THE EFFECTS OF MORTGAGE RATES ON THE HOUSING MARKET

Evidence from a discontinuity in availability of mortgage guarantees

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ABSTRACT

In the Netherlands buyers of houses can opt for the Dutch National Mortgage Guarantee (NHG), this guarantee leads to lower mortgage rates because risks for lenders are lowered. It is not known what the effect of this guarantee is on prices. This could be of interest to policy makers, because it can have unwanted side-effects or be an effective instrument to influence housing prices. To investigate these effects a Regression Discontinuity Design is used that exploits a jump in quality characteristics of houses at a cutoff. The maximum price of houses that qualify for NHG is used as cutoff. These results are translated into monetary values using a hedonic pricing model and compared with the results of a difference in difference approach using repeated sales. Data of the NVM is used on property transactions in the province *Zuid Holland*, from 2010 until 2020 is used. Surprisingly a negative impact on house prices is found. Which is not in line with the hypotheses and unlikely to be the case. Manipulation on the transaction prices or the limit of NHG functioning as a focal point of house prices could influence the results. This makes it not possible to make definitive recommendations and give a conclusive answer to the research question.

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1 INTRODUCTION

House prices in the Netherlands are rapidly rising. The prices of existing owner-occupied homes where already at record levels in 2020. Reaching the highest level since 1995 (CBS, 2021c). This rise has continued in 2021, with existing owner-occupied homes 11.3% more expensive in March 2021 than in March 2020, which was the highest increase in prices since 2001 (CBS, 2021b). There was, next to the increase in prices, also a large increase in the number of transactions in the first quarter of 2021 in the Netherlands. In the first quarter of 2021 66,627 existing owner-occupied homes were sold, an increase of 29.2% (CBS, 2021a).

There is lots of speculation about the underlying reasons of these increases. Covid seems to have some impact on the amount of people who want to move or renovate their house (NOS, 2021a). Although it seems more probable that the historical low interest rates and shortage of houses are driving the increase of prices and transactions.

The Rabobank expects an increase in house prices for 2021 of 8%. A shortage of construction in relation to the demand result in bidding wars between buyers, with 58% of the houses being sold for above the asking price. The low mortgage rates are having an even higher effect on the development of the prices than the shortage of homes (De Groot, Erken, & Van Harn, 2021)

In the meantime the government is struggling to get policies in place to counter this enormous rise of prices. Especially to keep it possible for young people to enter the housing market without an extraordinary high income. The share of sales to individuals who buy their first home has decreased from 48% in 2013 to 32% in 2019 (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2020). To accommodate starters, the transfer tax for starters has been lowered. It is however a measure that is criticized, because it might only increase prices even more (Nieuwsuur, 2021). There are therefore also plans for increasing the supply on the housing market by building 1 million extra houses in the next decade (Couzy, 2021).

However there are also possibilities that are not considered. The NHG might have an effect on housing prices. The NHG guarantees mortgages of individuals, which results in a lower mortgage rate. It is only available for prices under a certain limit (NHG, 2021). This policy might have an impact on housing prices, either through the discount or the limit itself. It could, therefore, be an instrument for policy. Or it could have unwanted side-effects.

There has been research after the effect of mortgage rates, and most of them find a relationship between rising prices after mortgage rates dropped. Bhutta & Ringo however find no evidence of a change in housing prices after a policy that effectively increases the mortgage rate (2017). It is not clear what the effect is of the NHG in the Dutch housing market. The research question in this thesis is therefore:

"What are the effects of the NHG on prices in the Dutch housing market?"

For this research the imposed limit of the NHG will be exploited. A jump in quality characteristics of houses is expected which is caused by the NHG. This jump is exploited by comparing houses in a bandwidth around the limit using a Regression Discontinuity Design (RDD). Then a hedonic pricing model is used to investigate the monetary value of the change in quality characteristics. These results are then verified by conducting a difference in difference analysis of houses that are sold multiple times and comparing their price increase relative to other houses in the neighborhood in the same period.

The research is structured as follows. First, the context of the NHG in the housing market will be given, followed by a literature review. Thirdly, the used methodology for the RDD, the hedonic pricing model, and the difference in difference analysis will be explained. Then the data that has been used will be described, and the manipulation of the data will be stated. Next, the results will be presented for the different models. Finally, a conclusion and a discussion will follow.

2 DUTCH NATIONAL MORTGAGE GUARANTEE (NHG)

In the Netherlands, the government insures or guarantees mortgages of people who comply with the terms of the Dutch National Mortgage Guarantee or *Nationale Hypotheek Garantie* (NHG). When an individual has a mortgage with NHG and you are not able to pay your mortgage anymore, or you are forced to sell your house for less than the amount of your mortgage. The NHG helps finding a solution or takes over the remaining debt (NHG, 2021).

The NHG lowers the risk of mortgage lenders. They are therefore able to offer a lower mortgage rate. This gives mortgage lenders the chance to lower their rates for homeowners who opt for NHG. Potential owner-occupants can get a discount on their mortgage rate of up to 84 basis points. This discount was 45 basis points at the end of 2019. Defined as: the weighted average of the difference between the ten years mortgage rate with and without NHG for the maximum available loan-to-value-ratio (LTV) (NHG, 2020). When individuals opt for a mortgage with NHG, they have to pay a percentage of the amount they borrow for the purchase of the home. This percentage is 0.7% in 2021. This costs is quickly retrieved, because of the discount on mortgage rates (ABN AMRO, 2021).

There are a couple of conditions you have to meet for being able to get NHG with your mortgage. The home is meant for housing of the individual who gets the mortgage, so it is not possible to get NHG on real estate meant for subletting. Next to this there is a maximum amount for which a house can be bought with the guarantee, and there is a maximum LTV that NHG allows. The LTV has been lowered to 100% since 2018. This makes the maximum amount people can borrow with NHG the same as the maximum transaction price. In previous years costs of transaction could be financed with NHG. In these years there is a difference between the maximum amount an individual can loan and the maximum transaction price. The NHG calculates a fixed amount of extra costs, resulting in a known maximum transaction price to which NHG is available (NHG, 2019). The different NHG terms can be found in table 1.

Start new conditions	Maximum amount NHG	Additional costs calculated	Maximum purchase price house
01-07-2009	€ 350.000	12%	€ 312.500
15-06-2011	€ 350.000	8%	€ 324.074
01-07-2012	€ 320.000	8%	€ 296.296
01-01-2013	€ 320.000	5%	€ 304.762
01-07-2013	€ 290.000	5%	€ 276.190
01-01-2014	€ 290.000	6%	€ 273.584
01-07-2014	€ 265.000	6%	€ 250.000
01-07-2015	€ 245.000	6%	€ 231.132
01-01-2017	€ 245.000	0%	€ 245.000
01-01-2018	€ 265.000	0%	€ 265.000
01-01-2019	€ 290.000	0%	€ 290.000
01-01-2020	€ 310.000	0%	€ 310.000

Table 1, maximum transaction prices that can get NHG after deducting additional costs, source: NHG Terms & Conditions 2009-2020

This guarantee offers mainly two advantages to buyers. First they are protected when they are not able to pay their mortgage. Second, and more important for this research, the discount on mortgage rate effectively decrease the transaction price, because monthly payments are lowered. When a buyer wants to buy a home that is below the NHG limit, and the buyer meets the income requirements, this individual can opt in for NHG. This is done by the mortgage lender, who then will offer the discount on the mortgage rate.

3 LITERATURE REVIEW

In this section an overview of existing literature is presented. We will start with a theoretical framework of the housing market, where mainly the model of DiPasquale and Wheaton will be used to show the powers at play in the housing market, and there is some theory on hedonic pricing models and their implication for demand of properties. Next research after the interest rate and house price levels is presented, followed by other research after the effect of the mortgage rate. Then some specific characteristics of the Dutch housing market are explained. Finally the hypotheses for this research are stated.

3.1 THEORETICAL FRAMEWORK OF HOUSING MARKET

There has been conducted a lot of research into the housing market and the different economic factors that influence each other in this market. A widely renowned theoretical framework that addresses this interplay of different factors is that of DiPasquale and Wheaton (1992). Their framework concerns with both residential real estate as commercial real estate. In their framework the market for real estate is divided into two markets: one for property (space), and one for assets (ownership). These markets affect each other and this results in changes of the equilibrium of the real estate market.

