparent instruments that were illiquid when housing prices started to drop. Most defaults were among less creditworthy individuals. Government across the globe acted to secure financial stability and protect private consumers.

In Norway, the Financial Supervisory Authority, known as Finanstilsynet, introduced new guidelines to secure private households against the growth of debt. High levels of credit obligations raise the vulnerability towards increased interest rates, unemployment, and reduced real wages. Norwegian government implemented a 10% down payment requirement on March 1st 2010, later increased to 15% on December 1st 2011 (Finanstilsynet, 2011).

The primary intention behind the guidelines was to ensure financial stability and secure a well-functioning housing market. It is empirically tested by Jappelli and Pagano (1994) that using a higher down payment requirement leads to a significantly higher savings rate among households. Equity requirements create stability for the financial institutions but come at the cost of the homeowners. Further supported by Campbell & Hercowitz (2005, p. 4) stating that an equity increase reduces the probability of systematic default but comes at the cost of the borrower requiring more equity in their housing. Down payments give an equity stake for the homeowner that induces risk sharing between the lender and owner in case of a market-wide decline (Engelhardt, 1996).

The Norwegian bank crisis between 1987-1993, linked the sharp decline of housing prices to monetary policy and high real interest rates (Moe et al., 2004, p. 18). Housing prices correlate with consumption (Grindaker, 2017), and if a sudden consolidation of housing debt leads to lower consumption, it could reduce the financial stability of Norway. Further, the net worth of a house works as

collateral for credit access, thus a decline in housing prices lead to households cutting back their spending (Mian et al., 2013, p. 29).

Other Scandinavian countries have implemented down payment requirements. In 2010 the Financial Supervisory Authority of Sweden introduced a requirement of 15% equity when purchasing a home (Mäklarsamfundet, 2013). The Swedish government faced critics due to the implications for first-time buyers and financially weak individuals not being able to participate in the housing market (Törnberg, 2012).

Higher equity demands increase the barrier of entry for new homeowners and individuals within the lower part of the financial ladder (Linneman & Wachter, 1989, p. 400). Research done in the US by Herberth & Tsen (2005, p. 25), states that down payment assistance programs can significantly impact the homeownership among low-income households. There is a pattern among home-owning households and the likelihood of their children becoming homeowners (Boehm & Schlottmann, 1999).

Homeownership is an increasing trend in Norway, and eight out of ten household's own property (SSB, 2017). However, in the lower percentile of the income ladder, individuals earning less than 60% of the median income, homeownership is reduced to four out of ten (SSB, 2017). An essential part of purchasing a home is the required down payment as depicted by the guidelines. The Norwegian Institute for City and Region Research (NIBR) report from 2013 shows that the new down payment requirement has affected first-time buyers and individuals in the lower part of the financial ladder (Astrup, Medby & Johannesen, 2013). However, we find a lack of empirical research that studies the comparison between low- and high-income individuals and the impact of the down payment requirement on the development of housing prices in Norway.

A report from Omholt (2016) shows evidence that Oslo is the city in Norway with the most significant differences in income per household. Oslo consists of more than 50% one-person households, and in later years there has been a constant flow of immigrants moving to Oslo from Eastern-Europe, Asia, Africa, and Latin-America. These individuals are often represented in the lower ends of the income

distribution. In contrast, Oslo accommodates a substantial amount of corporate institutions that generate an extensive amount of capital gain and income. These factors are all important when understanding the income differences in Oslo and display the diversity of the population. Research shows that there is a clear distinction between the amount of benefits received in western and eastern parts of Oslo (Sandvik & Kvien, 2015), which can have significant effects on housing prices and development in different city districts.

A previous unpublished thesis implies that the introduction of down payment requirements had an impact on the housing market in Oslo (Holmen & Håkonsen, 2014), but not to the extent that it was able to affect the market trend. Well-known Norwegian economists such as Jan Andreassen (Tjersland, 2015) and Christian Dreyer (2014) have shared concerns regarding the down payment requirements and inequality among the population. A survey done by Norstat for Finans Norge (2012) shows that 80% of the Norwegian population thinks that the new down payment requirement creates a class distinction. The survey further shows that the number of individuals receiving help from family and friends when financing housing has increased from 15% to 35% between 2009 and 2012. Access to liquidity through family support could create distinctions, benefiting those who receive backing.

There has been some empirical research done on the impact of the down payment requirement in Oslo. However, we consider the research done on the guidelines effect on social groups based on wealth to be limited. Jan L. Andreassen (Tjersland, 2015) argue that the down payment requirement leads to substantial class distinctions in society, where wealthy individuals can save capital to buy real estate. Typical young working-class individuals are not able to enter the housing market because their parents do not have the means to offer financial support.

Previous research on the effects of down payment requirements on renting and purchasing has been conducted (Johannessen et al., 2013). However, there has been limited research regarding the impact of a down payment requirement on housing prices in Oslo, and the impact on different demographics and income levels.

In this thesis, we want to investigate the impact of the down payment requirement on housing prices in Oslo. The primary method used is a forecasting model predicting housing prices in Oslo as if no down payment requirement was implemented and comparing the results with the actual housing prices observed. Further to strengthen the analysis, additional tests are conducted to investigate how the requirement has affected different geographical areas in Oslo based on their level of wealth. In this paper, wealth is defined as a composition of income and assets. We consider it essential to assess if some city districts have been affected differently by the requirement than others. The additional analysis serves to strengthen our main research by analysing four different city districts using a trend analysis, a prediction model, and a regression discontinuity design. The last part of our research is an investigation of how rental prices have reacted to the down payment requirement. The implementation of the down payment requirement was done in two stages, 10% on March 1st 2010 and 15% on December 1st 2011. In our thesis, we want to look at the effects of the down payment requirements, not the individual effects of each implementation, thus we concentrate our research on the first introduction date, 1st March 2010.

Our goal of this thesis is to increase the knowledge on how governmental actions affect housing markets. Understanding the consequences of public guidelines on housing prices and the influence on social classes is of high interest. We expect that the introduction of the down payment requirement affects housing prices negatively, influencing individuals purchasing patterns. We expect that low wealth individuals are influenced unfavourably compared to high wealth individuals, due to potential differences in access to liquidity. The down payment introduction may increase barriers of entry to the housing market for low wealth individuals, increasing the demand for rental properties in low wealth areas. We hypothesise that if the requirement leads to greater barriers of entry in the less wealthy parts of Oslo, the rental prices increase relative to the high wealth city districts.

Our extensive research shows that the implementation of the down payment requirement had no impact on the Oslo market. Our additional research supports these results, concluding that there is no evidence on the population level that the

requirement has influenced different geographical areas based on their level of wealth.

2 Main empirical test

In this section, we present the main empirical test of the down payment guidelines and the impact on housing prices in Oslo.

The data used is collected through Eiendomsverdi, Norway's leading supplier of real estate data to professionals in the housing environment. Their dataset is the most comprehensive collection in Norway, giving detailed sales data from 1985-2018. More concrete, the dataset consists of every single sale made in Oslo for a specific city district in the timespan of interest. The high level of detail in our raw dataset makes it suitable for regression analysis with daily observations. See table 1 for the list of variables collected from Eiendomsverdi.

Table 1: List of variables

This table shows the list of variables available when collecting housing price data from Eiendomsverdi's database. Living area is the quantifiable area of living space. Registration date is the date when the housing was registered. Days in market are the number of days when the housing was available for purchase in the. Common debt is the amount of debt the housing is obliged to. Property size is the amount of land. Broker firm represents the broker used when selling. City districts represent what city district the housing belongs to. Estate type define if the housing is detached or an apartment. Gross area represents the floor area within the walls of the building. Ownership represents the ownership type of the housing. Sales date is the date of sale. Year built represents the original building year of the housing. Valuation represents the asking price in the market. Postcode is the postcode of the address. Price M2 is the price divided by the number of square meters. Address is the address of the housing. Price is the salesprice of the housing. Source: Eiendomsverdi. Area transaction report.

Living area (size)	Broker firm	Ownership	Postcode
Registration date	City district	Sales date	Price M2
Days in market	Estate type	Year built	Address
Common debt	Gross area	Valuation	Price
Property size			

We collect a randomised selection from the 15 city districts in Oslo, with a limitation in our data collection of 30.000 observations. A weighted number of observations are selected to represent each city district based on the total number of observations from 1st January 2008 to 31st August 2015. The randomised sample consists of daily observations including all city districts. We divide the city into two segments based on the level of wealth. Oslo consists of the following 15 city districts: Alna, Bjerke, Frogner, Gamle Oslo, Grorud, Grünerløkka, Nordre

Aker, Nordstrand, Sagene, St. Hanshaugen, Stovner, Søndre Nordstrand, Ullern, Vestre Aker, and Østensjø. See appendix 1 for a map of the city districts.

Due to the nature of our thesis and variables missing observations, certain variables were dropped, see table 2 for variables used.

Table 2: List of variables used

This table represents the variables used in the analysis. Value is calculated as price plus common debt. Source: Eiendomsverdi. Area transaction report.

Living area (size)	City district	Ownership	Value*
Common debt	Estate type	Sales date	Price
Property size	Gross area	Price M2	

To split the city into our two segments, data from SSB (2018) are collected and analysed. Through SSB's extensive database, Statistikkbanken, the following tables are used to gather all relevant information: (1) Individuals 18 years and older in private households. Share that lives/does not live in couples. (2) Registered unemployed at the age between 15-74 years. (3) Median taxable wealth. (4) Education level. (5) Social support, (6) Singles living in a household, and (7) Ratio of age groups in each city district. See appendix 2-5 for a full outlay of relevant data in SSB analysis.

Some issues should be noted about the SSB data. Specific areas have missing values or years. Taking the average for each city district gives certain biases as different city districts experienced unequal growth. These deviations are noted, but we consider our research to be representative and accurate for our needs. Our goal of looking at this data is not to create an accurate representation of the city districts, but rather create a way of identifying different districts that are of interest.

The dataset consists of 29.993 observations, where 2.995 (10%) are deleted due to missing values on key variables such as price and living area. Including these observations can create noise in our analysis, potentially leading to a biased result. See table 3 for data trim.

Table 3: Datatrim

This table show the number of observatons collected, number of observations deleted due to missing values, and the net number of observations used in the main model. Source: Eiendomsverdi. Area transaction report.

	Deleted	Observations
	-	29.993
Living area (size)	2.342	-
Common debt	-	-
Property size	-	-
City district	-	-
Estate type	-	-
Gross area	-	-
Ownership	-	-
Sales date	-	-
Price M2	-	-
Value	-	-
Price	653	-
Total	2.995	26.998

The descriptive statistics show issues related to data entry or other numeric errors, which is controlled for by winsorizing the dataset at the 1% level. See appendix 6 and 7 for data description. Macro data is collected from the Central Bank of Norway (Norges Bank, 2018) to control for general growth. Data used include inflation, key policy rate, and GDP.

To analyse the implementation of the down payment requirement, we predict what the housing prices would have been if no down payment requirement was implemented. By fitting two regressions (one per wealth segment) up to the introduction date of the down payment requirement, we extrapolate the linear trend before the implementation. Using these trends, we predict housing prices after the introduction date, given no down payment requirement, and compare the high wealth areas with the low wealth areas. The analysis examines if any significant changes occur in either of the two areas after the implementation of the down payment requirement, comparing predicted prices with actual observed

prices. The results of interest are the distribution of sales for each area, individually and relatively to each other, before and after the implementation.

Forecasting is a prediction process where past knowledge is used to predict the future outcome on variables of interest. According to Adkins & Hill (2011, p. 338), forecasts are essential for decision-making institutions such as banks, governments and investment firms. Accurately forecasting variables of economic interest give objective criteria to base decisions on when there is a large amount of uncertainty. The field of forecasting is extensively researched through papers from writers such as Baltagi & Griffin (1997), Sims (1986) and Brown et al. (1997). According to Stock & Watson (2008, p. 525), regressing on time series data can be used to determine historical relationships. If the future is similar to the past, these relations can be used to forecast the future. Fundamental differences in the past compared to the future create inconsistent and non-reliable results. However, our research design investigates the differences between low and high wealth areas relative to each other. These results give indications if there is an unfavourable outcome even though the trend is not captured precisely. These limitations are noted, but with our research design, we are confident that the results are consistent.

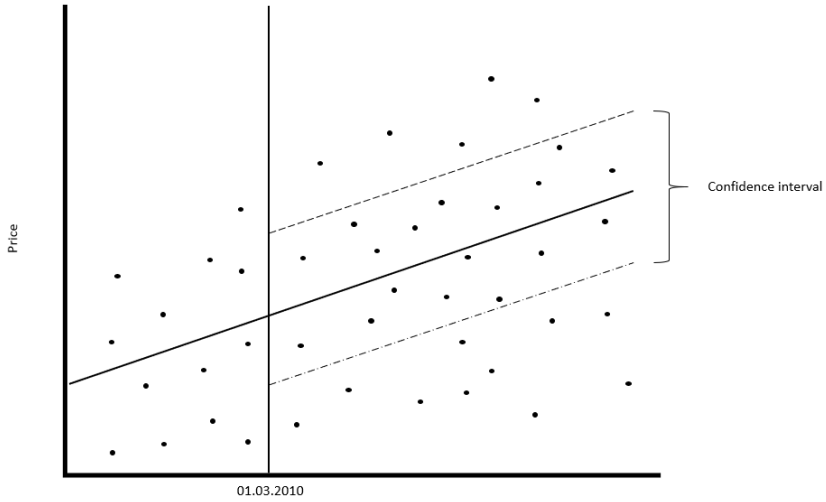
The forecasting model is based on the principles from Adkins & Hill (2011, p. 372), where the pooled OLS regression is fitted in the period before the implementation of the down payment requirement. With this data in memory, the linear prediction is calculated from the fitted model for what housing prices and standard errors would be assuming no implementation of the down payment requirement. Using the predicted prices and standard errors we create a 95% confidence interval for each sample. Two regressions are fitted, one per wealth segment.
See equation 1 for confidence interval.