According to the framework there are four quadrants that are interrelated and always changing. The framework describes in what way the quadrants influence one another. The four quadrants are: rent determination, stock adjustment, valuation, and construction. The framework is best interpreted counter clockwise. This means that when we start in the NE quadrant, rent determination, rent is determined in the property market via a demand curve. Demand is a function of rent and macroeconomic factors and is equal to the stock of space in equilibrium. This given rent is also an axis in the NW quadrant, valuation. Where prices of assets are determined, based on the rent and dependent of a capitalization rate, *i*. This capitalization rate is described as follows:

"[The capitalization rate, i, is] the current yield that investors demand in order to hold real estate."(DiPasquale & Wheaton, 1992, p. 187)

This yield consists of mainly four drivers: long-term interest rate, expected future rents, risks, and taxes.

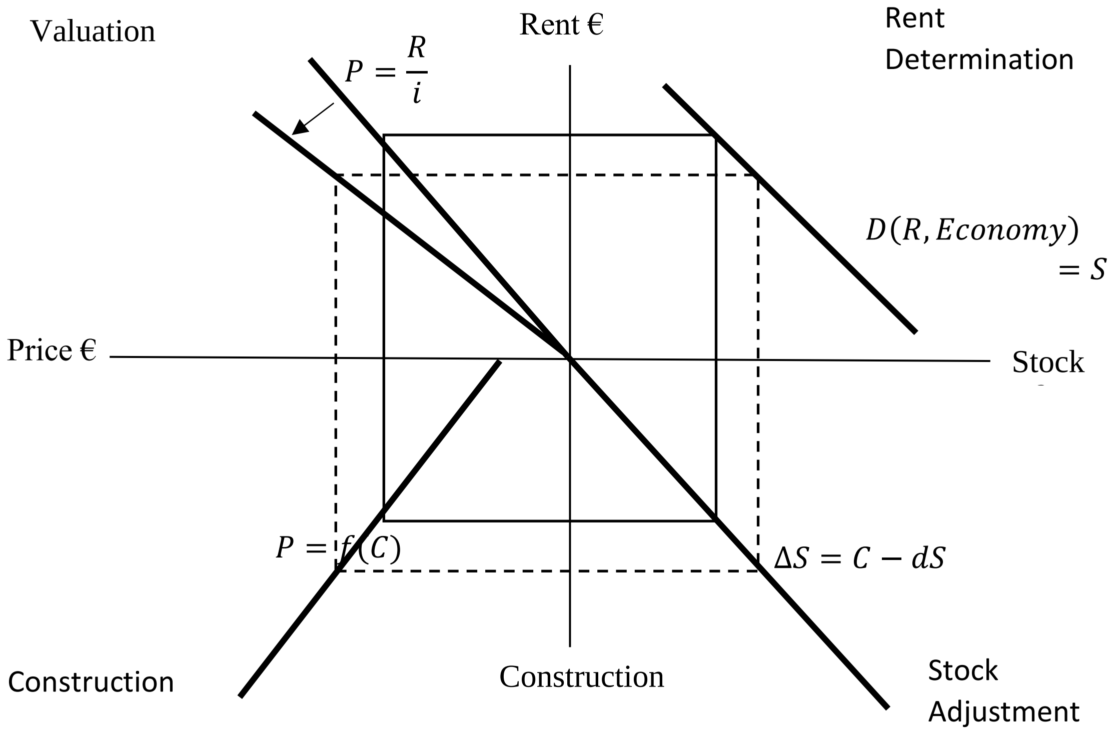


Figure 1. Graphic depiction of house price theory. Source: (DiPasquale & Wheaton, 1992)

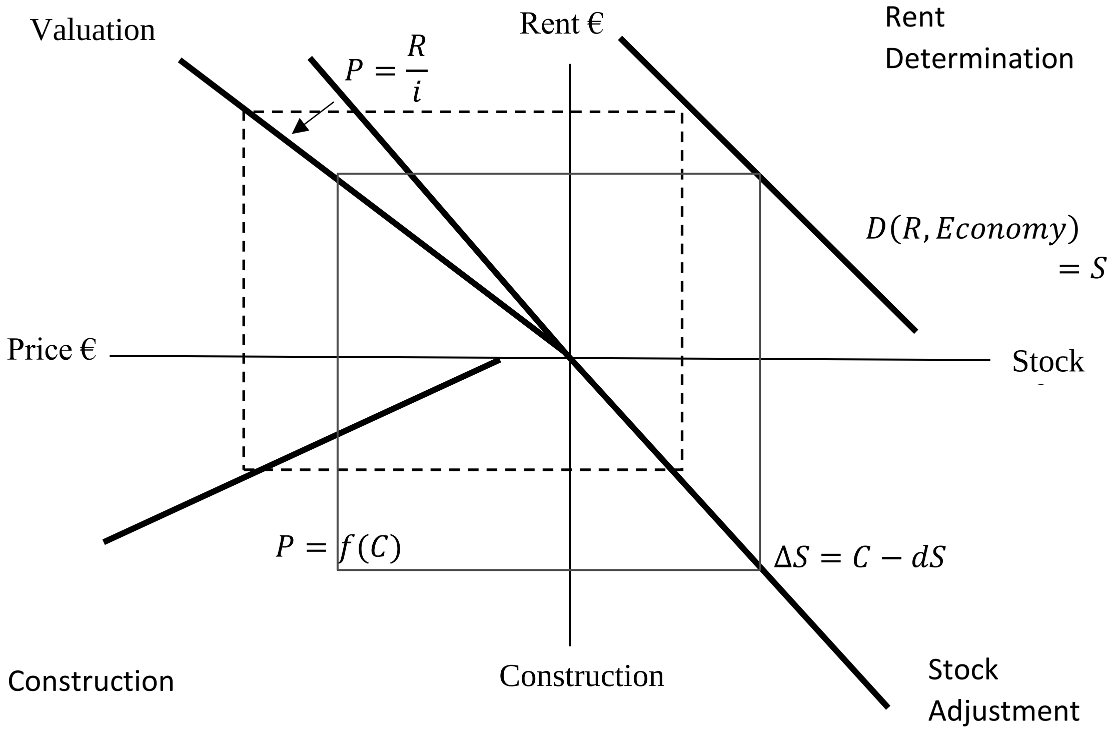


Figure 2. Graphic depiction of same change with inelastic supply. Source: (DiPasquale & Wheaton, 1992)

The price level is also the top axis in the SW quadrant, construction, where the amount of construction is a function of this price level. In the final quadrant stock adjustment takes place. The increase in stock is the difference between construction and depreciation of older stock. The stock level is input for the rent determination quadrant and the system continues.

The framework is depicted in figure 1. Where is also shown what happens if all else remains equal, except for the capitalization rate which declines caused by, for instance, a lowering of the interest rate. We see an increase in prices, which results in more construction and lower rent levels.

When the supply is inelastic, so there is not much construction after prices increase. The same change in capitalization rate causes lower stock adjustment, which lead to higher rents and even higher prices.

These are long-term effects, it can be expected that prices change on the short-term, but changes in real estate stocks would not be affected instantaneously. For this paper we are interested in short-term effects. This theory gives us a sense of the direction of the effect we expect to find when interest rates are declining, namely an increase in prices.

3.1.1 Hedonic pricing models and their implications on demand

Hedonic pricing models are used in real estate to determine the price based on underlying characteristics of properties. It is widely used in real estate and research in real estate. So the hedonic pricing model assumes that the price of a property is the sum of the value of the characteristics of these houses. A model would look like this:

$V = f(S, N, L, C, T)$,

Where V is the value of a given property, that is made out of: structural characteristics (S), neighborhood characteristics (N), location of the property (L), the period of the transaction (T) (Malpezzi, 2003).

An example of a structural characteristic is the size of a property. Larger properties are worth more, ceteris paribus. For this research it is theorized that individuals on the housing market have a certain willingness to pay for houses that have certain characteristics. This willingness to pay is dependent on if they can apply for NHG, because this effectively lowers their monthly payments. NHG will therefore increase the willingness to pay, or if prices are fixed, it will cause people to accept a lower quality (smaller) house for the same price if it is just below the NHG limit. Compared to if the transaction price is just above the NHG limit.

3.2 EMPIRICAL RESEARCH ON THE HOUSING MARKET

3.2.1 Interest rate and house price levels

In theory the housing market is affected by interest rate through the capitalization rate and because it determines, as a (macro)economic factor, the demand curve in the rent determination quadrant. There exists some literature on house prices and how price levels are affected by (macro)economic factors. Most of this research has been conducted up to, and in the years just after, the global crisis starting in 2008.

Baffoe-Bonnie (1998) finds that housing prices and houses sold respond to economic fundamentals such as: regional employment growth, inflation, national interest rate and money supply. Fluctuations in prices, however, cannot be explained by macroeconomic factors alone.

In contrast to his findings, research indicates that the effect of the housing market on the economy is larger than that of the economy on the housing market. This research finds that interest rate shocks lower real house prices as is expected according to the DiPasquale and Wheaton framework. Interest rate shock explain between 12% and 24% of the fluctuations in house prices in the 10 OECD countries investigated. Mostly because a change in interest rates translates in a change in mortgage rates. Which impacts financing costs that influences demand and thus prices (Demary, 2010).

Kishor and Marfatia (2017) state that: "There is […] consensus in the literature about income and interest rates as two of the most important determinants of house prices" (p. 238). They have conducted research on the dynamics between house prices, income, and interest rate in 15 OECD countries. They find a negative relationship between interest rates and house prices in the long-run. Deviations of this in the short-run is mostly corrected by movements in house prices. Because of these corrections through the house prices, they find no short-term relationship between interest rate and house price levels.

This response of house prices to changes in short- and long-term interest rates is further investigated and it is found that interest rates do have an effect on house prices, but gradually rather then on impact. Another finding is that this effect is differs largely between countries. It is believed that the difference between the expectation of the effect of interest rates and the actual effect can be explained by the large search and transaction costs that are present in the housing market (Sutton, Mihaljek, & Subelyte, 2017).

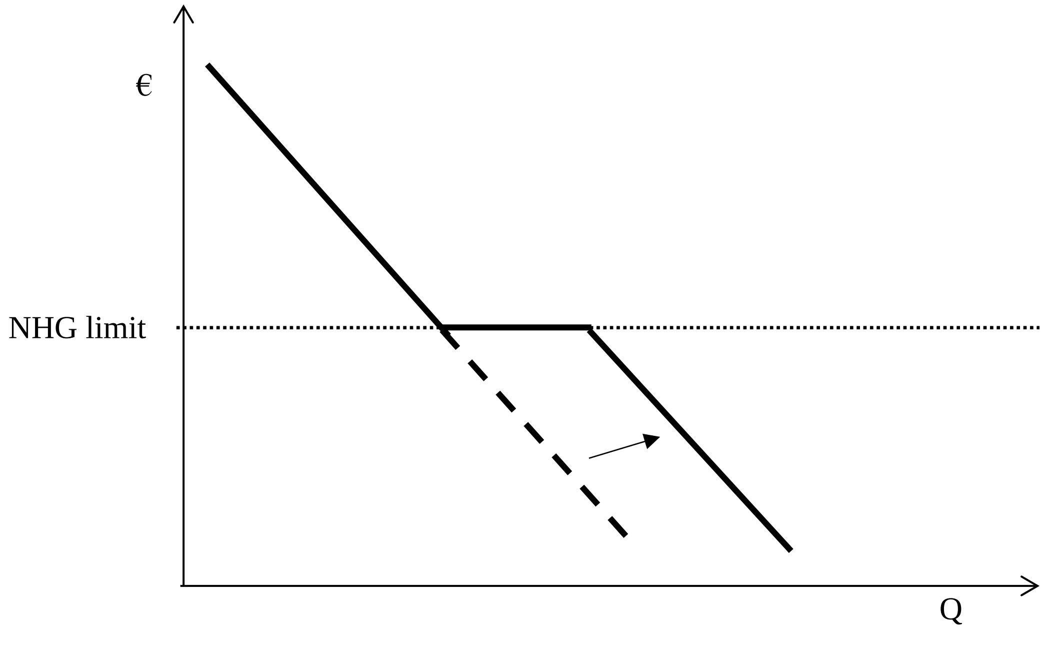
All in all it can be said that there consists a consensus about the fact that if there is a strong relationship between house prices and interest rate, that an increase in rents leads to a decrease in price level if other factors remain equal. There is no consensus about if this effect does also take place in the short-run and if this effect is of a size that is considered significant.

3.2.2 The effect of the mortgage rate

The interest rate does not only affect the state of the economy, but also has a direct impact on mortgage rates. Since mortgage payments can be seen as rents in the theoretical framework, these rates are expected to have an effect on the valuation of properties. This section dives deeper into the available empirical literature on the effect of the mortgage rate.

Economic theory sees the mortgage as a complementary good to the housing market. Therefore it is expected that demand for houses declines when costs of mortgages increases. In this research the mortgage rates for individuals that qualify for NHG are able to get a lower mortgage rate. These individuals are effectively subsidized by the NHG in their monthly payments of their mortgage. This subsidy shifts the demand curve for properties below the limit outwards, while properties above the limit are unaffected. This is graphically depicted in figure 3. The striped line reflects the situation if NHG is not in place.

Figure 3. Shift in demand curve after NHG



Note: The shift in demand for properties below the NHG limit. The demand curve shifts outwards for these properties, because they are effectively subsidized through the NHG.

In contrast to this theory it shows that increasing nominal interest rates during the 70's resulted in increasing house prices and declining nominal interest rates in the 80's had no significant effect on house prices. This increasing of interest rates does not only affect financing costs however. It also has an impact of the expected future rate. Research shows that when the real rate is considered, defined as: "after-tax mortgage rate net of expected annual appreciation"(Harris, 1989, p. 49). Then the house prices increase when the real mortgage rate decreases.

For our research this means that if different interest ratees occur in the market at the same time, then it would be expected that real interest rates are different by the same base points as the nominal interest rated differ. So a discount on interest because of the NHG leads to a higher willingness to pay for the individual.

This seems logical since how much individuals can borrow is probably having an effect on how much people are able or willing to pay for a house. McQuin and O'Reilly tested this theory on de Irish property market. They conclude that the level of borrowing is dependent form disposable income levels in combination with current interest rates. They find a long-run relationship between actual house prices and the amount people can borrow, since stocks on the housing market are fixed in the short-run this relationship is expected to be even greater (2008).

Similar results are found in the Netherlands by conducted research on the terms of credit and availability of mortgage lending. Stricter credit conditions lead to lower house prices. This effect is observed in the 1990's and early 2000's when conditions for getting a mortgage got more relaxed. This period was followed by a period with more strict conditions with lower maximum loan-to-value-ratios (LTV). Francke et al. constructed a credit conditions index and showed that a relaxation of this index with 1% leads to 0.6% higher real house prices. They conclude that this is a causal effect and that there is no presence of reverse causality (2015).

A study in the United States, that also uses an RDD strategy, has contradicting findings. A sudden change in annual mortgage insurance premium (MIP) of the Federal Housing Administration (FHA) was used to identify the effect of an unsuspected decrease of effective interest rates by 50 basis points. An increase of home purchases among the people who rely on the FHA was found, but there seems to be no evidence for increased house prices (Bhutta & Ringo, 2017).

3.3 DUTCH HOUSING MARKET

3.3.1 Elasticity of supply

The DiPasquale and Wheaton (1992) framework expects an increase in construction and supply when prices increase. This would dampen the effect of an increase in demand on prices in the long run, dependent of how elastic the supply of housing is and how quickly supply reacts on an increase in prices. It is found that the supply of housing in the period 1970-2005 is almost inelastic with respect to house prices in the Netherlands (Rouwendal & Vermeulen, 2007). The same results are found in the Netherlands from 1976-1998, in contrast to a comparatively large price elasticity of new construction in the United States (Swank, Kakes, & Tieman, 2003). These findings are confirmed for the period onto the crisis of 2008, but after this crisis there is a higher elasticity between prices and construction. In this period prices and construction went down, it is therefore speculated that supply is more responsive to a downward adjustment in prices. This could be because procrastination or cancellation of planned construction is better possible than an increase in construction due to building restrictions. However, in this period there was also decentralization of government policies, so this could also influence the elasticity (Michielsen, Groot, & Maarseveen, 2017).

Other research does confirm the 'downward elasticity' hypothesis though. The weaker supply responsiveness has been linked to a more restrictive land-use regulation. It is shown that the Netherlands have relatively high land-use restrictions in combination with a supply elasticity that is significantly below one and one of the lowest among the OECD countries. This lower supply elasticity leads to a larger increase in prices when demand rises (Cavalleri, Cournède, & Özsöğüt, 2019).