(1) $$\mathrm{CI} = \bar{\mathrm{Y}} \mp \mathrm{Z}_{\alpha/2} * \mathrm{SE}$$

$\bar{\mathrm{Y}}$ is the predicted housing value
Z is the confidence level set at the 5% level
SE is the predicted standard error
CI is the confidence interval

See figure 2 for a visual example were the observed values before the down payment are used to create a predicted confidence interval.

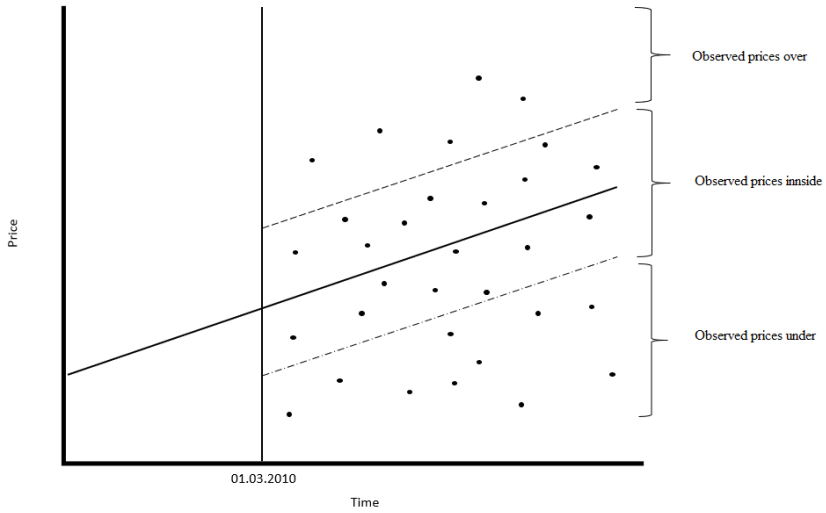
Figure 2
Confidence interval



The figure is a visual representation of the prediction method. The Y-axis represents the price (value) of housing, while the X-axis represents dates. The dots represent actual sales price for the period which works as a base for the fitted line and confidence interval through the figure. The figure is not representative for our dataset but works as a theoretical example to further explain our model.

By overlaying the predicted confidence interval on the real observed prices, we look for patterns and sales that are over, under and inside the confidence interval as seen in figure 3.

Figure 3
Confidence interval and amount of sales



The figure is a visual display of the actual observed prices, and where they appear relative to the confidence interval. The number of interests is the amount of observed prices that appears under, inside, and over the confidence interval. The figure is not representative for our dataset but works as a theoretical example to further explain our model.

We cross-reference the predicted confidence interval with the actual prices after the implementation of the down payment requirement. If a substantial part of the observed prices falls under our predicted confidence interval, the hypothesis of the down payment requirement having a negative impact on housing prices is strengthened. Further, changes in the two areas relative to each other are interesting observations that may indicate a different effect on the two areas respectively.

The regression model used in our prediction is specified using macro factors to remove general trend and hedonistic attributes to distinguish house specific characteristics. We remove general price growth by introducing variables for GDP per capita, inflation, and interest rates. See equation 2 for regression used.

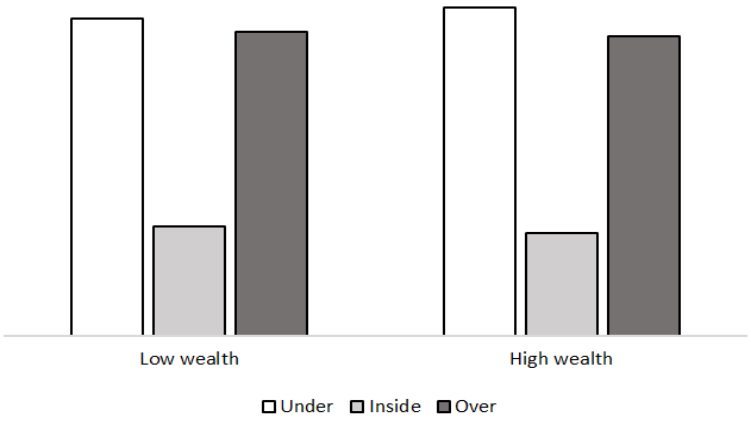
$$\ln Value = \beta_0 + \beta_1 A_i + \beta_2 M_t + U_{it} \quad (2)$$

We regress the natural logarithm of Value on housing attributes (A_i), and the general price and economic growth through macro-economic variables (M_t). β_0 is the intercept in our regression, while β_1 and β_2 represent the coefficients for housing attributes and macro factors.

The goal is not to predict housing prices but look for differences, trends and patterns that emerge in our data. We look at how the housing prices group according to each other, how they react before and after the implementation, and the distribution inside, under and over the confidence interval. For full calculations see appendix 8 and 9.

The results from the prediction before the implementation of the down payment requirement are displayed in figure 4.

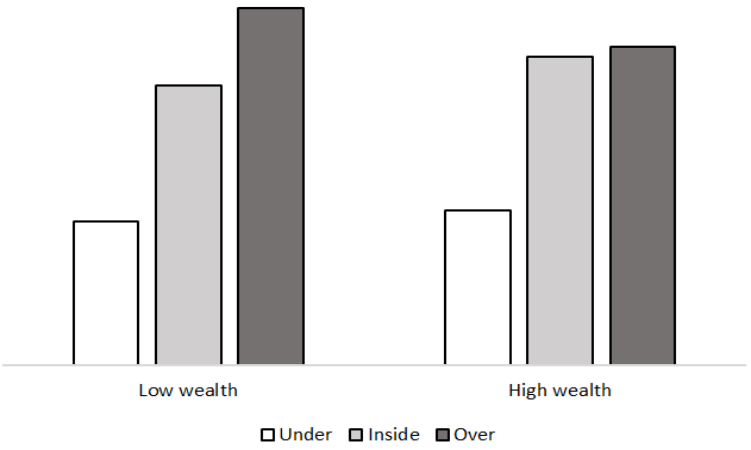
Figure 4
Results before the down payment introduction



The figure displays the results from the prediction model before the implementation of the down payment requirement. The white area represents the number of actual observed sales under the confidence interval. The grey area represents the number of actual observed sales inside the confidence interval. The black area represens the number of actual observed sales over the confidence interval.

Figure 5 shows the results after the implementation of the down payment requirement.

Figure 5
Results after the down payment introduction



The figure displays the results from the prediction model after the implementation of the down payment requirement. The white area represents the number of actual observed sales under the confidence interval. The grey area represents the number of actual observed sales inside the confidence interval. The black area represens the number of actual observed sales over the confidence interval.

We anticipate that the down payment requirement would have reduced the sales price of housing sold, increasing the amounts of housing under the confidence interval. Our hypothesis states that the lower wealth areas should experience a less favourable outcome, increasing the amount of housing under the confidence level compared to the high wealth areas after the introduction of the down payment requirement. Further, the average distance for the predicted sales under the confidence interval is expected to be larger in the low wealth areas, supporting arguments of a negative impact.

Inspecting the total amount of sales under the confidence interval after the implementation of the down payment requirement, certain observations are noted. The high wealth areas are slightly more negatively affected than the low wealth areas. After the implementation, 18,41% of sales in the low wealth area are under the confidence level, while 19,77% of sales are under in the high wealth areas.

Looking at the percentage change from before the implementation to after we see on average a reduction of about 25% in the number of sales under the confidence interval for both wealth segments. The low wealth areas have a marginally more negative development compared to the high wealth areas with a 0,09% increase compared to the high wealth areas. Looking at the percentage change from before the implementation to after in the number of sales over the confidence interval we see a 3,88% increase for the low wealth areas compared to the high wealth areas. This insight gives mixed signals. The increase of 0,09% in sales under the confidence interval indicates that the low wealth areas were more negatively affected compared to the high wealth areas, but the increase of 3,88% over the confidence interval suggests the opposite.

In the high wealth areas, there is a 0,34% higher average deviation in the number of sales under the confidence interval compared to the low wealth areas. Similarly, we found a 0,24% higher deviation in the high wealth areas for the sales over the confidence interval compared to the low wealth areas. These results show that the deviation under the confidence interval was on average more extensive in the high wealth areas compared to the low wealth areas. This further strengthens our research that the low wealth areas have not been more negatively affected than the high wealth areas.

Our goal with the forecasting model is not to predict housing prices, but rather look at the distribution of sales after the down payment requirement. The predicted confidence interval would contain the estimated amount of sales that were not impacted by the down payment according to our prediction. Any higher or lower concentration of sales under the confidence interval would be interesting results when comparing the low wealth areas to the high wealth areas.

3 Additional tests

To further strengthen the analysis of this thesis we look closer at four selected city districts in Oslo, chosen for their resemblance in demographics, and contrast in wealth.

The four city districts are selected using statistics from SSB, similar to the tables described in the main model. We focus on four city districts due to the 30.000 observation limitation on our dataset. By limiting our scope of interest, we gather a significant amount of observations for each district, compared to the primary analysis that covers the whole city. The city districts selected are similar in household attributes, such as the ratio of singles living alone and family sizes, but differ in social and economic attributes, such as wages, assets, and level of education. By limiting our data scope, the number of observations is below our limit. See appendix 10 for initial calculations of the four city districts, and appendix 11-12 for descriptive statistics of the four selected city districts.

The parameters used to differentiate the city districts are: wages, assets, unemployment, education level and social support through the state. Family compositions differ by the number of singles living and the age distribution in each city district. By analysing the data, we identify city districts that are similar in household composition but differ in level of wealth.

The four city districts selected are Ullern, Stovner, Alna, and Nordre Aker. Ullern and Stovner are comparable in residence and age composition but differ in level of wealth. Similar characteristics are identified when comparing Alna and Nordre Aker. Ullern and Nordre Aker are classified as high wealth areas while Stovner and Alna as low wealth areas. We aim to investigate if the city districts

experienced an effect from the down payment requirement and if these effects where unequal, supporting our hypothesis that low wealth areas where affected less favourably.

From Eiendomsverdi we collect a dataset consisting of 29.538 observations from 1st January 2008 to 31st August 2015 with a weighted number of observations for each city district based on the total number of observations. Table 4 shows a complete list of variables available.

Table 4: List of variables

This table shows the list of variables available when collecting housing price data from Eiendomsverdi's database. Living area is the quantifiable area of living space. Registration date is the date when the housing was registered. Days in market are the number of days when the housing was available for purchase in the. Common debt is the amount of debt the housing is obliged to. Property size is the amount of land. Broker firm represents the broker used when selling. City districts represent what city district the housing belongs to. Estate type define if the housing is detached or an apartment. Gross area represents the floor area within the walls of the building. Ownership represents the ownership type of the housing. Sales date is the date of sale. Year built represents the original building year of the housing. Valuation represents the asking price in the market. Postcode is the postcode of the address. Price M2 is the price divided by the number of square meters. Address is the address of the housing. Price is the salesprice of the housing. Source: Eiendomsverdi. Area transaction report.

Living area (size)	Broker firm	Ownership	Postcode
Registration date	City district	Sales date	Price M2
Days in market	Estate type	Year built	Adresse
Common debt	Gross area	Valuation	Price
Property size			

Due to the nature of our thesis and certain variables missing observations, variables used are presented in table 5.

Table 5: List of variables used

This table represents the variables used in the analysis. Value is calculated as price plus common debt. Source: Eiendomsverdi. Area transaction report.

Living area (size)	City district	Ownership	Value*
Common debt	Estate type	Sales date	Price
Property size	Gross area	Price M2	

The descriptive statistics of the data shows issues related to data entry or other numeric errors, see appendix 11 and 12 for more information. The dataset is winsorized at the 1% level to combat extreme outliers. Removing the outliers could have been applicable but preserving the size of the dataset was preferred.

The dataset consists of 29.538 observations, where 2.456 (8,31 %) are deleted due to missing values on key variables such as price and living area. Including these observations could create noise in our analysis, potentially leading to a biased result. See table 6 for data trim.

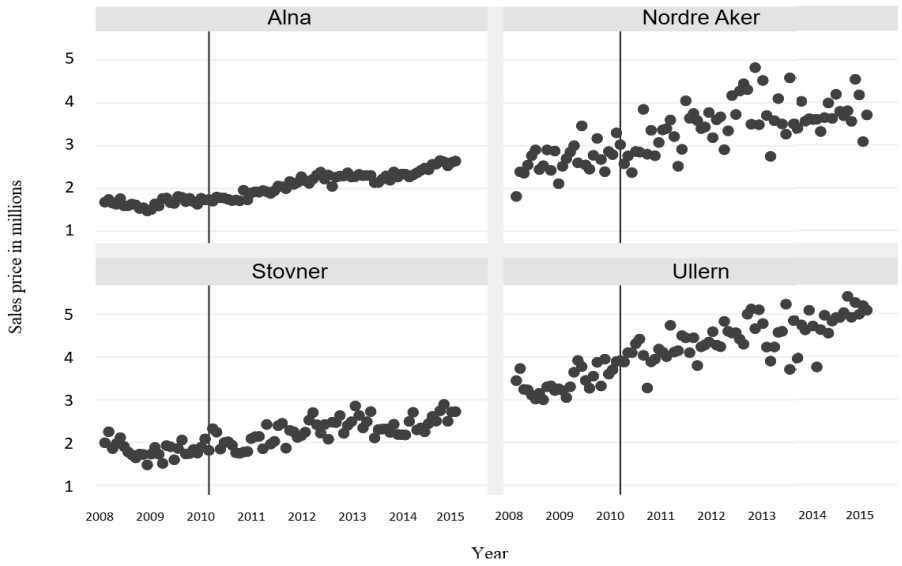
Table 6: Datatrim

This table show the number of observatons collected, number of observations deleted due to missing values, and the net number of observations used in the main model. Source: Eiendomsverdi. Area transaction report.