Next to this low response of construction to an increase in prices, the Netherlands also has one of the slowest responses to an increase in house prices among the OECD countries (Caldera & Johansson, 2013). A paper on the state of the Dutch housing market confirms this and finds that there is a maximum of 1.5% added to the stock yearly and no short-term adjustment in supply, as well as not so much adjustment on the medium-term (Verbruggen, Kranendonk, Van Leuvensteijn, & Toet, 2005).

Their research concludes that prices are more determined by demand, since supply is more or less steady. In the short-run the level of house prices is mainly driven by real disposable income, nominal interest, the price index, stock of houses and the discrepancy between the actual and long-term level of prices.

Another finding is that house prices are more easily adjusted when undervalued than overvalued. An overvaluation has a larger impact on the average sales time instead of a decrease in prices (Verbruggen et al., 2005). This stickiness of house prices implies that it is probable that properties that are priced too high have a longer 'Time on Market'. After this longer time on the market, they are either sold for the higher price or the seller adjust the asking price downwards.

3.3.2 Mortgages in the Dutch housing market

The Dutch market is characterized by a high amount of mortgages and a generally high LTV-ratio. Dutch households together have a mortgage debt of 740 billion euros and are able to lend a maximum of 100% of the value of their house where this is 90% or less in a lot of other countries (De Nederlandsche Bank, 2020). In 2017 69.4% of the households live in owner-occupied houses of which 87.4 % with a mortgage or loan (60.7 % of households). This makes the Netherlands the EU country with the highest share of homeowners with a mortgage (CBS, 2019).

There are however more houses sold without a mortgage than these statistics would imply. This is because an increasing amount of houses are bought by private investors to sublet them. In 2020 it is estimated that of the approximately 8 million homes about 680,000 are owned by investors, or 8.5 %. This amount is larger in the four large cities (G4): Den Haag, Rotterdam, Utrecht, and Amsterdam (NOS, 2021b). In the period 2011-2021 about 15 % of the houses were sold to investors, this percentage is over 25% in the G4 (Kadaster, 2021). Houses sold to investors are more often without a mortgage and people who are buying a house for investing purposes cannot apply for the NHG.

It is found that shocks to the mortgage rate have a significant effect on the housing market in the Netherlands. This impact consists of: "[An] immediate and significant impact on the rate of sale, little impact on the rate of entry of new houses for sale, and a gradual impact on the house prices"(de Wit, Englund, & Francke, 2013). It is however highly possible that the increase of investors on the market that do not need a mortgage decrease these effects of a shock to the mortgage rate. It does however not change the direction and duration of these effects.

3.3.3 Possible manipulation of transaction prices

Although transaction prices are well monitored in the Dutch housing market there are possibilities for manipulation of the transaction prices for tax evading purposes. There has been research to manipulation of transaction prices in Washington D.C. where it is found that sales prices are manipulated to a lower-tax-rate region around the price where the tariff changes (Slemrod, Weber, & Shan, 2017). This kind of manipulation also takes place in the Netherlands to evade taxes. This happens for instance by buying a floor or curtains for a to high price and keeping this amount out of the transaction price (Teije, 2021). It is possible that prices are also manipulated to be eligible for NHG.

3.4 HYPOTHESES

The conducted literature review lead to the following hypotheses. It is expected that:

- There is more demand just below the cutoff.
- properties sold for a price just above the maximum transaction price for NHG are less expensive, defined by the amount of m^2 of living space. In other words, properties just below this border are generally expected to be smaller.
- Properties just above the maximum transaction price for NHG are longer on the market, because properties that are overpriced do not tend to get a price correction, but a longer time on the market.
- Transaction prices are manipulated, but only slightly, since no agent has full control over the prices.

4 METHODOLOGY

4.1 REGRESSION DISCONTINUITY DESIGN

The effect of mortgage rates on housing prices is difficult to identify. Mostly because the mortgage rate is indirectly derived from the interest rate on the market, which is also an indicator of the state of the economy as a whole. This makes it difficult to isolate the mortgage rate effect.

Next to this, the mortgage rate is generally the same across the Netherlands at the same moment in time. This creates a situation where it is only a possibility to compare different time periods and look at the trend in housing prices versus the trend in mortgage rate. It goes without saying that pinpointing the mortgage rate effect, while there are a lot of other affecting factors turns out to be complicated.

In this research a regression discontinuity design (RDD) is used to model the mortgage rate effect without distortion of other factors on the housing market. With RDD a quasi-experiment is performed in which we have a treatment and a control group. The design uses the fact that there is an observed variable, called the running variable, with a known discontinuity. This discontinuity is imposed by a difference in treatment of units above and below a certain cutoff. This separates the units of observations in to a group just below the cutoff and a group just above the cutoff. Differences between these groups are assumed to be random except for the fact that they receive a different treatment (Lee & Lemieux, 2010).

In this case transaction prices are the running variable and the NHG-limit is used as cutoff. Since this limit divides the housing market in two groups, where the group below the NHG-limit has the option of paying a lower mortgage rate than the group just above the NHG-limit. The underlying assumption is that properties sold for a price just below the cutoff could apply for NHG and thus a lower mortgage rate than the ones above the cutoff. This makes the houses just below the cutoff effectively cheaper, resulting in higher demand and a lower value-for-money in terms of the transaction price. When there is concluded that the properties with NHG are of a lower quality in terms of size (smaller), or these properties are longer on the market. It can be concluded that properties with NHG are in general more "expensive", meaning that they offer less value for the same price.

4.1.1 Estimation approaches

First, the following equation is estimated:

$$Y_i = \beta_0 + \beta_1 D_i + \beta_2 (x_i - L_t) + \beta_3 T_i + \varepsilon_i \qquad (1)$$

With this equation the effect of being on the left side of the cutoff versus being on the right side of the cutoff is estimated. This is done with an ordinary least squared linear regression. The outcome variable Y_i can take different outcomes indicating the quality of the property. For this analysis the following variables are used: the log of squared meters, the log of cubic meters, the log of usable floor area, and time on market.

We divide the observation in two groups with the use of a dummy, D_i. This variable indicates if a transaction price is below the NHG-limit. If a transaction price is below the limit, the buyer of the property could qualify for NHG, and the dummy takes on the value of 1. Our coefficient of interest is therefore β_1, this coefficient indicates the effect the NHG has on the quality of the property.

The running variable, x_i, is the transaction price of house *i*. The cutoff, or the NHG limit at period *t*, denoted by L_t is subtracted from this transaction price. Therefore the coefficient β_2 can be seen as the effect of the distance to the transaction price from the NHG limit.

In general it is unnecessary to include fixed effects for identification in an RD design(Lee & Lemieux, 2010). For this research it is decided to include a fixed effect for the different periods of NHG limits however. The reasoning behind this is that treatment and control groups differ between these periods. The fixed effect is included by adding dummies for the different periods of NHG limits as indicated in table 1. These dummies are T_i.

4.1.2 Assumptions

According to Smith et al., there are four assumptions that need to hold if the implementation of RDD is considered(2017). They are:

1. Discontinuity in the probability of exposure
2. No complete manipulation of the running variable
3. The assignment of treatment is random around the cutoff
4. There would be no effect without the intervention

In the following section an argument will be held why these assumptions are expected to hold. It is unfortunately not possible to statistically test for the assumptions due to data limitations.

4.1.2.1 Discontinuity in the probability of exposure

The core of the RDD is that there is a threshold in the running variable, at which point there is a discontinuity in the probability of receiving treatment. Since there is a distinct limit that is handled by NHG at which a mortgage lender qualifies for receiving NHG it is believed that this assumption holds. To see if there is indeed a jump in quality metrics at the cut off, the observations will be plotted in the data section. There are off course possibilities where lenders opt out of NHG even when they qualify or where people do not qualify for NHG but still receive a lower mortgage rate because they come up with a large share of the payment with savings. Nonetheless it can be stated that since the amount of financing for homes in the Netherland is very high, and the NHG offers a high discount on mortgage rates that the probability of receiving treatment is higher below the limit than above. Because there is no data available on the financing of the buyers in the dataset, it is not possible to test for this assumption.