	Deleted	Observations
	-	29.538
Living area (size)	1.660	-
Common debt	-	-
Property size	-	-
City district	-	-
Estate type	-	-
Gross area	-	-
Ownership	-	-
Sales date	-	-
Price M2	-	-
Value	-	-
Price	796	-
Total	2.456	27.082

By visually inspecting the data, knowledge and patterns of the dataset are better understood. Looking for changes before and after the implementation of the down payment requirement, and differences in the four city districts compared to each other could strengthen the analysis. We inspect the dataset on a monthly and yearly basis, with vertical lines to visualise the implementation of the down payment requirement on March 1st 2010. See figure 6 for a visual presentation.

Figure 6
Visual inspection



This figure is a visual inspection of the average housing value (price + common debt) for the four city districts. The values are calculated as the average price monthly from 2008 to 2015. The Y-axis represent value in millions, while the X-axis represents time (years). Source: Eiendomsverdi. Area transaction report

The visual inspection gives no clear evidence of the down payment requirement impact. However, some notable discoveries need to be mentioned for further analysis. There is a higher variation in sales price in the high wealth areas (Ullern and Nordre Aker) compared to the low wealth areas (Stovner and Alna). The variation may be due to the difference in residential types sold. Ullern and Nordre Aker consist of more detached houses that have a larger average size, compared to Alna and Stovner, which have a higher density of apartments. There seems to be some stagnation in housing prices for the low wealth districts at the implementation date, relative to the high wealth areas. These results are recognised and give support for further investigation, but care should be taken when interpreting the visual inspection. The down payment requirement is a guideline, giving banks possibilities to accommodate exceptions when providing debentures. The implementation started on March 1st 2010 which implies that

households could have received debentures before the implementation and buying later without being affected by the down payment requirement.

The visual inspection increases our knowledge of the data, complementing further results from the statistical modelling and regression analysis. These descriptive statistics are not causal interpretations but gives ground for further research.

3.1 Forecasting model

In the main model, we predicted the prices for a random selection from Oslo city, in this section we apply the same methodology, using our four selected city districts.

We run a regression up to the date of the down payment requirement implementation and with this in memory we predict prices as if no requirement where introduced. Comparing the predicted prices with the actual observed prices, we see how the observed prices appear relative to the confidence interval. A regression line is fitted for each city district and analysed first separately, and then together. See equation 3 for the model.

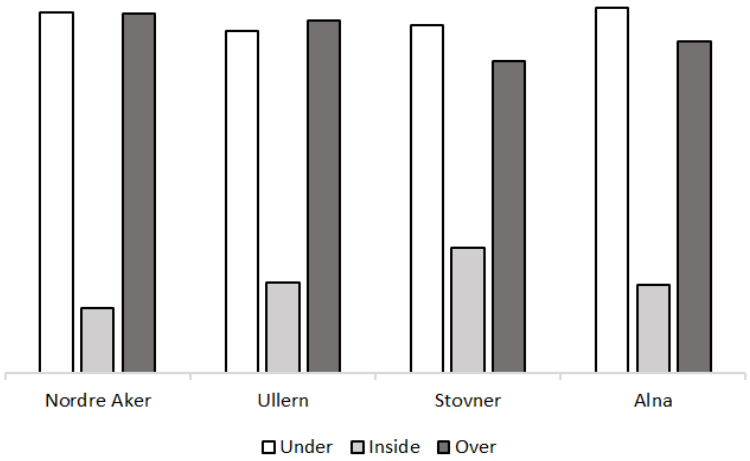
$$\ln Value = \beta_0 + \beta_1 A_i + \beta_2 M_t + U_{it} \quad (3)$$

The model is specified using macro factors to remove general price growth, and hedonistic attributes to distinguish house specific characteristics. General price growth is removed by introducing variables for GDP per capita, inflation, and interest rates. We regress the natural logarithm of the variable Value on housing attributes (A_i), and the general price and economic growth through macroeconomic variables (M_t). β_0 is the intercept in our regression, while β_1 and β_2 represent the coefficients for housing attributes and macro factors.

For full calculations of the predictions, see appendix 13-16.

Results from the four city districts prediction before the implementation of the down payment requirement are displayed in figure 7.

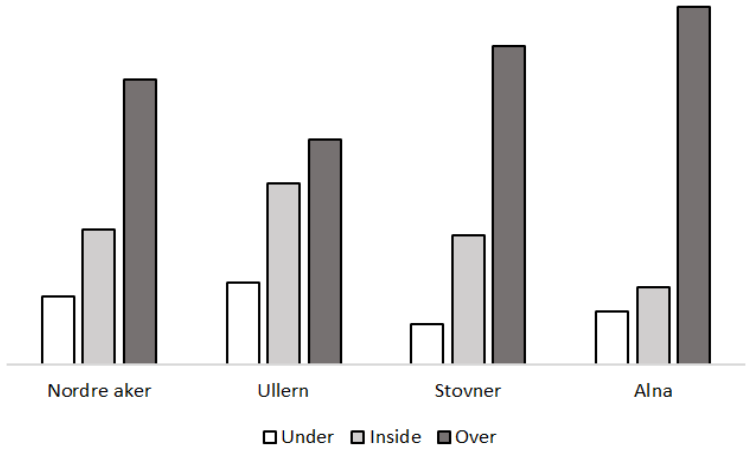
Figure 7
Results before the down payment introduction



The figure displays the results from the prediction model before the implementation of the down payment requirement. The white area represents the number of actual observed sales under the confidence interval. The grey area represents the number of actual observed sales inside the confidence interval. The black area represens the number of actual observed sales over the confidence interval.

Figure 8 presents results from the four city districts after the implementation of the down payment requirement.

Figure 8
Results after the down payment introduction



The figure displays the results from the prediction model after the implementation of the down payment requirement. The white area represents the number of actual observed sales under the confidence interval. The grey area represents the number of actual observed sales inside the confidence interval. The black area represens the number of actual observed sales over the confidence interval.

Looking at the total amount of sales under the confidence interval after the implementation of the down payment requirement we notice some interesting results. There is a higher amount of sales for the high wealth areas (Nordre Aker 13,92% and Ullern 16,83%) compared to the low wealth areas (Stovner 8,27% and Alna 10,78%).

Inspecting the percentage change from before the implementation to after in the number of sales under the confidence interval we see an average reduction of about 32,8% for all four city districts. The decrease is lower in the high wealth areas compared to the low wealth areas, where the reduction was 32,05% for Nordre Aker and 26,68% for Ullern. In comparison, the low wealth areas experience a decrease of 36,07% for Stovner and 35,78% for Alna. We see the same trend in change of sales over the confidence interval in the high wealth areas of 12,63% for Nordre Aker and 1,21% for Ullern. For the low wealth areas, there is an increase of 25,6% in Stovner and 31,15% in Alna for the number of sales over the confidence interval.

3.2 Regression discontinuity design (RDD)

In this section, we look at the implementation of the down payment requirement using a regression discontinuity design (RDD) on the four city districts. RDD is a quasi-experimental design with increased popularity in social science and econometric research in recent years. Dividing observations into a treated and non-treated group based on a cut-off point, we assess the effect of the treatment. Thistlethwaite & Campbell (1960) implemented RDD as a research design by applying it to the field of psychology. Goldberger (1972) contributed further by implementing the design in economics. In the 1990`s RDD was favoured in psychology and education, in work such as the study of class sizes on school performance (Angrist and Lavy,1999), treatment in randomised controlled clinical trials (Finkelstein et al., 1996) and analysis of randomised clinical trials (Cappelleri, 1994). In later years, influential papers such as incentive effects of social assistance (Lemieux & Milligan, 2004), the effect of financial aid offers on college enrolment (van der Klaauw, 2002), and the effects of delayed entry to

kindergarten (McEwan & Shapiro, 2008) has continued developing this statistical tool.

The paper by Jacob et al. (2012) discuss the application of RDD in medical research, where the cut-off point separates the control group into a non-treated and a treated group. Given that the treatment had no effect, the regression line moves continuously through the cut-off point. If the treatment had an effect, a shift in the observations would appear, creating a discontinuity at the cut-off point. See appendix 17 for a visual presentation.

Similar research done in China by Sun et al. (2017) on the implementation of a house purchase restriction (HPR) in Beijing, employ a regression discontinuity design. They found that the HPR triggered a 17-32% reduction of housing prices, and further a drop of 25% in the price-to-rent ratio. Given the resemblance of this research paper to our thesis, we find it adequate to use RDD to measure the down payment implications on housing prices.

Similarly, to the work done by Sun et al. (2017), we check the guidelines introduced in 2010, where the data before the implementation in 2010 are the control group, and data after the implementation are the treated group. The null hypothesis is that there is no discontinuity, that the down payment requirement had no effect on the selected city districts in Oslo, see equation 4.

(4) $$\alpha_0 = \alpha_1, \qquad \beta_0 = \beta_1$$

Equation 4 shows the null hypothesis, that there is no discontinuity in the dataset.

The alternative hypothesis is that there was a discontinuity and housing prices in the city districts were affected by the down payment guidelines as shown in equation 5.

(5) $$Y_i = \alpha_0 + \beta_0 T_i < \bar{c}$$
$$Y_i = \alpha_1 + \beta_1 T_i > \bar{c}$$

Equation 5 shows the alternative hypothesis, that there is a discontinuity in the dataset.

Contamination is a real threat when using RDD. If other incidents happen in the same timespan as the guidelines, the measured discontinuity may be attributed to other events than the down payment guidelines. Such events could be other regulations, tax measures, change in saving incentives and credit restrictions. By carefully monitoring the discontinuity we cross-reference it with other events, minimising the risk of contamination. Further, through our close inspection of the data, we are confident about the design and fitting issues of the model.

According to Stock & Watson, there are two types of RDD, sharp- and fuzzy regression discontinuity design, known as SRDD and FRDD (Stock & Watson, 2015, p. 546). In SRDD, the cut-off point is absolute, and any participant above the threshold are given the treatment. In FRDD, the threshold gets "fuzzy", were being over the threshold increases the probability of getting the treatment, but it is not an absolute.

We expect the change in housing prices not to react precisely at the cut-off point, but at a prolonged period subsequently. The delayed reaction is due to market adaptation, and financial institutions usually grant loans certificates to individuals for periods of three months at a time. However, we choose a sharp RDD approach using the cut-off date at the implementation for the first down payment requirement on March 1st 2010. The goal of the thesis is to examine if the down payment requirement influenced housing prices, not to pinpoint the exact date or size of the effect. Different cut-off points and time intervals are tested, but with no noticeable change in the results. Further, the implementation of the down payment requirements was implemented within a narrow time window of each other in 2010 and 2011.

The model is specified using macro factors to remove general price growth, hedonistic attributes to distinguish house specific characteristics, dummies for the city districts, dummy for the implementation of the down payment and interaction terms to isolate the effects of the down payment requirement on each city district. We remove general price growth by introducing variables for GDP per capita, inflation, and interest.

The dummy capturing the down payment requirement is 0 before the implementation and 1 after. The included interaction term consists of the city district multiplied with the down payment dummy to capture the city district specific effect of the down payment requirement. The city district dummies are represented through Alna, Ullern, and Stovner, with Nordre Aker as the reference category. See equation 6 for the model.

$$\ln Value = \beta_0 + \beta_1 A_i + \beta_2 M_t + \beta_3 EQ_t + \beta_4 Dist_i + \beta_5 (Dist_i * EQ_t) + U_{it} \quad (6)$$

We regress the natural logarithm of the variable Value on housing attributes (A_i), the general price and economic growth through macroeconomic variables (M_t), the down payment implementation dummy for reference city district EQ_t, city district dummy $Dist_i$, the interaction term ($Dist_i$*EQ_t). Lastly, U_{it} is the error term assumed to have zero mean and constant variance. β_0 is the intercept in our regression, while β_1 and β_2 represent the coefficients for housing attributes and macro factors, β_3 represents the down payment requirement coefficient for the reference category, β_4 represent the city district specific dummies, while β_5 represents the coefficient for the city district specific down payment interactions.

Our research design assumes that there is a shift in housing prices after the introduction of the down payment requirement. The structural break is caused when over the sample period the population regression function changes (Stock & Watson 2008, p. 565). The issue with structural breaks is the OLS estimation containing an average of both periods, even though each period differs from each other, causing poor performance of the regression (Stock & Watson 2008, p. 565).

To investigate the assumption, we apply an F-test called The Chow test on the coefficients of the regression function in the period before the implementation of the down payment versus the period after. We test the null hypothesis of no structural break versus the alternative hypothesis that there is a break in the dataset. See equation 7 for the null hypothesis and the alternative hypothesis.

(7)
$$H_0: \gamma_0 = \gamma_1 = \gamma_2$$
$$H_1: \gamma_0 \neq \gamma_1 \text{ or } \gamma_1 \neq \gamma_2 \text{ or } \gamma_0 \neq \gamma_2$$

Equation 7 represents the null hypothesis where the coefficients before and after the implementation are equal, that there is no break in the dataset and the alternative hypothesis stating that there is a difference between at least one of the coefficients, that there is a break in the dataset.

Implementing the test, we get a F_{obs} value of 35 while our critical value F is 1,78. The observed value is larger than the critical value. We reject the null hypothesis and accept the alternative hypothesis that there is a structural break in our dataset. Due to the structural break, interaction terms are included for all the independent variables as seen in equation 8.

(8)
$$\ln Value = \beta_0 + \beta_1 A_i + \beta_2 M_i + (\beta_3 A_i + \beta_4 M_t) EQ_t + \beta_5 EQ_t + \beta_6 Dist_i + \beta_7 (Dist_i * EQ_t) + U_{it}$$

The housing attributes in our regression are living area, gross area, property size, estate type, and ownership. The coefficients of interest are the ones representing EQ_t and the interaction term EQ_t*$Dist_i$. Their significance gives indications that the down payment requirement has influenced the different city districts. Further, their relative size could give information to which degree the down payment has affected the different city districts after the introduction.

Understanding and working with second order polynomial interaction terms are challenging, and to a certain degree misleading. According to Gill (2001, p. 1) including interaction terms in a model fundamentally changes the interpretation of the coefficients. The statistical software presents results of coefficients assuming all other interacting variables equal zero. Since the interactions are conditional on the other co-interacting variables, similarly is the associated standard error giving misleading statistical significance.

To identify the isolated effect, we must calculate the corrected standard errors for the interaction terms Ullern*EQ_t, Alna*$EQ_t$and Stovner*EQ_t given that EQ_t = 1. Following the same procedures as Gill (2001, p.14):

The standard error of the interacting variables conditional on EQ_t = 1 as seen in equation 9.

(9) $$\sigma = \sqrt{\text{var}(\beta_1) + Z^2\,\text{var}(\beta_2) + 2Z\,\text{cov}(\beta_1, \beta_2)}$$

Dividing the marginal standard error on the coefficients, we calculate the marginal t-statistics and p-statistics for the interaction terms.

The structure of the data is panel data, with city districts as our panels and sales dates representing our time variable. When dealing with panel data there are different methods to estimate the coefficients, and fixed- and random effects are the preferred models. The fixed effects model would have been the construct of choice, supported by the Hausmann test performed. Sadly, our methodology and the mean subtracting approach of fixed effects removed the city district specific effect of interest, thus the random effects model was chosen.

One aspect should be noted regarding the implementation of the down payment requirement. The requirements were guidelines that Finanstilsynet recommended but still gave substantial incentives through special capital requirements for the involved banks that did not meet the guidelines.

Our estimated model gives good explanatory power with an overall R-squared of 0,8523. All variables are significant at a 5% level, which supports that they have an impact on the value of housing statistically. Results from the RDD are represented in table 7.

Table 7: The impact of the down payment requirement on housing prices in Oslo

The table shows the results of regressing housing prices on the down payment requirement, housing attrbutes, macro-economic variables, city district variables, and control variables representing interactions between the down payment requirement and city districts. EQ represents the down payment requirement with city district Nordre Aker as the reference category. All variables are statistically significant at a 5%-level.

	Coefficients	Z	P > |Z|
Property Size	3,4E-07		0.007
Estate Type	-0,044593		0.000
Living Area	0,0080172		0.000
Gross Area	0,0002779		0.000
Ownership	0,0478843		0.000
EQ	-1,798649	-6,02	0.000
EQ Stovner	-0,077349	-8,32	0.000
EQ Ullern	-0,036558	-4,58	0.000
EQ Alna	-0,025979	-3,16	0.002
Stovner	-0,429807		0.000
Ullern	0,0774302		0.000
Alna	-0,380111		0.000
GDP	0,0019108		0.000
Key Policy Rate	-0,031596		0.000
Inflation	-0,008528		0.009
Number of observations	27.082		
Number of groups	4		
R-squared	0,8523		

As expected, the coefficients for the variables connected to the size of the property has a positive impact on the value of a resident, and living area is the variable with the most significant impact. Estate type has a negative coefficient which implies that apartments, in general, are cheaper than other resident types. The coefficient of the ownership variable is positive, which indicates that self-ownership residents are, in general, more expensive than others. All the variables are significant at a 5% level, which supports that they have an impact on the value of housing statistically.

The variable EQ is the down payment effect on housing prices in our reference category Nordre Aker. The coefficient of -1,79865 implies that the down payment requirement isolated had a negative effect. Variables EQ Stovner, EQ Ullern, and EQ Alna represent the interaction terms of the down payment requirement and the city district specific dummies. These interactions must be seen in context with the reference category to see the full effect for each city district. See table 8.

Table 8: Interaction effects

This table shows the effect of the down payment requirement including the city district specific effects from the interaction variables. EQ coefficents represents the coefficitent value as presented in the regression output for the reference category. The interaction represents the city district specific effects as shown in the regression output. Total is the EQ coefficient plus the interaction coefficient.

	EQ Coefficient	Interaction	Total
EQ	-1,799		-1,799
EQ Ullern	-1,799	-0,036558	-1,835
EQ Alna	-1,799	-0,025979	-1,825
EQ Stovner	-1,799	-0,077349	-1,876

To control for the co-interacting instrumental variables the adjusted standard errors and statistical significance are calculated using equation 9 and presented in table 9.

Table 9: Interaction variables and statistical significance

This table shows the interaction effects as presented in the interaction effects table, their Z-values, and statistical significance. Using equation 9 to calculate the standard errors, and further calculating for statistical significance.

	Coefficients	Z	P > |Z|
EQ	-1,799	-6,02	0.000
EQ Ullern	-1,835	-6,13	0.000
EQ Alna	-1,825	-6,10	0.000
EQ Stovner	-1,876	-6,27	0.000

From our hypothesis, we expect that the down payment requirement had a negative impact on the low wealth areas such as Alna and Stovner compared to the high wealth areas, Nordre Aker and Ullern. The results show that all EQ variables are negative, implying an unfavourable effect from the down payment requirement on all city districts. We notice a significant difference between the coefficients of Nordre Aker and Stovner which is in line with our hypothesis. However, as we continue to inspect the estimated coefficients, there could be some issues with the down payment effect on either Alna or Ullern. Given that our hypothesis is correct, we assume that the instrument variables representing the down payment effect for each city district are higher for Ullern than Alna, but that

is not the case. Including the city district variables in our model seen in table 8, we see that the coefficients for Ullern together are lower than the coefficients for Alna. Through our initial work with the regression, we noticed that the city district specific effects had a large impact on housing prices, as seen in the regression output in table 7. These observations might compromise the results leading to misleading coefficients from the interaction variables of EQ and the city districts. There could be an issue of city district specific factors that our model does not capture, and that the effects of the down payment requirement are hard to isolate. There might be entity-specific factors or events, leading to a positive development in housing prices, that our model does not capture.

The most significant results in our model show a difference between the impact on the two city districts with the highest and lowest level of wealth, Nordre Aker and Stovner which supports our hypothesis. However, inspecting the city districts Ullern and Alna show results in the opposite trajectory.

3 Rental prices

In this section, we analyse if the down payment requirement has affected rental prices in the Oslo market. Our hypothesis states that the down payment introduction influences the rental market indirectly where the barriers of entry increase, potentially leading to a shift in demand. Investigating the rental market is important when analysing the consequences of governmental actions on the housing market.

The analysis of rental prices is feasible due to data collected from Boligbygg (2018). Boligbygg is a municipal-owned company that owns, administrates and rents out Oslo's municipal housing. With over 11.000 housing units in their portfolio, they are among the largest supplier of rental properties in Norway. To our knowledge, there are no readily available rental data over Oslo with this level of detail. Their rental database goes from 2003 to 2017, giving quarterly prices for Oslo housing. Boligbygg divides their housing data by size ranging from the smallest bedsit to the largest five-room apartments. Ideally, we would have rental prices for the city districts we observe isolated, but the data is aggregated into zones. See table 10 for city zones. The data is not entirely comparable but help us look at trends in rental prices in low and high wealth areas after the

implementation of the down payment requirement. The primary areas of interest are zone 1 (Bjerke, Grorud, Stovner and Alna) and zone 4 (Ullern, Nordre Aker and Vestre Aker). Further, we reference zone 1 as the low wealth area, and zone 4 as the high wealth area.

Table 10: City zones

The table shows the city zones as presented from Bolibygg's database. The sizes of the rental housing is bedsit, 1 room, 2 room, 3 room, 4 room, and 5 room.

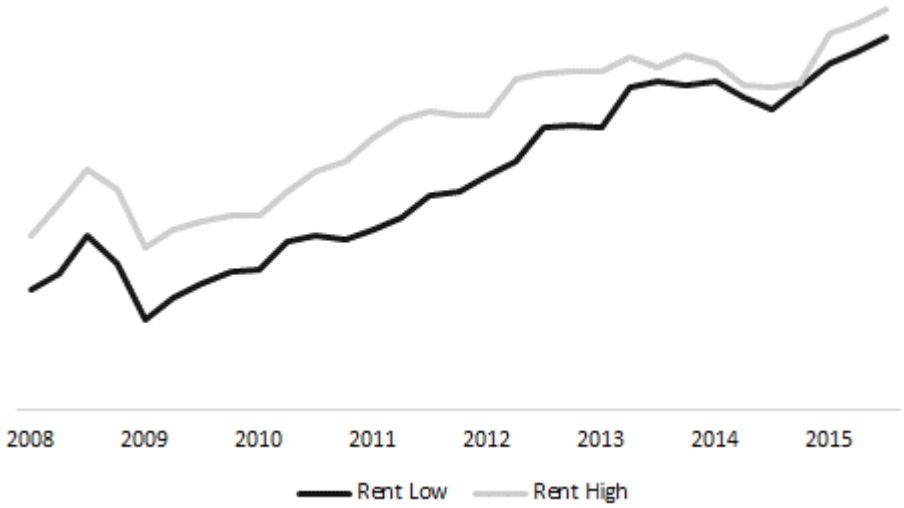
1	Bjerke, Grorud, Stovner and Alna
2	Gamle Oslo, Grunerløkka and Sagene
3	St. Hanshaugen and Frogner
4	Ullern, Nordre Aker and Vestre Aker
5	Østensjø, Nordstrand and Søndre Nordstrand

Insights gained from analysing rental prices are complementary information on the housing market, rather than conclusive results. We interpret the information with care both due to the complexity of the housing market and aggregation level of the data collected from Boligbygg.

Inspecting the rental market in Oslo, we focus our research on changes in rents over time using a graphical display and a rental index. The rental index shows the relative differences in rental price in the two areas and the difference displayed in 2008 term with the high wealth area as the reference category. Figure 9 shows the average rental prices per square meter for both low and high wealth areas in the timespan 2008-2015. See appendix 18 for the rental index.

The implementation of the down payment requirements took place in the first quarter of 2010 and the last quarter of 2011. Inspecting figure 9, we see that after the financial crisis of 2008 there is a minor reduction in rental prices for both areas, but with a slightly higher impact on the low wealth areas. Rents stabilise towards pre-2008 levels at the beginning of 2010. Between late 2010 and 2012, there is a change in the rental trend where rents in the high wealth areas increase more than the ones in the less wealthy areas before a trend change in 2013. However, after 2013 the rental prices reach an equilibrium. The first half of 2013 the rental prices in the low wealth areas have a steeper development compared to the high wealth rental prices. At one point, at the end of 2015, they are at the same level.

Figure 9
Average rental prices

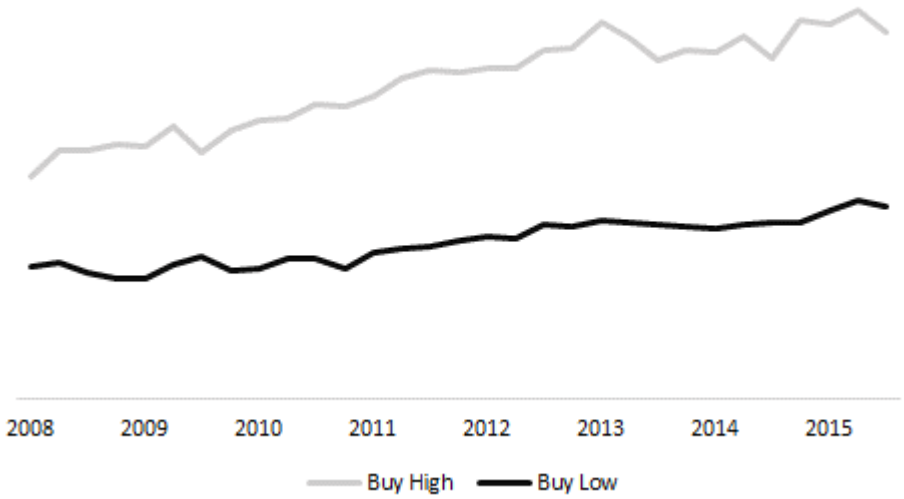


The figure shows rental prices per square meter for the low wealth areas and the high wealth areas. The average rental prices for the high wealt areas (Ullern, Nordre Aker & Vestre Aker) are represented through the grey line. The low wealth areas (Stovner, Alna, Bjerke & Grorud) are represented through the black line. Prices are calculated as the average, independent of size of the housing, for the time span between 2008 and 2015. Source: Boligbygg, Markedsleie for private utleieboliger i Oslo.