4.1.2.2 No complete manipulation of the running variable

The underlying assumption with RDD is that the running variable is continuous and that the assignation of treatment is random. This means that strategic behavior of subjects could be problematic. However some manipulation is acceptable according to McCrary:

"Only some varieties of manipulation lead to identification problems. I draw a distinction between *partial* and *complete* manipulation. Partial manipulation occurs when the running variable is under the agent his control, but also has an idiosyncratic element. Typically, partial manipulation of the running variable does not lead to identification problems." (McCrary, 2008)

Since multiple buyers could bid on a house and sellers want the highest price they can get, there is no possibility to fully control the prices for an agent. It is, thus, unlikely that any individual can fully control the transaction price. It is however possible, as was explained in the theoretical framework, that transaction prices are being manipulated through the making of side-deals. It is not expected that this happens on a large scale, because it is considered fraudulent. Or that there is some buyer power in certain markets that forces the prices just below the NHG limit. These are considered partial manipulations, since it is not likely that there are agents with full control over the market prices on the housing market.

When partial manipulation is in the market, it is still expected to measure a statistical effect, because there is still a discontinuity in the probability of exposure and since the agent has no full control, the properties where prices are manipulated are expected to be distributed randomly.

In the data section a histogram will be shown to look at a jump in density of observations at the cutoff.

4.1.2.3 The assignment of treatment is random around the cutoff

This means that there are no differences in houses around the cutoff that are not caused by a difference in the running variable or outcome variables. To test for this assumption there will be covariates included. Since we expect the assignment of treatment to be random these should not change the sign or the magnitude of the effect. The formula will then be:

$$Y_i = \beta_0 + \beta_1 D_i + \beta_2(x_i - L_t) + \beta_3 Z_i + \beta_4 T_i + \varepsilon_i \quad (2)$$

Where Z_i is the set of covariates that are included in the regression

As a robustness check the analysis will be repeated with different bandwidths. Smaller bandwidths lead to less significant results due to less observations, but the closer the properties are with respect to price, the more likely it is that this assumption will hold.

4.1.2.4 There would be no effect without the intervention

If there is also an effect without the intervention, then the treatment does not cause the difference in outcome variable. In other words, there would be no gap in quality of properties around the cutoff if this was not the limit imposed by the NHG.

To test for this assumption different cutoff points will be tried to test for "placebo effects". These cutoff points are taken as well below as above the original cutoff. It is expected that at these cutoffs no effect is observed. If there are no effects at the placebo cutoffs, then it is also not likely that these jumps are found at different rounded prices. To test for these different cutoffs the NHG limit was increased by 25000 for every year, and also diminished by 25000 for every year as a robustness check. This creates NHG limits where there should not be a jump in the dependent variable.

4.1.3 Different order polynomials

To check if a linear form might not be the best approach 2^{nd} order polynomials are added. The model including 2^{nd} order polynomials will look like:

$$Y_i = \beta_0 + \beta_1 D_i + \beta_2(x_i - L_t) + \beta_2(x_i - L_t)^2 + \beta_4 Z_i + \beta_5 T_i + \varepsilon_i \qquad (3)$$

4.2 HEDONIC PRICING MODEL

To know what the effect of the NHG would mean in monetary terms an hedonic pricing model was created to gain some insight in the value of size. This model is not very extensive or complete, but it gives an idea of the economic value of the effect. And it makes it comparable to the other approach. For this model the following regression is estimated

$$\log(P) = \alpha_1 Y_i + a_2 Z_{ij} + a_3 N_i + a_4 T_i \qquad (4)$$

With P as the transaction price of the property. Y_i are the size variables, so either the log of squared meters, the log of cubic meters, or the log of usable floor area.

Z_{ij} are different variables that describe attributes of the property. Number of rooms, plot size, maintenance, type of property, number of bathrooms, number of kitchens, location of the garden, maintenance of the garden, isolation, way of heating, centrality, if the property is nicely located, and if the property is on a busy road are used.

N_i and T_i are neighborhood and period of transaction fixed effects respectively.

Our coefficient of interest is α_1 which can be used to calculate the monetary effect that is found in the RDD analysis. It reflects the percentage change in price when we change Y_{ij} with one percent.

The complete dataset, after cleaning, is used for this model. So also the values outside of the bandwidth.

4.3 REPEATED SALES

To verify our results there is also a different approach that has been conducted. For this approach the fact that some properties are sold multiple times is exploited. Since some of the houses that are sold multiple times moved from below the NHG limit to above, or vice versa, a difference in difference model can be estimated. For this approach properties that 'switch' from NHG status and that are changed over time (remodeled) are removed from the dataset. The other properties are used to calculate the growth of prices for every neighborhood-period combination. Therefore it is possible to calculate how much more (less) houses that changed in NHG status raised in price. The regression that is fitted takes on the following formula:

$$\log(P) = \theta_1 D_i + \theta_2 N_i T_i + \theta_3 H_i \quad (5)$$

Where D_i is the same dummy that takes the value of 1 if a property was sold for a price below the NHG limit. And $N_i T_i$ are dummies for every neighborhood-period combination. H_i represents a unique ID for every property. This creates a model where not houses are compared to each other but to themselves over time. This ensures that there are no differences between houses disturbing the effect, which could be the case in our RD design. This model is estimated for different bandwidths around the NHG limit.

5 DATA

In this section the data will be presented, the data cleaning process will be explained, and some checks on the assumptions will be performed ass well as some initial effects.

The data used for this analysis is date retrieved from the *Nederlandse Coöperatieve Vereniging van Makelaars* (NVM). The NVM is an association of realtors, and appraisers. Together they have a market share of about 70% in the Netherlands (NVM, 2019). The dataset retrieved for this analysis contains only data for the province of South-Holland and includes all transactions on the housing market which were handled by a realtor who is a member of the NVM from 2010 up to and including 2020.

The dataset contains a lot of characteristics of houses, such as: number of rooms, amount of squared meter, plot size if it does not concern an apartment, transaction price, asking price, and address. The data contains 305,600 observations before cleaning.

5.1 CONSTRUCTION OF VARIABLES

Some variables were constructed. First a variable was constructed that reflected the limit to which transaction price NHG was an option in a certain period. The data in table 1 is used to construct this variable, where we used the transaction date as the date of interest and created a variable 'limit' to reflect the NHG-limit at that point in time.

When the limit was created it was possible to create a dummy variable indicating if a house had the option of using NHG or not, 'NHG'. When the transaction price was lower than the limit at the transaction date, then this variable would indicate 1. Otherwise it would indicate 0.

Next our running variable was constructed. Since the NHG limit changes over time, the cutoff is different in every period. To normalize prices and create an uniform cutoff the NHG limit was deducted from the transaction price. This created a variable that reflects the distance from the NHG limit. This distance, the limit variable and the prices of the properties were then all divided by 1000, to make the coefficients better interpretable.

Then a time on market variable was constructed, by taking the difference between the list date and the transaction date in days. Ceiling height was constructed by dividing the volume by the squared meters of floor and a dummy was created indicating if the property was in one of the two big cities in *Zuid Holland*; *Rotterdam* and *Leiden*.

For the difference in difference design we created unique ID's for every property based on their address and created a variable that combines the first four digits of the postal code with the period in which it was sold. The periods out of *table 1* were used.

5.2 DATA CLEANING

It is likely that there are some mistakes in the data and not all data is of interest. Therefore sanity checks were performed, outliers were removed and properties outside of the bandwith of our interest were removed. Firstly the variable values that are used to identify null values are adjusted so they accurately represent the unavailability of the data. This is needed because the NVM uses -1 and 0 instead of NA which could result in wrong outcomes.

Next to this properties that have different conditions than *kosten koper* are removed as well properties that are on leased ground *(erfpacht)*. Because of different valuation these could distort the analysis.

After the removal of these properties, some sanity checks were performed. A variable that represents ceiling heigh was constructed by dividing the volume of the properties by the amount of squared meters floor area. Then the properties with a ceiling height higher than 10 meters and lower than 1.4 meters were removed, because it is likely that these contain errors in the data entry. For the same reason we removed properties with more than 800 cubic meters or less than 100 cubic meters of volume. To remove outliers we also deleted the observations that had a floor area of less than 40 squared meters or more than 250 squared meters. It was also checked if there were observations that had a larger usable floor area (UFA) than squared meters of total floor area, these observations were removed.

Finally the observations were removed that are too far from the NHG limit and therefore outside of the bandwidth of interest. To do this we removed all observations with an transaction price that lies more than 2500 euros above or below the cutoff, which is the NHG-limit at the transaction date.

5.3 RUNNING VARIABLE

As mentioned the distance in euros from the cutoff transaction price is used. Figure 4 and figure 5 shows that there is a clear decrease in density to the right of this cutoff and that a lot of properties are sold just below the cutoff.