We investigate the rental index based on the average rental price in the two different city parts as seen in appendix 18. We calculate the index by adding the development in average rental prices for each year, with 100 as the base. From the index, we see that rental prices follow the same pattern until 2010. However, there is a shift from approximately the third quarter of 2012, where the relative difference between high and low wealth is increasing. Looking at the index, and the previous graphical outlay is a crucial part in establishing a pattern for the rental price development, even though the numbers are not entirely as detailed as the sales prices from Eiendomsverdi.

Figure 10 shows the average buying prices for housing in high wealth areas (Ullern & Nordre Aker) and low wealth areas (Stovner & Alna) in the timespan 2008 - 2015.

Figure 10
Average buying price



The figure shows the average buying prices per square meter for the high wealth areas and the low wealth areas. Average buying prices for the high wealth areas (Ullern, Nordre Aker & Vestre Aker) are represented through the grey line. Average buying prices for the low wealth areas (Stovner, Alna, Bjerke & Grorud) are presented through the black line. Buying prices are presented as average independent of size for the time span 2008 to 2015. Source: Eiendomsverdi, Area report.

By comparing buying and rental prices, we see no clear patterns in the period of the down payment requirement implementation. There is a slightly higher growth rate in the buying prices in the high wealth areas, especially in 2009-2012, that coincides with the higher marginal spread in rents for the same period.

Inspecting the rental prices gives a greater understanding of the relation between the rental market and the buying market. Specific observations are made from the research, despite the challenges of concluding the rental price analysis. There has been a higher growth in buying prices in the high wealth areas compared to the low wealth areas. At the implementation date of the 10% down payment requirement, there are some movements in the rental prices where the high wealth areas have slightly higher growth in rents until 2012. However, after the second quarter of 2012 rental prices in the low wealth areas start to increase, and at some point in 2015, they converge.

We state in our hypothesis that rental prices in the less wealthy areas in Oslo would be unfavourably treated by the down payment requirement through an increase in rental prices. The analysis shows that there is a clear shift in rental prices after the implementation. However, these changes occur at some point in 2013. We see from both the figures and index that rental prices have increased in the low wealth area, but we cannot conclude that there is a causal link between the down payment requirement and the increase in rental prices for the low wealth city districts. However, the shift in rental prices is still a fact that needs to be recognised to see the full development of the housing market in Oslo.

4 Analysation

From the main empirical test, we argue that the down payment requirement did not affect housing prices. These results could be compromised by trends but are strengthened by our discoveries when testing the four city districts in our additional tests with similar average reductions in amounts of sales under the confidence interval. When comparing high and low wealth areas from our main model after the introduction of the down payment requirement, the amount of actual observed sales under the confidence interval are 18,41% for the low wealth areas, and 19,77% for the high wealth areas. We find similar results when analysing the four city districts, where the high wealth areas (Nordre Aker 13,92% and Ullern 16,83%) have a higher amount of sales under the confidence interval compared to the low wealth areas (Stovner 8,27% and Alna 10,78%). We hypothesise that the number of actual observed prices under the confidence interval is higher for the low wealth areas compared to the high wealth areas. The difference is expected since the introduction of a down payment requirement might lead to higher barriers of entry in the housing market for the low wealth areas. This due to lower liquidity access compared to the high wealth areas.

Further, looking at the changes after the implementation of the down payment requirement, we see an average reduction of housing sold under the confidence interval. The reduction is approximately 25% in the main test and 32,8% in the additional test. We hypothesise that the amount of housing sold under the confidence interval would increase, however, these results are in the opposite direction. Several factors might cause these ambiguous results. The model might have limitations not being able to capture a change in trends giving false positive

results, or that the down payment requirement had no significant effect. Issues with trend may harm the results, but we look at this as indications and not a causal interpretation. Given our research design, the relative differences are the main area of interest. The observations are interpreted with care but looking at the relative changes the results are still consistent.

From the main test, the changes in the number of sales under the confidence interval are approximately even for the two different areas. The low wealth areas have a marginally negative development of 0,09% compared to the high wealth areas, which is at an insignificant level relative to the amount within and over the confidence interval. Results from the additional tests show some deviations from the discoveries in the main test. Low wealth areas have a higher reduction of actual observed sales under the confidence interval (Stovner 36,07% and Alna 35,78%) compared to the high wealth areas (Nordre Aker 32,05% and Ullern 26,68%). Our hypothesis states that the down payment requirement leads to more favourable results for the high wealth areas compared to the low wealth areas. The main test shows no significant difference, while the additional tests indicate a more favourable outcome for the low wealth areas in contradiction to our hypothesis.

Calculating the average deviation under the confidence interval after the implementation of the down payment requirement we see similar results from both the main and the additional test. Observing the actual prices, we see on average that the deviation decreases for both high and low wealth areas. The deviation is higher for the high wealth areas compared to the low wealth areas under the confidence interval. Isolating the results tells us that the average relative sales price under the confidence interval are lower for the high wealth areas. Concluding on these results isolated are challenging since we notice from our visual inspection that the variation in sales prices for the high wealth areas is higher than the low wealth areas. The results are in favour of the low wealth areas in contradiction with our hypothesis but are interpreted with care.

We anticipate that the down payment requirement reduces housing prices and leading to actual observed sales under the confidence interval to increase. Further, we expect that the actual observed sales under the confidence interval increase in

the low wealth areas, compared to the high wealth areas, indicating that the low wealth areas where unfavourably affected. From our results, we see the opposite outcome where the high wealth areas have increased the number of sales under the confidence interval compared to the low wealth areas. We argue that this indicates no impact from the down payment requirement.

The results from the RDD analysis are ambiguous giving mixed results. The negative coefficient of the down payment requirement variable indicates a negative impact on housing prices. Further, Nordre Aker, the city district with the highest wealth level, had a coefficient value of -1,799 while Stovner, the city district with the lowest wealth level, had a coefficient value of -1,876. The results implicate that Stovner has been affected more negatively than Nordre Aker in line with our hypothesis. Isolating these results are not enough to conclude significant differences between the two city districts since the interaction coefficient of -1,835 for Ullern is lower than the coefficient -1,825 for Alna. This is in contradiction of what we expect given the hypothesis that the low wealth area Alna is more negatively affected than the high wealth area Ullern. The city districts Nordre Aker and Stovner are in line with the hypothesis, while Alna and Ullern are in contradiction which gives mixed signals. The negative coefficients from the EQ variable and interactions are statically significant implying an unfavourable impact from the down payment requirement on all city districts. The results might implicate that there is city district specific or trend specific implications that our model struggles to capture. Analysing housing prices are challenging, and instrument variables are hard to isolate with strong district specific interactions in our model, challenging the causal interpretation. Even though our results show a slightly negative impact from the down payment requirement on all city districts, we are hesitant to give causal interpretation due to the complexity of the analysis. Given the data limitations and city district specific challenges influencing our model, we cannot conclude from our RDD analysis that the down payment requirement had a causal effect. We argue that the results from the additional test give no indication to contradict our main model, implying no further evidence that the down payment requirement had a significant impact on the Oslo housing market.

Inspecting the rental market shows that throughout our timespan the prices for the high and low wealth areas have converged towards each other, where rents in low wealth areas have increased relative to the high wealth areas. These discoveries are in line with the hypothesis that the down payment requirement could increase the rental prices in the low wealth areas. However, these results are not conclusive and give no causal interpretation of how the down payment requirement affect housing prices and rents. It should be noted that rents started converging in 2013, two years after the first implementation. The introduction of the down payment requirement cannot explain these changes alone but is a relevant observation that should be taken into consideration.

5 Conclusion

Housing policy and its effects on the population is an essential part of a well-functioning housing market. Through our work, we hope to increase the knowledge about governmental policies, and its potential to affect the population differently.

We argue that our results show no significant effect from the down payment requirement on the housing market in Oslo, and further little to no systematic implication on different wealth areas on the general population level. The forecasted results show no significance of the down payment requirement or an unfavourable effect on the lower wealth areas. The results are further supported by the RDD analysis, implying no significant negative effect from the implementation of the down payment requirement.

The increased capital requirements challenge the barriers of entry for individuals with lower access to liquidity in the housing market, however, inspecting the population of Oslo we see little indication of this. We believe that with more data and wealth level specifications on the individual level, further results may be achieved. Recommendations for future research is to access more detailed wealth- and housing data specified on the individual level to isolate them from the general population. We still believe that the introduction of the down payment requirement could affect certain social classes in the society on the individual level, thus we still consider the topic to be of high interest.

6 Challenges and limitations

The housing market is complicated, and price is a composition of several factors, some measurable and others not, that determine the supply and demand in the market. We face the complexity of price setting through our thesis, and the struggles when estimating housing prices.

Firstly, the introduction of the down payment requirement in both 2010 and 2011 was guidelines set for the banks to follow. The banks may deviate to some degree from the instructions from Finanstilsynet, implying that not everyone is affected equally by the down payment requirement.

Secondly, we experience city district specific differences that are hard to isolate, primarily through our RDD analysis. City district effects could be a new metro line, newly built or established apartments, or just a general trend in the market for specific city districts. These effects are hard to control since some of them are unmeasurable, such as a general trend, while others are hard to identify. Another aspect is that these effects both change across entities (city districts), and across time. There are city-specific factors that could bias our estimations and trouble the causality of our model. These are factors that do change over time, but not across our different entities. Political influence and regulations, such as property tax (not introduced before 2016), change individual's incentives and motivations in the housing market and quickly adjust personal preferences and behaviour. These types of regulations might give some individuals incentives to move to other parts of the city.

Our models assume that people buy and sell in the same market, causing the mobility in our selection to be constant. The assumption of constant mobility is challenging in the sense that it deviates from the real world where consumers of housing buy and sell across city districts. Our mission is to isolate the effect of the down payment requirement on the demand and supply in the market without taking other factors into account. There might be other circumstances influencing individuals to move across city districts, such as trends and housing development. Accounting for mobility is challenging due to the change over time and entities, creating complexity that might be misleading.

Approximately 85% of Norwegians live in residents that the household owns, 15% percentage points above EU mean, and way above comparable nations such as Sweden and Denmark (Langberg, 2016). A large part of the householders in Oslo has been able to take part in the rapid development in housing prices, thus we might face challenges isolating the effect on the population level.

We experience limitations in the data and data collection itself that potentially creates some disturbances in our conclusion. The number of observations was limited to 30.000. Using more observations could give better significance in the results, leading to more robust results.

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SSB (2018). Table 09428: Registrerte arbeidsledige 15-74 år, etter alder.

SSB (2018). Table 05854: Hovedposter fra ligninga for bosatte personer 17 år og eldre, etter alder. Gjennomsnitt og median

SSB (2018). Table 09434: Utdanningsnivå, etter bydel og kjønn

SSB (2018). Table 04932: G. Sosialtjenesten, bydel – nøkkeltall

SSB (2018). Table 06096: Personer 18 år og over i privathusholdninger. Andel som lever/ikke lever i par

SSB (2018). Table 06096: Personer 18 år og over i privathusholdninger. Andel som lever/ikke lever i par

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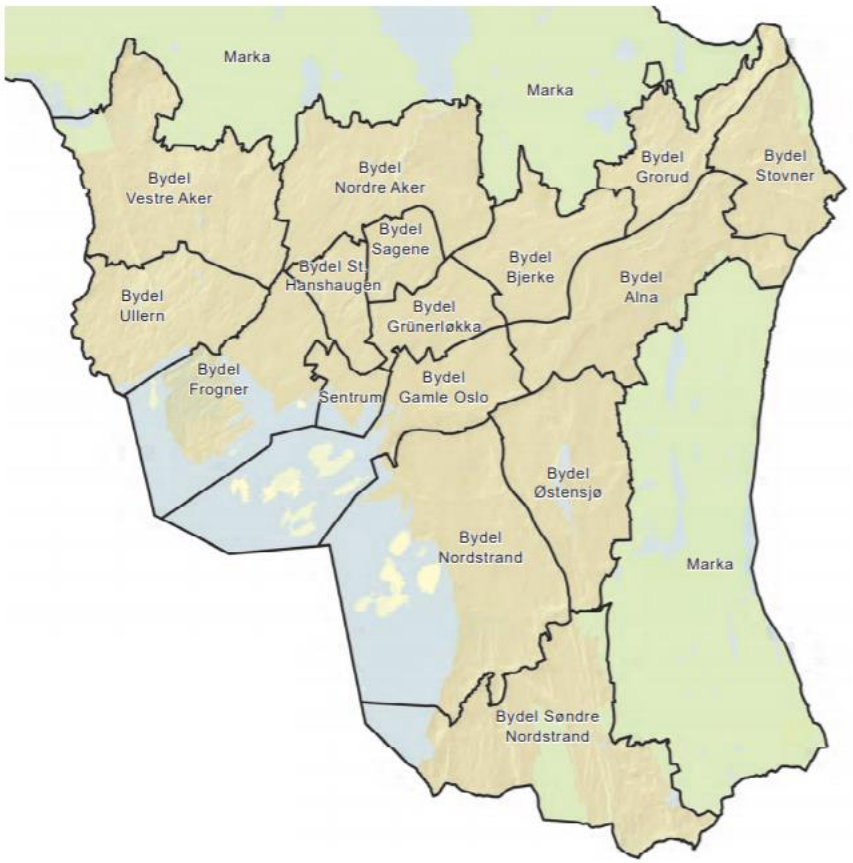
8 Appendix

Appendix 1: Map of city districts



Oslo kommune, Plan- og bygningsetaten. (2017) Map of city districts. Collected from: https://www.oslo.kommune.no/getfile.php/13206469/Innhold/Politikk%20og%20administrasjon/Statistikk/Geografiske%20inndelinger/Oslo_Bydelskart_20170221_A3.pdf

Appendix 2: City districts

This table shows the 17 city districts of Oslo 2018. Source: Eiendomsverdi. Area transaction report

St. Hanshaugen	Vestre Aker	Sentrum	Grorud
S Nordstrand	Gamle Oslo	Stovner	Marka
Grünerløkka	Østensjø	Sagene	Bjerke
Nordre Aker	Frogner	Ullern	Alna
Nordstrand			

Appendix 3: Unemployment and Income

This table shows the average unemployment rate and income in the time span 2008 to 2015 for the 17 city districts of Oslo. Unemployment is presented as per cent per capita for the age group 15 to 74 that are registerd as unemployd. Income is presented as median income per kapita in norwegian kroner for individuals older than 17. Source: SSB (2018). Table 05854: Hovedposter fra ligninga for bosatte personer 17 år og eldre, etter alder. Gjennomsnitt og median. Table 09428: Registrerte arbeidsledige 15-74 år, etter alder.

Unemployment*		Income**	
Vestre Aker	1,80 %	Vestre Aker	523.917
Nordre Aker	1,82 %	Ullern	508.417
Ullern	1,84 %	Marka	464.750
Marka	1,96 %	Nordstrand	451.333
Nordstrand	2,05 %	Nordre Aker	442.333
Østensjø	2,45 %	S Nordstrand	435.333
St. Hanshaugen	2,67 %	Østensjø	397.333
Frogner	2,82 %	Stovner	396.083
Sagene	2,95 %	Alna	372.916
Alna	3,86 %	Bjerke	367.916
Bjerke	3,88 %	Grorud	354.833
Grorud	4,01 %	Frogner	352.583
Grünerløkka	4,04 %	Sagene	336.666
S Nordstrand	4,10 %	Gamle Oslo	327.666
Stovner	4,15 %	St. Hanshaugen	327.333
Gamle Oslo	4,27 %	Grünerløkka	324.333
Sentrum	5,04 %	Sentrum	241.083

** Median income per capita

* Unemploymentrate in per cent per capita

Appendix 4: Benefits and Singel living

This table presents the average amount of benefits recived and amount of singel living in the time span 2008 to 2015 for the 17 city districts of Oslo. Benefits are presented in per cent per capita that recive social support from the state. Singel living is presented in per cent and is them amount of households that are registered as one person households that are 18 yers or older. Source: SSB (2018). Table 04932: G. Sosialtjenesten, bydel – nøkkeltall. Table 06096: Personer 18 år og over i privathusholdninger. Andel som lever/ikke lever i par

Benefits*		Singel**	
Ullern	1,21 %	Marka	39 %
Vestre Aker	1,25 %	Vestre Aker	40 %
Nordstrand	1,82 %	S Nordstrand	41 %
Nordre Aker	1,98 %	Nordstrand	41 %
Østensjø	2,44 %	Ullern	41 %
Frogner	2,55 %	Stovner	42 %
Alna	2,75 %	Nordre Aker	44 %
Stovner	3,45 %	Østensjø	44 %
St. Hanshaugen	3,66 %	Alna	46 %
Bjerke	3,98 %	Bjerke	46 %
S Nordstrand	4,17 %	Grorud	48 %
Grorud	4,55 %	Gamle Oslo	58 %
Grünerløkka	4,88 %	Frogner	59 %
Sagene	5,28 %	Sagene	60 %
Gamle Oslo	6,38 %	Grünerløkka	60 %
Sentrum	N/A	St. Hanshaugen	62 %
Marka	N/A	Sentrum	77 %

** Per cent of households living in singel family homes

* Per cent receving benefits per capita

Appendix 5: Age distribution and education level

This table presents the average age distribution and education level in the time span 2008 to 2015 for the 17 city districts of Oslo. The age distribution is presented in per cent and divided into groups 19 to 34 and 35 to 66. Education level presented in percent, showing the amount of the population with education higher than upper secondary school at age 16 and over. Source: SSB (2018). Table: 10826: Folkemengde, etter kjønn og ettårig alder. 1. januar (B) 2001 - 2018. Table 09434: Utdanningsnivå, etter bydel og kjønn.

19-34 år		35-66 år	
Sentrum	60 %	Marka	51 %
St. Hanshaugen	47 %	Ullern	43 %
Grünerløkka	45 %	Vestre Aker	43 %
Sagene	44 %	Nordstrand	43 %
Gamle Oslo	38 %	S Nordstrand	42 %
Frogner	38 %	Stovner	42 %
Bjerke	24 %	Grorud	42 %
Alna	24 %	Alna	41 %
Nordre Aker	24 %	Østensjø	41 %
Grorud	22 %	Nordre Aker	41 %
S Nordstrand	22 %	Bjerke	40 %
Stovner	20 %	Frogner	38 %
Østensjø	20 %	Gamle Oslo	38 %
Ullern	19 %	Sagene	35 %
Nordstrand	19 %	Grünerløkka	35 %
Vestre Aker	19 %	St. Hanshaugen	34 %
Marka	15 %	Sentrum	33 %

Education level above upper secondary school	
Sentrum	57 %
Ullern	53 %
Vestre Aker	53 %
Nordre Aker	51 %
St. Hanshaugen	50 %
Frogner	47 %
Sagene	46 %
Grünerløkka	40 %
Nordstrand	39 %
Gamle Oslo	36 %
Marka	33 %
Østensjø	31 %
Bjerke	28 %
Søndre Nordstrand	26 %
Alna	22 %
Grorud	20 %
Stovner	17 %

Appendix 6: Discriptiv statistics

This table presents the discriptive statistics for the random sample from the 17 city districts of Oslo in the timespan 2008 to 2015. Living area is the size of the housing. Registration date is the date when the housing was registered. . Common debt is the amount of debt the housing is obliged to. Property size if the size of the whole property. City districts represent what part of the city the housing belongs to. Estate type define if the housing is detached or an apartment. Gross area represents the floor area within the walls of the building. Ownership represents the ownership type of the housing. Sales date is the date of sale. Year built represents the original building year of the housing. Price M2 is the price divided by the number of square meters. Address is the address of the housing. Price is the salesprice of the housing. Source: Eiendomsverid. Area transaction report.

	Obs	Mean	Std. Dev.	Min	Max
Value*	26.998	3.200.000	2.000.000	135.000	38.812.000
Price	26.998	3.100.000	2.100.000	50.000	38.750.000
Common debt	26.998	191.272	357.889	10	6.352.282
Living area (size)	26.998	76	44	13	483
Price M2	26.998	44.504	14.337	3.205	334.586
Gross area	26.984	76	61	14	592
Property size	26.998	12.018	19.585	0	99.969

Appendix 7: Observations per city district

This table presents the observations per city districts for the random sample from the 17 city districts of Oslo in the timespan 2008 to 2015. Source: Eiendomsverdi. Area transaction report.

	Obs		Obs
Alna	1.780	Self owner	14.345
Bjerke	1.147	Cooperative	12.653
Frogner	2.906	Detached house	3.284
Gamle Oslo	2.625	Appartment	23.714
Grorud	957		
Grunerløkka	3.364		
Nordre Aker	1.492		
Nordstrand	1.652		
Sagene	2.831		
St Hanshaugen	1.983		
Stovner	833		
Søndre Nordstrand	1.005		
Ullern	1.177		
Vestre Aker	1.369		
Østensjø	1.877		

Appendix 8: Prediciton low income area

The table shows the results from the main model. First rows show results from before the introduction of the down payment requirement, while the last rows results from after the introduction of the down payment requirement. The first column (amount) represents number of observations observed in the area of interest. The second column (per cent) is the number of observed observations in the area of interest divided by the total amount of observations. The last column represents the change from before to after the introduction of the down payment requirement. Deviation size represents the average deviation from sales on average from the confidence interval.

	Amount	Per cent	Δ**
After down payment	13.549		
Amount of sales under	2.495	18 %	-25 %
Amount of sales innside	4.858	36 %	21 %
Amount of sales over	6.196	46 %	4 %
Deviation size sales under	-0,01869	-2 %	
Deviation size sales over	0,014397	1 %	
Before down payment	4.037		
Amount of sales under	1.753	43 %	
Amount of sales innside	608	15 %	
Amount of sales over	1.676	42 %	
Deviation size sales under*	-0,0325	-3 %	
Deviation size sales over*	0,012686	1 %	

Appendix 9: Prediciton high income area

The table shows the results from the main model. First rows show results from before the introduction of the down payment requirement, while the last rows results from after the introduction of the down payment requirement. The first column (amount) represents number of observations observed in the area of interest. The second column (per cent) is the number of observed observations in the area of interest divided by the total amount of observations. The last column represents the change from before to after the introduction of the down payment requirement. Deviation size represents the average deviation from sales on average from the confidence interval.

	Amount	Per cent	Δ**
After down payment	7.055		
Amount of sales under	1.395	20 %	-25 %
Amount of sales innside	2.787	40 %	25 %
Amount of sales over	2.873	41 %	0 %
Deviation size sales under	-0,02209	-2 %	
Deviation size sales over	0,016801	2 %	
Before down payment	2.349		
Amount of sales under	1.054	45 %	
Amount of sales innside	331	14 %	
Amount of sales over	964	41 %	
Deviation size sales under	-0,0255	-3 %	
Deviation size sales over	0,015206	2 %	

Appendix 10: Selected city districts

This table presents a summary for the four selected city districts identified from the analysation of the ssb data. The selected city districts are: Ullern, Stovner, Alna and Nordre Aker. Education is the per cent of the population over 16 years that has education past upper secondary school. Unemployment is presented as per cent per capita for the age group 15 to 74 that are registerd as unemployd. Income is presented as median income per kapita in norwegian kroner for individuals older than 17. Benefits are presented in per cent per capita that recive social support from the state. Singel living is presented in per cent and is them amount of households that are registered as one person households that are 18 yers or older. The age distribution is presented in per cent of the population. Source: SSB (2018). Table 05854: Hovedposter fra ligninga for bosatte personer 17 år og eldre, etter alder. Gjennomsnitt og median. Table 09428: Registrerte arbeidsledige 15-74 år, etter alder. Table 04932: G. Sosialtjenesten, bydel – nøkkeltall. Table 06096: Personer 18 år og over i privathusholdninger. Andel som lever/ikke lever i par. Table: 10826: Folkemengde, etter kjønn og ettårig alder. 1. januar (B) 2001 - 2018. Table: 10826: Folkemengde, etter kjønn og ettårig alder. Table 09434: Utdanningsnivå, etter bydel og kjønn.

	Ullern	Stovne	Alna	Nordre Aker
Education	53 %	17 %	22 %	51 %
Unemployment	2 %	4 %	4 %	2 %
Benefits	2 %	3 %	3 %	2 %
Singel	41 %	42 %	46 %	44 %
Age 18>	22 %	26 %	24 %	24 %
Age 19-34	19 %	20 %	24 %	24 %
Age 35-66	43 %	42 %	41 %	41 %
Age 67<	15 %	12 %	11 %	12 %
Income	508.416	396.083	372.916	442.333
Assets	870.658	347.650	362.250	650.941

Appendix 11: Descriptive statistics

This table presents the discriptive statistics for the four city districts Ullern, Alna, Stovner and Nordre Aker in the timespan 2008 to 2015. Living area is the size of the housing. Registration date is the date when the housing was registered. . Common debt is the amount of debt the housing is obliged to. Property size if the size of the whole property. City districts represent what part of the city the housing belongs to. Estate type define if the housing is detached or an apartment. Gross area represents the floor area within the walls of the building. Ownership represents the ownership type of the housing. Sales date is the date of sale. Year built represents the original building year of the housing. Price M2 is the price divided by the number of square meters. Address is the address of the housing. Price is the salesprice of the housing. Source: Eiendomsverid. Area transaction report.

	Obs	Mean	Std. Dev	Min	Max
Value*	27.082	3.354.571	2.065.695	1.090.000	11.200.000
Price	27.082	3.268.904	2.101.937	850.000	11.200.000
Common debt	27.082	128.281	203.237	1.149	1.523.950
Living area (size)	27.082	86	45	26	263
Price M2	27.082	39.755	13.199	18.578	75.684
Gross area	27.082	89	65	29	330
Property size	27.082	22.386	25.544	476	99.969

Appendix 12: Descriptiv statistics

This table presents the observations per city districts for the four city districts Ullern, Alna, Stovner and Nordre Aker in the timespan 2008 to 2015. Source: Eiendomsverid. Area transaction report.

Obs		Obs	
Alna	9112	Self owner	13377
Nordre Aker	7598	Cooperative	13705
Stovner	4282	Detached house	5480
Ullern	6090	Appartment	21602

Source: Eiendomsverdi. Area transaction report

Appendix 13: Prediction results Nordre Aker

The table shows the results from the additional forecasting model. First rows show results from before the introduction of the down payment requirement, while the last rows results from after the introduction of the down payment requirement. The first column (amount) represents number of observations observed in the area of interest. The second column (per cent) is the number of observed observations in the area of interest divided by the total amount of observations. The last column represents the change from before to after the introduction of the down payment requirement. Deviation size represents the average deviation from sales on average from the confidence interval.