Figure 4. Histogram of transaction price with a bandwidth of €100,000 around the cutoff

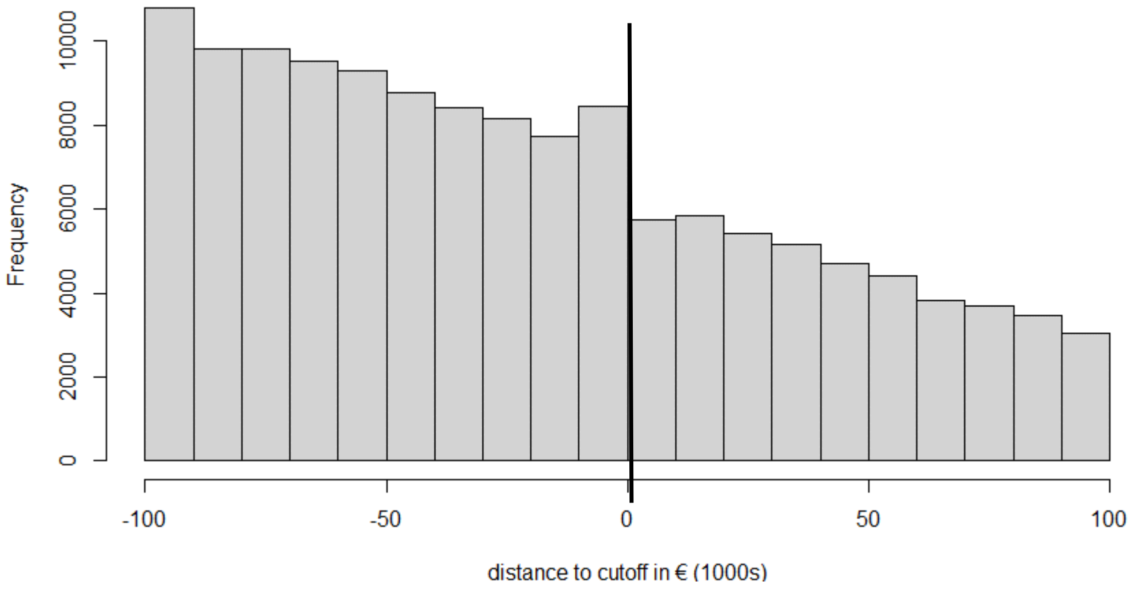
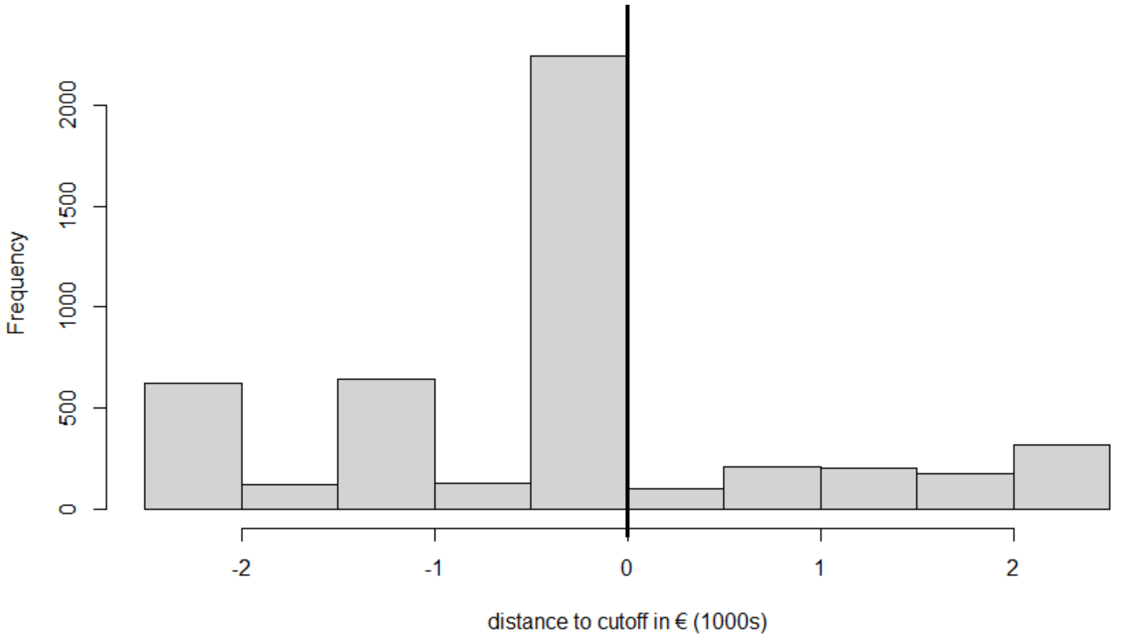


Figure 5. Histogram of transaction price with a bandwidth of €2,500 around the cutoff



This could imply manipulation of the running variable and lead to identification issues. This does not have to be a problem however, since it is unlikely that people have complete control over the transaction price.

Another possible explanation, and also an hypothesized one, is the fact that there is more demand just below the NHG-limit.

5.4 OUTCOME VARIABLES

For this analysis we test with different outcome variables. In this section they will be addressed shortly.

First there are multiple size-variables. These are: squared meters of floor space, volume in cubic meters and usable floor area (UFA). These variables are already in the dataset. The first two speak for themselves. UFA is the floor space that not taken up by halls and staircases. The log of these size variables are taken, this is done to be able to conclude how much the outcome variables change in relative terms.

Finally time on market is used as an outcome variable. This variable is constructed by taking the difference in days between the list date and the transaction date.

5.5 INITIAL EFFECTS

Looking at figure 6, it seems as if there is the opposite effect as hypothesized. It seems that houses are slightly bigger just below the NHG limit, making them effectively cheaper. The graphs for volume and usable floor area were plotted and show the same general effect. They are in the appendix (figure 8 & 9).

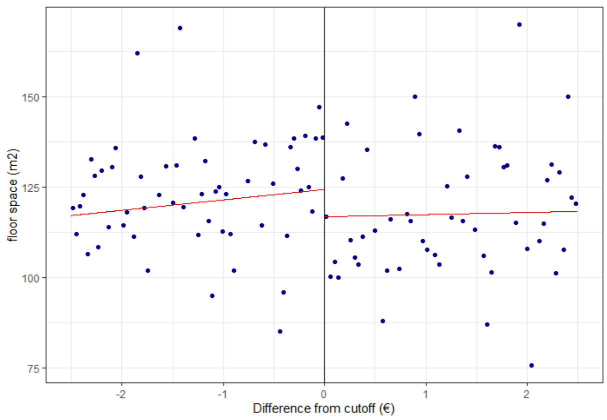


Figure 6. Initial effects on the size of the property in m2

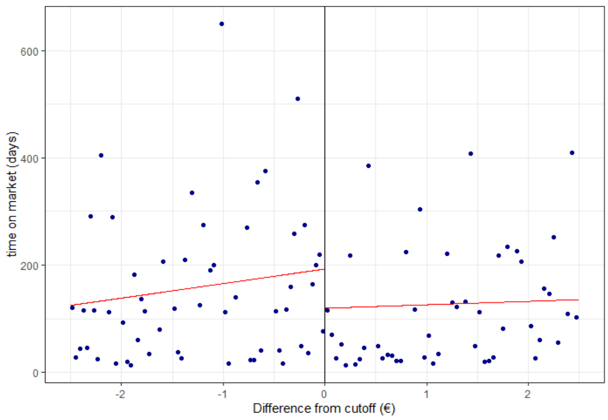


Figure 7. Initial effects on the time on market

Figure 7 counters this observation however. Showing that the time on market for houses with NHG seems to be longer, which would imply that they are priced to high relatively to the houses just above the limit.

It seems that the assumption of there being a jump at the cutoff is satisfied. Since there is a clear break in the plotted line at the cutoff.

6 RESULTS

6.1 REGRESSION DISCONTINUITY DESIGN

Running the regression with a bandwidth of €2,500 from the cutoff leads to the findings presented in table 2. These are the results for equation (1).