	Amount	Per cent	Δ**
After down payment	5497		
Amount of sales under	765	14 %	-32 %
Amount of sales innside	1521	28 %	19 %
Amount of sales over	3211	58 %	13 %
Deviation size sales under	-0,01106	-1 %	
Deviation size sales over	0,013889	1 %	
Before down payment	2097		
Amount of sales under	964	46 %	
Amount of sales innside	173	8 %	
Amount of sales over	960	46 %	
Deviation size sales under	-0,01305	-1 %	
Deviation size sales over	0,01246	1 %	

Appendix 14: Prediction results Ullern

The table shows the results from the additional forecasting model. First rows show results from before the introduction of the down payment requirement, while the last rows results from after the introduction of the down payment requirement. The first column (amount) represents number of observations observed in the area of interest. The second column (per cent) is the number of observed observations in the area of interest divided by the total amount of observations. The last column represents the change from before to after the introduction of the down payment requirement. Deviation size represents the average deviation from sales on average from the confidence interval.

	Amount	Per cent	Δ**
After down payment	4463		
Amount of sales under	751	17 %	-27 %
Amount of sales innside	1656	37 %	25 %
Amount of sales over	2056	46 %	1 %
Deviation size sales under	-0,01072	-1 %	
Deviation size sales over	0,01019	1 %	
Before down payment	1625		
Amount of sales under	707	44 %	
Amount of sales innside	189	12 %	
Amount of sales over	729	45 %	
Deviation size sales under	-0,01173	-1 %	
Deviation size sales over	0,010908	1 %	

Appendix 15: Prediction results Stovner

The table shows the results from the additional forecasting model. First rows show results from before the introduction of the down payment requirement, while the last rows results from after the introduction of the down payment requirement. The first column (amount) represents number of observations observed in the area of interest. The second column (per cent) is the number of observed observations in the area of interest divided by the total amount of observations. The last column represents the change from before to after the introduction of the down payment requirement. Deviation size represents the average deviation from sales on average from the confidence interval.

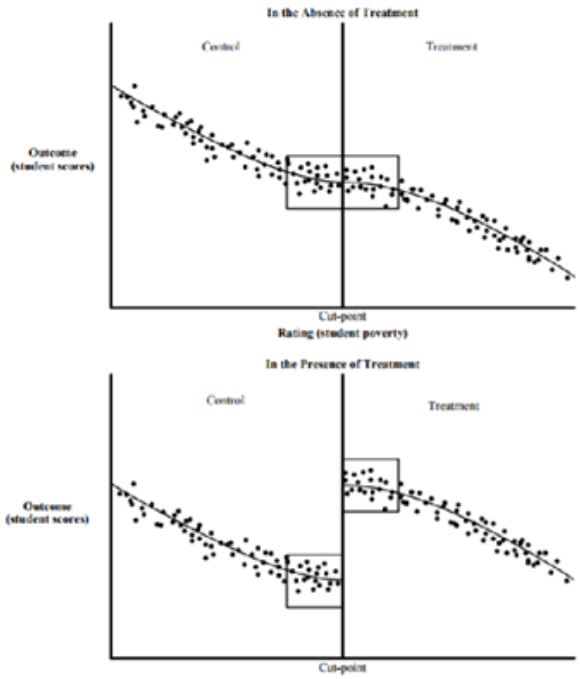
	Amount	Per cent	Δ**
After down payment	3168		
Amount of sales under	262	8 %	-36 %
Amount of sales innside	838	26 %	10 %
Amount of sales over	2068	65 %	26 %
Deviation size sales under	-0,00515	-1 %	
Deviation size sales over	0,009045	1 %	
Before down payment	1114		
Amount of sales under	494	44 %	
Amount of sales innside	178	16 %	
Amount of sales over	442	40 %	
Deviation size sales under	-0,00617	-1 %	
Deviation size sales over	0,006873	1 %	

Appendix 16: Prediction results Alna

The table shows the results from the additional forecasting model. First rows show results from before the introduction of the down payment requirement, while the last rows results from after the introduction of the down payment requirement. The first column (amount) represents number of observations observed in the area of interest. The second column (per cent) is the number of observed observations in the area of interest divided by the total amount of observations. The last column represents the change from before to after the introduction of the down payment requirement. Deviation size represents the average deviation from sales on average from the confidence interval.

	Amount	Per cent	Δ**
After down payment	7013		
Amount of sales under	756	11 %	-36 %
Amount of sales innside	1112	16 %	5 %
Amount of sales over	5145	73 %	31 %
Deviation size sales under	-0,0056	-1 %	
Deviation size sales over	0,010764	1 %	
Before down payment	2094		
Amount of sales under	975	47 %	
Amount of sales innside	235	11 %	
Amount of sales over	884	42 %	
Deviation size sales under	-0,00603	-1 %	
Deviation size sales over	0,006605	1 %	

Appendix 17: RDD



Source: Jacob, R., Zhu, P., Somers, M. A., & Bloom, H. (2012). A Practical Guide to Regression Discontinuity. *MDRC*. RDD cut-off point, p. 5. Collected from: https://files.eric.ed.gov/fulltext/ED565862.pdf)

Appendix 18: Rental index

The table shows the rental index calculated using rental prices from both the low wealth and the high wealth areas. 100 is used as the base from the first quarter of 2008, and the number after are calculated based on the development in rents from one quarter to the next. Source: Boligbygg.

Index	Low	High
Q1 2008	100	100
Q2 2008	102,36	104,09
Q3 2008	107,69	109,65
Q4 2008	103,76	106,61
Q1 2009	95,59	100,10
Q2 2009	98,86	101,84
Q3 2009	100,74	102,53
Q4 2009	102,49	103,08
Q1 2010	103,00	103,47
Q2 2010	106,91	106,62
Q3 2010	107,61	108,82
Q4 2010	107,26	110,07
Q1 2011	108,68	112,90
Q2 2011	110,42	115,29
Q3 2011	113,40	116,18
Q4 2011	114,01	116,11
Q1 2012	116,21	116,58
Q2 2012	118,49	121,08
Q3 2012	123,10	122,15
Q4 2012	123,40	122,30
Q1 2013	123,28	122,15
Q2 2013	128,99	124,13
Q3 2013	129,90	123,27
Q4 2013	129,37	124,97
Q1 2014	129,86	124,66
Q2 2014	127,58	122,32
Q3 2014	125,80	122,29
Q4 2014	129,05	122,21
Q1 2015	132,53	127,77
Q2 2015	134,23	128,77
Q3 2015	136,03	130,22

Preliminary thesis

Table of content

1. Introduction

The Norwegian housing market has experienced a significant growth from 1993 until 2016 (SSB, 2018), and especially Oslo has seen a major boom in the later years. The increase in prices can to some extent be explained through demographic factors such as urbanization and centralization, and macroeconomic factors such as decreasing interests, access to liquidity, favorable tax incentives and an increase in real wages (Larsen & Sommervoll, 2004). There are opinions that the escalation in prices also have a speculative component to it, that investors speculate in real estate to monetize on short term gains with significant profits. However, these arguments have been backed up by limited empirical research.

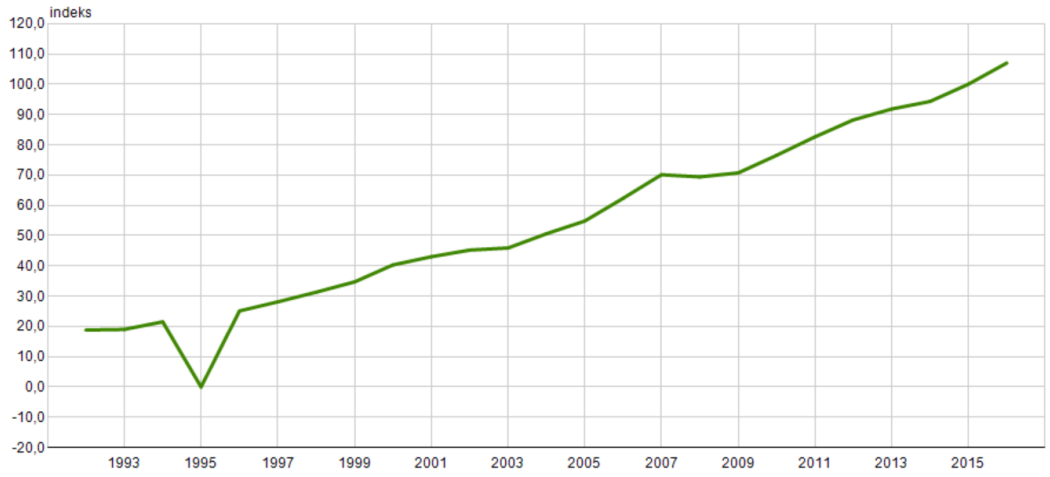


Figure 1. Norwegian house price index (Source:https://www.ssb.no/statbank/table/10187/?rxid=3f004ce4-2373-4a83-ac41-effcb9ca3bdc)

The rapid development in housing prices, especially in Oslo, have been a hot topic among press and academics the last couple of years. After the American housing bubble that later lead to an international financial crisis, government across the globe started taking actions to protect private consumers and financial stability. Baffoe-Bonnie (1998) research show that that idiosyncratic shocks such as tax policy and land regulations affect housing prices to some extent. In Norway, the Financial Supervisory Authority of Norway, known as Finanstilsynet, introduced new guidelines to secure private household's sensitivity from increased interests on high mortgages among other factors. The new down payment requirement demanded an equity stake of 10 % of the purchasing price from the 3rd of March 2010, that later increased to 15% the 1st of December 2011 (Finanstilsynet, 2011).

Owning your own home has for many years been an increasing trend in Norway, and 8 out of 10 households own their own property (SSB, 2016). In the lower percentile of the income ladder (earning less than 60% of the median income) homeownership is less than 4 out of 10 (SSB, 2016). An essential part of being applicable for buying a home is that you have the required down payments as depicted by the guidelines. (Finanstilsynet, 2011).

Oslo is a city with social differences, and this is being supported through a report from Statistical Norway, known as SSB in 2016 (Omholt, 2016). The report shows that Oslo is the county in Norway with highest differences in wages per household, and that can be explained by different factors. First of all, Oslo households consists of more than 50% one-person households. Secondly, in later years there has been a consistent flow of immigrants moving to Oslo from Eastern-Europe, Asia, Africa, and Latin-America. These individuals are to a large extent represents in the lower ends of the income distribution. On the other hand, Oslo accommodates a substantial amount of corporate institutions that generates an extensive amount of capital gain and income.

These factors are all important when understanding the income differences in Oslo and shows the diversity of the population. Research also show that there is a clear distinction between the amount of benefits received in western and eastern parts of Oslo (Sandvik & Kvien, 2015), that can have significant effects on housing prices and development in different suburbs.

2. Research question

The down payment guidelines have led to many heated discussions and opinions among both experts and academia regarding the impact on the Norwegian housing market. There has previously been some research on the effects of down payment requirements on renting and purchasing prices of housing (Johannessen et al., 2013). However there has been limited previous research regarding the impact of a down payment requirement on housing prices in Oslo, and especially when it comes to the impact of the guidelines has had on different demographics, income levels and age groups. The research question we want to investigate is as follows:

What is the impact of the down payment requirement on housing prices in Oslo?

3. Literature review

Price setting in the private housing market is complex, and a composition of demand and supply in the market, together with macroeconomic factors such as interests, wage level and unemployment (Larsen & Sommervoll, 2004). Credit availability is also a decisive factor according to Lamont & Stein (1997), where high leveraged household react more sensitive to shocks and changes such as per-capita income. Where the amount borrowed is tied with the value of the of the house and a fall in housing prices could lead to drop in house prices. This due to the ability of the borrower to use their house as collateral for the loan leading to a lower demand (Stein & Jeremy, 1995).

Surveys conducted by Shiller (1990) reveals that speculative considerations when investing in large city housing in the US was the major motive for private actors. They considered small or no risk when investing in housing, and had the impression that if they did not invest in housing now, they would not be able to enter the market at a later stage. This is a known as the psychological factor of investing in real estate, and can lead to significant changes in price.

Noted by Khan and Reza (2017), private consumption can be affected by government actions through liquidity access, that influence real estate prices, and further the aggregate demand in the market. Government actions through a down payment introduction will influence the typical household at some point by giving them a liquidity constraint states Engelhardt (1996). Engelhardt further suggests in his conclusion that to examine the effects of liquidity constraints on consumption it is important to look at liquidity constraints given from lenders in the housing market.

It is empirically tested by Jappelli and Pagano (1994) that countries using higher down payment requirements have a significantly higher savings rate among households, and that binding liquidity constraints may in some cases promote growth through higher savings. In conclusion this shows that government

guidelines and actions towards liquidity access through banks is of huge impact, not only on housing prices, but on private consumption in general.

The worldwide financial crisis that hit in 2008 was induced, according to Rogoff et al. (2008), in part by the sub-prime crisis that had its roots in the rapid decline of housing prices in the US. Were complex bundling of obligations were packed together in non-transparent instruments that were illiquid when housing prices started to drop. Most of defaults were among less creditworthy individuals.