Table 2. coefficients of all Y-variables for the Regression Discontinuity

	Dependent variable:			
	Square meters of floor space	Volume in cubic meters	Usable Floor Area	Time on market
	log(m2)	log(m3)	log(m2)	(days)
Distance to cutoff in EUR	0.011^{***}	0.014^{***}	0.010^{***}	4.973
	(0.003)	(0.003)	(0.003)	(4.085)
NHG	0.056^{***}	0.060^{***}	0.051^{***}	21.433^{*}
	(0.009)	(0.011)	(0.010)	(12.684)
limit FE	Yes	Yes	Yes	Yes
Observations	4,786	4,786	4,786	4,786
R^2	0.173	0.100	0.210	0.116
Adjusted R^2	0.171	0.098	0.208	0.113
Residual Std. Error (df = 4772)	0.176	0.202	0.180	236.719
F Statistic (df = 13; 4772)	76.904^{***}	40.997^{***}	97.639^{***}	48.077^{***}

$^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$

Note: Table 2 shows the estimated discontinuities in different quality variables caused by the NHG. A bandwidth of 2,500 is used for the running variable: "Distance to cutoff"

All variables are significant at the 1 percent level for: squared meters of floor space, volume, and usable floor area. For these three models the results are comparable. There is a positive relation between the price of an object and its size. A property gets between 1.1 % and 1.4 % bigger when the price increases by €1000, dependent on the metric used.

The NHG has a positive effect on size. Meaning that houses with NHG are bigger on average than houses without when we look at houses just around the limit. This effect is significant on the 1% level and of serious magnitude. Varying from 5.1 % to 6.0% depending on the metric used.

The results for time on market are not as significant. There seems to be a longer time on market for houses with NHG, but this effect is only significant on a 10 % level. And the relation between the transaction price and time on market is not significant at all.

6.2 ROBUSTNESS CHECKS

6.2.1 Including covariates

Including the covariates (table 3) does not change the significance or direction of the effect. It does however impact the magnitude of the effect for the size variables slightly.

Table 3. The coefficients for equation (2) adding property type and Big City covariates.

	Dependent variable:			
	Square meters of floor space	Volume in cubic meters	Usable Floor Area	Time on market
	log(m2)	log(m3)	log(m2)	(days)
Distance to cutoff in EUR	0.007^{***}	0.008^{***}	0.005^{*}	5.433
	(0.003)	(0.003)	(0.003)	(4.051)
NHG	0.036^{***}	0.033^{***}	0.028^{***}	26.350^{**}
	(0.009)	(0.009)	(0.009)	(12.616)
Big City	0.010	-0.012	0.007	-37.246^{***}
	(0.007)	(0.008)	(0.007)	(10.579)
limit FE	Yes	Yes	Yes	Yes
Property type FE	Yes	Yes	Yes	Yes
Observations	4,786	4,786	4,786	4,786
R^2	0.304	0.322	0.382	0.138
Adjusted R^2	0.300	0.318	0.378	0.132
Residual Std. Error (df = 4754)	0.162	0.175	0.160	234.198
F Statistic (df = 31; 4754)	67.081^{***}	72.946^{***}	94.666^{***}	24.511^{***}

*p<0.1; **p<0.05; ***p<0.01

Note: Table 3 shows the results when covariates are included. There are fixed effects included for the type of property and a dummy is included that shows if a property is in one of the two big cities in Zuid Holland.

The time on market model is mostly affected. The effect of NHG is significant at the 5 % level after we add property type controls and a dummy if a property is located in one of the two big cities. The control for cities is significant at the 1 % level and houses in one of the two big cities are 37 days shorter on the market ceteris paribus.

Houses with NHG are 26 days longer on the market than houses without, when the covariates are added.

6.2.2 Different bandwidths

Equation (1) is also estimated for different bandwidths. In table 4 the results for a bandwidth of €500 is used and in table 5 are the results for a bandwidth of €10,000.

It seems that the effect diminishes when we take a larger bandwidth, but there are no changes in the sign of the effects found. We do however see that results with the smaller bandwidth are less significant due to the decline in observations. Mainly volume and usable floor area are less significant, now being only significant at a 5 % level.

Time on market is not significant anymore when we enlarge the bandwidth used.

Table 4. Effect of the NHG with a bandwidth of €500

	Dependent variable:			
	Square meters of floor space	Volume in cubic meters	Usable Floor Area	Time on market
	log(m2)	log(m3)	log(m2)	(days)
Distance to cutoff in EUR	0.022	0.035	0.001	48.436
	(0.036)	(0.041)	(0.037)	(46.268)
NHG	0.060^{***}	0.064^{**}	0.054^{**}	54.644^{*}
	(0.022)	(0.025)	(0.023)	(28.826)
limit FE	Yes	Yes	Yes	Yes
Observations	2,431	2,431	2,431	2,431
R^2	0.165	0.095	0.209	0.123
Adjusted R^2	0.161	0.090	0.205	0.118
Residual Std. Error (df = 2417)	0.178	0.202	0.181	229.140
F Statistic (df = 13; 2417)	36.805^{***}	19.414^{***}	49.143^{***}	26.015^{***}

$^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$

Note: Table 4 shows the estimated discontinuities in different quality variables caused by the NHG. A bandwidth of 500 is used for the running variable: "Distance to cutoff". This smaller bandwidth is used to check for robustness.

Table 5. Effect of the NHG with a bandwidth of €10.000

	Dependent variable:			
	Square meters of floor space	Volume in cubic meters	Usable Floor Area	Time on market
	log(m2)	log(m3)	log(m2)	(days)
Distance to cutoff in EUR	0.004***	0.004***	0.004***	0.678
	(0.0004)	(0.001)	(0.0005)	(0.586)
NHG	0.033***	0.029***	0.030***	4.970
	(0.006)	(0.006)	(0.006)	(7.247)
limit FE	Yes	Yes	Yes	Yes
Observations	15,302	15,302	15,302	15,302
R^2	0.150	0.087	0.180	0.099
Adjusted R^2	0.150	0.086	0.179	0.099
Residual Std. Error (df = 15288)	0.182	0.206	0.187	239.180
F Statistic (df = 13; 15288)	208.101***	112.107***	257.844***	129.618***

*p<0.1; **p<0.05; ***p<0.01

Note: Table 5 shows the estimated discontinuities in different quality variables caused by the NHG. A bandwidth of 10.000 is used for the running variable: "Distance to cutoff". This larger bandwidth is used to check for robustness.

6.2.3 Different cutoff points

The results for the different cutoff points are in table 6 and 7. In both cases, if the cutoff is either higher or lower than the true NHG limit, there is no significant effect jump in the dependent variables. This confirms the assumption that this jump is caused by the NHG and not by other influences, for instance jumps at round prices.

Table 6.Effect of the NHG at lower 'placebo' cutoff

	Dependent variable:			
	Square meters of floor space	Volume in cubic meters	Usable Floor Area	Time on market
	log(m2)	log(m3)	log(m2)	(days)
Distance to cutoff in EUR	0.003	0.003	0.003	2.596
	(0.003)	(0.004)	(0.003)	(4.189)
NHG	0.011	0.007	0.009	17.114
	(0.010)	(0.012)	(0.011)	(13.385)
Period FE	Yes	Yes	Yes	Yes
Observations	4,570	4,570	4,570	4,570
R^2	0.178	0.098	0.204	0.103
Adjusted R^2	0.175	0.095	0.202	0.100
Residual Std. Error (df = 4556)	0.187	0.211	0.194	240.326
F Statistic (df = 13; 4556)	75.743^{***}	37.960^{***}	90.002^{***}	40.193^{***}

*p<0.1; **p<0.05; ***p<0.01

Note: In table 6 the effect of the NHG is presented at a 'placebo' cutoff 25,000 below the actual NHG limit. This checks if there are also jumps in the dependent variables at other values.

Table 7. Effect of the NHG at higher 'placebo' cutoff

	Dependent variable:			
	Square meters of floor space	Volume in cubic meters	Usable Floor Area	Time on market
	log(m2)	log(m3)	log(m2)	(days)
Distance to cutoff in EUR	0.003	0.0003	0.002	4.208
	(0.004)	(0.004)	(0.004)	(4.957)
NHG	0.011	0.00004	0.004	17.227
	(0.012)	(0.014)	(0.012)	(15.866)
limit FE	Yes	Yes	Yes	Yes
Observations	3,051	3,051	3,051	3,051
R^2	0.152	0.075	0.189	0.110
Adjusted R^2	0.149	0.071	0.185	0.106
Residual Std. Error (df = 3037)	0.177	0.204	0.181	233.803
F Statistic (df = 13; 3037)	41.978^{***}	19.028^{***}	54.291^{***}	28.795^{***}

$^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$

Note: In table 6 the effect of the NHG is presented at a 'placebo' cutoff 25,000 below the actual NHG limit. This checks if there are also jumps in the dependent variables at other values.