Engelhardt (1996) states that down payments give an equity stake for the homeowner that induces risk sharing between the lender and owner in case of market wide decline. This equity increase reduces the probability of systematic default risk, but comes at the cost of the borrower requiring more equity in their house (Campbell & Hercowitz, 2005). Empirical evidence also shows that equity requirements reduce financial risk, but at the same time increases the barrier of entry for new house owners and individuals within the lower part of the financial ladder (Linneman & Wachter, 1989).

Academia and experts on the field point out that the down payment requirement will have a much higher impact on low-income individuals (Johannessen et al., 2013), often young individuals, than settled older individuals. However, we find a lack of empirical research that studies the comparison between low-income individuals and high-income individuals, and the impact of a change in down payment requirements on the development of housing prices in these two types of areas.

Research done on the Norwegian bank crisis in 1987-1993, links it to the strong decline of housing prices in the timespan 1986-1992 due to monetary policy and high real interest rates (Moe et al., 2004). Showing the need for instruments to reduce the downside risk in case of a market wide crisis. Previous unpublished thesis implies that the introduction of a down payment requirement had an impact on the housing market in Oslo (Holmen & Håkonsen, 2014), but not to an extent that was able affect the market trend. Holmen and Håkonsen also point out the fact that the requirement might create a class distinction, where low-income

individuals cannot be a part of the growth in the housing market. Well known Norwegian economists and writers such as Jan Andreassen from Eika Gruppen (Tjersland, 2015) have stated that the down payment requirement brings inequality among the population favoring the percentile in the higher part of the income ladder.

When Finanstilsynet introduced the down payment requirements their intention was to diminish risk among house owners in Norway and reduce the debt increase among Norwegian households (Finanstilsynet, 2011). The rapid increase of debt over the last years has created concern if a sudden consolidation of housing debt would lead to lower consumption that could in theory reduce the financial stability of Norway. NIBR (Norwegian institute for city and region research) report from 2013 shows that the new down payment requirements have affected first time buyers and individuals in the lower part of the financial ladder. Where first time buyers that must be assisted by parents or relatives has increased.

Norwegian economists such as Christian Dreyer have been critical of the new down payment requirements especially when it comes to creating a distinction among classes in society (Dreyer, K. 2014). Lastly a survey done by Norstat for Finans Norge (2012) shows an opinion in the Norwegian population that 8/10 people think that the new down payment requirements creates such a distinction among classes in society. Another interesting point uncovered by the survey shows that the number of individuals receiving help from family and friends when financing housing has from 2009 to 2012 increased from 15% to 35%. This could create a distinction where the individuals that have the access to financial support would benefit over the individuals that don't.

Similar down payment practice has been done in other Scandinavian countries. In Sweden 2010, the Financial Supervisory Authority of Sweden set a requirement of 15% equity when purchasing a home (Mäklarsamfundet, 2013). In 2011, a survey was produced showing a trend reduction in housing with low down payments (Finansinspektionen, 2011) which coincides with research done on the US housing market. Many had critical opinions on these new requirements due to the implications on first time buyers and financially weak individuals not being able

to participate in the housing market, creating a distinction between different classes in society (Mäklarsamfundet, 2013) (Törnberg, 2012). In the first quarter of 2011 to the last quarter of 2016 the average price of used housing in Norway has increased by almost 37% (SSB, 2017).

4. Methodology

4.1 Statistical approach

We want to research if the new down payment guidelines set by Finanstilsynet has influenced the housing market in Oslo. This paper will take an empirical approach using time series data and the span we want to observe is 2005-2016, depending on the data available. Wen working with time series it is applicable to use panel data regressions (Stock & Watson, 2015, p.396). The shift we want to study is before and after 2010 and 2011 when the down payment requirement guidelines where set into effect, and analyze house prices in the time span noted previously.

Similar research has been done in China by Sun et al (2014) on the implementation of a house purchase restrictions (HPR) in Beijing. Employing regression discontinuity design (RDD) they found that the HPR triggered a 17-32% price drop on housing. Further, a drop of 25% in the price-to-rent ratio, and interestingly enough rental prices that were not significantly impacted. Given the resemblance of this research paper to our thesis, we find it adequate to use RDD to measure the down payment implications on housing prices.

Thistlethwaite & Campbell (1960) were the first researchers to implement RDD by applying it to the field of psychology, and continued working with it until 1980. Further confirmations were made by Goldberg (1972) showing further proof, reinforcing the design in economics. In the 1990`s RDD was favored in psychology and education, in work such as the study of class sizes on school performance (Angrist and Lavy,1999), treatment in randomized controlled clinical trials (Finkelstein et al., 1996) and analysis of randomized clinical trials (Cappelleri, 1991). In later years, influential papers such as incentive effects of social assistance (Lemieux & Milligan, 2004), the effect of financial aid offers on college enrollment (Klaauw, 2002), and the effects of delayed entry to

kindergarten (McEwan & Shapiro, 2008) has continued developing this statistical tool.

There are two types of RDD (Stock & Watson, 2015, p.546), sharp- and fuzzy regression discontinuity design, known as SRDD and FRDD respectively. In SRDD, the cut-off point is absolute and any participants above the threshold c$\underline{\leq}$ are given the treatment. In FRDD, the c threshold gets "Fuzzy", were being over the threshold increases probability of getting the treatment, but it is not an absolute. Same with being under the threshold greatly lowers probability, but is not absolute. In our analysis, we want to apply both designs to further understand how the guidelines has affected the housing market. SRDD is useful to create a clean cut-of date of the implementation of payment requirements, and by using FRDD we can look at intervals creating a prolonged cut-of period. We expect that the changes in housing prices will not react exactly at the cut-off point, but rather at a prolonged period subsequently. This is due to the time that the market uses to adapt to changes, and that financial institutions usually grants loans certificates to individuals for periods of about 3 months at a time.

In the paper by Jacob et al. (2012) they discuss the application of RDD in medical research, where the cut-off point separates the control group into non-treated and treated group. Where if the treatment regression line moves continuously through the cut-off point implies that the treatment had no effect (figure 2, top part). If the treatment had an effect we would see a shift in the observations, creating a discontinuity at the cut-off point as seen in the bottom part of figure 2.

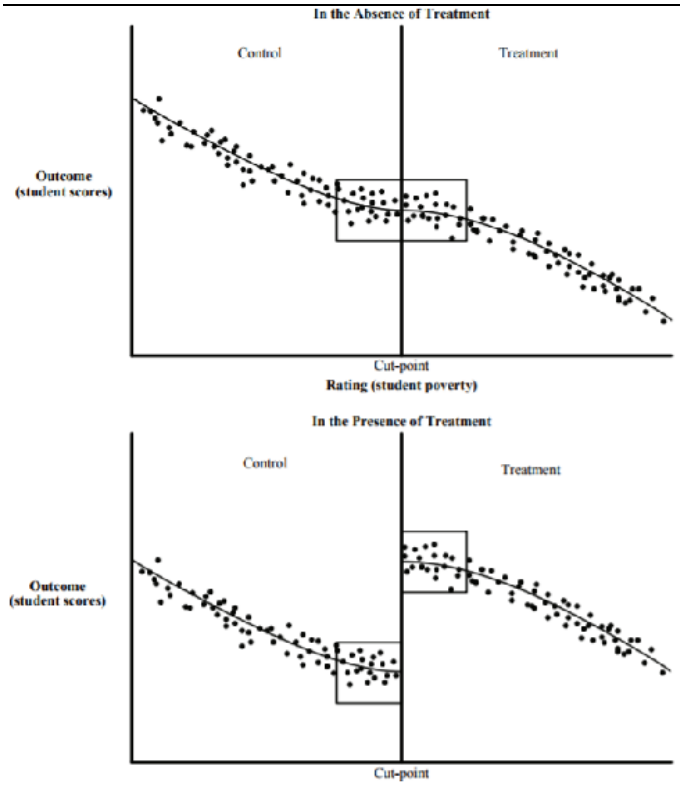


Figure 2. RDD cut-of point. (Source: https://files.eric.ed.gov/fulltext/ED565862.pdf)

$$Y_i = \alpha + \beta_0 T_i + f(r_i) + \varepsilon_i$$

α = the average value of the outcome for those in the treatment group after controlling for the rating variable;
Y_i = the outcome measure for observation i;
T_i = 1 if observation i is assigned to the treatment group and 0 otherwise;
r_i = the rating variable for observation i, centered at the cut-point;

Figure 3. RDD regression design. (Source: https://files.eric.ed.gov/fulltext/ED565862.pdf)

We want to use a similar approach, but where we have two cut of points that we want to investigate. First, we want to check the guidelines introduced in 2010, where the down payment requirements were set to 10%, and secondly the guidelines set into effect in 2011, increasing the down payment requirements to 15%. Where the data before the implementations of 2010 and 2011 will be the control group, and data after the implementation will be the treated group. We test the null hypothesis that there is no discontinuity, that the down payment requirements have had no effect on the housing market in Oslo. The alternative hypothesis will be that there was a discontinuity and housing prices in Oslo were affected by the down payment guidelines as shown in figure 4.

Null hypothesis:

$\alpha_0 = \alpha_1, \beta_0 = \beta_1$

Alternative hypothesis:

$Y_i = \alpha_0 + \beta_0 T_i, \quad < \bar{c}$
$Y_i = \alpha_1 + \beta_1 T_i, \quad \geq \bar{c}$

Figure 4. Hypothesis design.

The RDD approach has several weaknesses, and some issues can appear compromising the results. Contamination is a real threat when using RDD. If other incidents happen in the same timespan as the guidelines, then the measured discontinuity may be attributed to other events than the down payment guidelines. Such events could be other regulations, tax measures, change in saving incentives and credit restrictions etc. A lot depends on the detail level on the dataset acquired. If we can monitor the discontinuity closely we will be able to cross reference it with other events, minimizing the risk of contamination. The fact that we have two cut-off points makes it easier to follow. Further, through closely inspecting the data to get a deep understanding, we hope to avoid any concerns about design and fitting issues of the model.

4.2 Hypothesis

Based on our research question and the methodology applied on our thesis, we have developed a few hypotheses that we want to check:

- Has there been a difference in housing price development in the eastern part of Oslo compared to the western part, after the introduction of down payment requirements?
- Have the renting prices in low income suburbs developed more rapidly than renting prices in high income suburbs due to lower access to equity?
- Have the down payment requirements increased the average age of a first-time buyers due to equity constraints?
- Have the down payment requirements affected the price-to-rent ratio in Oslo?

4.3 Data Collection

To collect the data needed to implement our analysis we have decided to contact different types of companies to gather the information desired. First, we will contact Eiendomsverdi. Eiendomsverdi is Norway's largest database consisting of housing prices in the Norwegian housing market. We are interested in collecting detailed information regarding square meter prices in Oslo in total, as well as dividing Oslo into their 15 different suburbs and gather data from each suburb.

From SSB and The Norwegian Tax administration, known as Skatteetaten we want to collect data regarding income and wealth. We either want to calculate the average income in each suburb, and then establish the low-income suburbs and high-income suburbs to analyze the differences in price development. Or, we want to divide Oslo into two parts, namely west and east to establish differences in income and wealth.

To gather data about the rental market in Oslo we plan to contact SSB, and Norwegian house renting companies like Utleiemegleren and Leiebolig, among others. Since the renting market for housing is dependent on the development in housing prices, it would be interesting to check the development in renting prices after the introduction of the down payment requirement. One might think that development in renting prices in areas where individuals face challenges in entering the housing market will increase if the housing prices is being affected by the government guidelines.

The Norwegian State Housing Bank, known as Husbanken, is an important branch of the Norwegian government in order to assist municipalities, both through experience and financials, in supporting disadvantaged individuals getting into the housing market. As a part of our analysis it might be helpful for us to get insight to their data on the development of mortgages for first-time buyers after the introduction of the down payment requirement. If the restriction has had a negative effect on the number of first-time buyers it will be reasonable to think that the number of debts issued by Husbanken has dropped.

Other organizations we plan to contact:

- Finans Norge
- Finanstilsynet
- Eiendom Norge
- Norges Eiendomsmeglerforbund
- Schibsted / Finn.no

Schedule of work

This is a guideline schedule and is subject to change, depending on progress and unknown events that may appear in our work.

Week	
4	Break
5	Breakdown of tasks, planning of work
6	Data collection, comunicationg with Eiendom Norge
7	Data collection, comunicating with SSB
8	Reaserch and prepare model
9	Reaserch and prepare model
10	Specify model
11	Estimate and develop housing prices
12	Estimate and develop housing prices
13	Easter
14	Interpret results from model
15	Interpret results from model
16	First draft finalized
17	Deliver first draft
18	Prepare for exam in GRA 6214
19	Prepare for exam in GRA 6214
20	Feeddback and supervisor adjustments
21	Adjust and develop final thesis
22	Break
23	Final work
24	Final work
25	Proofreading
26	Feedback and minor adjustments
27	Print and deliver

Figure 5. Schedule thesis work.

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Appendix

Figure 1: SSB. (2018). Prisindeks for brukte boliger. Collected from https://www.ssb.no/statbank/table/07230/chartViewLine/?rxid=1a7baec3-5c26-4167-86ba-c11c674cf2fd

Figure 2: RDD cut-of point. Jacob, R., Zhu, P., Somers, M. A., & Bloom, H. (2012). A Practical Guide to Regression Discontinuity. MDRC.

Figure 3: Jacob, R., Zhu, P., Somers, M. A., & Bloom, H. (2012). A Practical Guide to Regression Discontinuity. MDRC.

Figure 4: Hypothesis design.

Figure 5: Thesis schedule.