6.2.4 Different order polynomials

The model with the second order polynomial (Table 8) shows similar results for the NHG dummy. The effect seems to be slightly larger, but the magnitude stays the same. The squared difference to the cutoff is not significant in any of the models.

Table 8. results for equation (3) where a second order polynomial was added

	Dependent variable:			
	Square meters of floor space log(m2)	Volume in cubic meters log(m3)	Usable Floor Area log(m2)	Time on market (days)
Distance to cutoff in EUR	0.013***	0.016***	0.012***	0.977
	(0.004)	(0.004)	(0.004)	(5.072)
(Distance to cutoff in EUR)^2	0.001	0.001	0.002	-2.798
	(0.002)	(0.002)	(0.002)	(2.106)
NHG	0.061***	0.067***	0.059***	6.804
	(0.013)	(0.014)	(0.013)	(16.796)
limit FE	Yes	Yes	Yes	Yes
Observations	4,786	4,786	4,786	4,786
R^2	0.173	0.101	0.210	0.116
Adjusted R^2	0.171	0.098	0.208	0.114
Residual Std. Error (df = 4771)	0.176	0.202	0.180	236.700
F Statistic (df = 14; 4771)	71.430***	38.100***	90.728***	44.776***

*p<0.1; **p<0.05; ***p<0.01

Note: In table 8 a second order polynomial is added to check if it is a better fit and if this changes the effect that NHG has on de outcome variables

6.3 HEDONIC PRICING MODEL

The results for the hedonic pricing model are presented in table 9. All models are explaining a large part of the variance in prices, with an Adjusted R^2 between 0.865 and 0.871. Some variance stays unexplained but this will give an indication of the monetary effects of the increase in size from the previous models.

Coefficients for the three size variables are all significant at the 1 % level. The size of a property has a positive effect on its price. An 1% increase in squared meters of floor space leads to a 0.612% increase in price. This increase is 0.574% and 0.611% for volume, and usable floor area respectively.

Table 9. Hedonic pricing model for houses in the dataset.

	Dependent variable:		
	log(price)		
	Hedonic pricing model m2	Hedonic pricing model m3	Hedonic pricing model UFA
log(m2)	0.624***		
	(0.005)		
log(m3)		0.573***	
		(0.004)	
log(UFA)			0.609***
			(0.005)
log(nkamers)	0.025***	0.044***	0.016***
	(0.005)	(0.004)	(0.005)
log(plot_size)	0.147***	0.147***	0.156***
	(0.001)	(0.001)	(0.001)
Period FE	Yes	Yes	Yes
Neighborhood FE	Yes	Yes	Yes
Type house FE	Yes	Yes	Yes
Number of bathrooms and kitchen FE	Yes	Yes	Yes
Location and maintenance of garden FE	Yes	Yes	Yes
heating and isolation FE	Yes	Yes	Yes
Location FE	Yes	Yes	Yes
Maintenance FE	Yes	Yes	Yes
Observations	40,072	40,072	40,072
R^2	0.860	0.873	0.868
Adjusted R^2	0.858	0.871	0.866
Residual Std. Error	0.160 (df = 39500)	0.152 (df = 39492)	0.156 (df = 39492)
F Statistic	425.339*** (df = 571; 39500)	468.984*** (df = 579; 39492)	446.601*** (df = 579; 39492)

*p<0.1; **p<0.05; ***p<0.01

Note: Hedonic pricing model for all properties in the province of 'Zuid Holland' for the different size outcome variables of interest.

6.4 MONETARY EFFECTS

These models combined give us an estimation of the monetary effects of the NHG. Houses with NHG are on average 5.6% larger in squared meters of floor space. An 1 % increase of floor space leads to a 0.624% increase in price according to the hedonic pricing model. This implies that houses with NHG have a higher value of are 5.6 * 0.624 = 3.494%. This means that the NHG has a negative value of 1 / 1.03494 = 3.38%.

The negative value of the option on NHG varies between 3.02% and 3.33% as can be seen in table 10.

Table 10. The effects of NHG in monetary terms, combining the insights of both models

	If NHG then increase of	Value Hedonic pricing model	Percentage higher value houses with NHG	Implied value NHG
m2	5.6%	0.624	3.494%	-3.38%
m3	6%	0.573	3.438%	-3.32%
UFA	5.1%	0.609	3.1059%	-3.01%

Note: The model that estimates the quality differences between NHG and non NHG houses combined with the hedonic pricing model to estimate the effect of NHG in monetary terms

6.5 REPEATED SALES APPROACH

To verify these results a difference in difference approach was also conducted. The results for this model, equation (5), are in table 11. With this approach there is also a significant effect of the NHG and the sign of this effect is also negative. Meaning that houses that are sold more than once and have at least one time a change in NHG incline less in price over time than other houses in the same neighborhood. This effect seems to diminish when a subset with a smaller bandwidth around the NHG limit is taken. When we include all observations a house with NHG is on average 8.6% cheaper than houses without. While with a bandwidth of only €2500 this effect is only 0.8%.

Table 11. Results for difference in difference model.

	Dependent variable:				
	log(price)				
	All data	bandwidth 2.5	bandwidth 5	bandwidth 10	bandwidth 25
NHG	-0.086***	-0.008***	-0.014***	-0.046***	-0.077***
	(0.005)	(0.000)	(0.003)	(0.003)	(0.005)
Period Neighborhood FE	Yes	Yes	Yes	Yes	Yes
Observations	47,861	706	1,219	2,207	5,217
R^2	0.776	1.000	1.000	0.998	0.986
Adjusted R^2	0.547	1.000	0.977	0.944	0.786

*p<0.1; **p<0.05; ***p<0.01

Note: The effect of NHG on the log of price with the difference in difference approach

7 CONCLUSION

The results from the different models are surprising. It was hypothesized that the NHG would have a positive effect on prices, but this does not seem the case. We find that houses with NHG are between 0.8% and 3.33% less expensive than houses just above the limit.

It is unlikely that this is actually the case. Because NHG is not mandatory when people are eligible for it, it should not have a more negative effect than 0. Since people could simply opt out if they are not interested.

There are a couple explanations possible on why this effect is found. First it is plausible that the NHG limit functions as a focal point in the market. Meaning that houses above this limit are perceived to be too expensive, because the NHG is perceived as the highest price for a 'normal' house.

It is however still surprising that houses with NHG are so significantly smaller than houses just above the limit. Another possibility is that houses that are sold with NHG are houses where there is more bargaining power from the buyer his side. The fact that these houses are longer on the market, and thus overpriced or less demanded, supports this claim. This could be an indication that houses that are less demanded for other reasons then size are more likely to be sold below the NHG limit, because the buyer is in a position where he can negotiate a price just below the limit. Which is something that has more value to the buyer than it has to the seller of the house. Another possibility is that the buyer negotiates manipulation of the transaction price. This could be in exchange for less strict terms for the transaction, but it is also a possibility that part of the transaction price is handled unofficially by taking over movable property for a higher price than would be reasonable.

Finally there is the possibility that there are selection effects in place, disturbing the analysis. Since there is no insight in how these transactions are financed, due to data restrictions, it cannot be observed if NHG is used or if there is financing at all. It could be the case that houses just above the NHG are sold without (much) financing and that people who do not need financing are also people that value other aspects then size in a property.

Because the results are not in line with the hypotheses and it cannot be ruled out that either manipulation or other effects are causing this discrepancy it is not possible to give an exclusive answer to the research question.

However it is possible to speculate about the results. Given the fact that both methods result in a different magnitude of the effect, but they do both present a significant negative effect of the NHG, it is likely that transaction prices are manipulated. Or at least some strategic behavior influences the findings to a greater extent than expected. It is probable that houses where manipulation is possible are on average larger because larger houses are in general in areas that are less popular, making the bargaining power of the buyer larger. This is supported by the fact that there seems to be some evidence on these houses being longer on the market on average.

If this would be the case, then the NHG is not a decent instrument to control house prices. Strategic behavior will undo the effect of the policy and there is no evidence found what soever that the discount on the mortgage rate drives prices upwards.

For further research it would be interesting to investigate how transactions are financed and if the effect of the NHG will change when its application is taken into account.

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9 APPENDIX

Figure 8

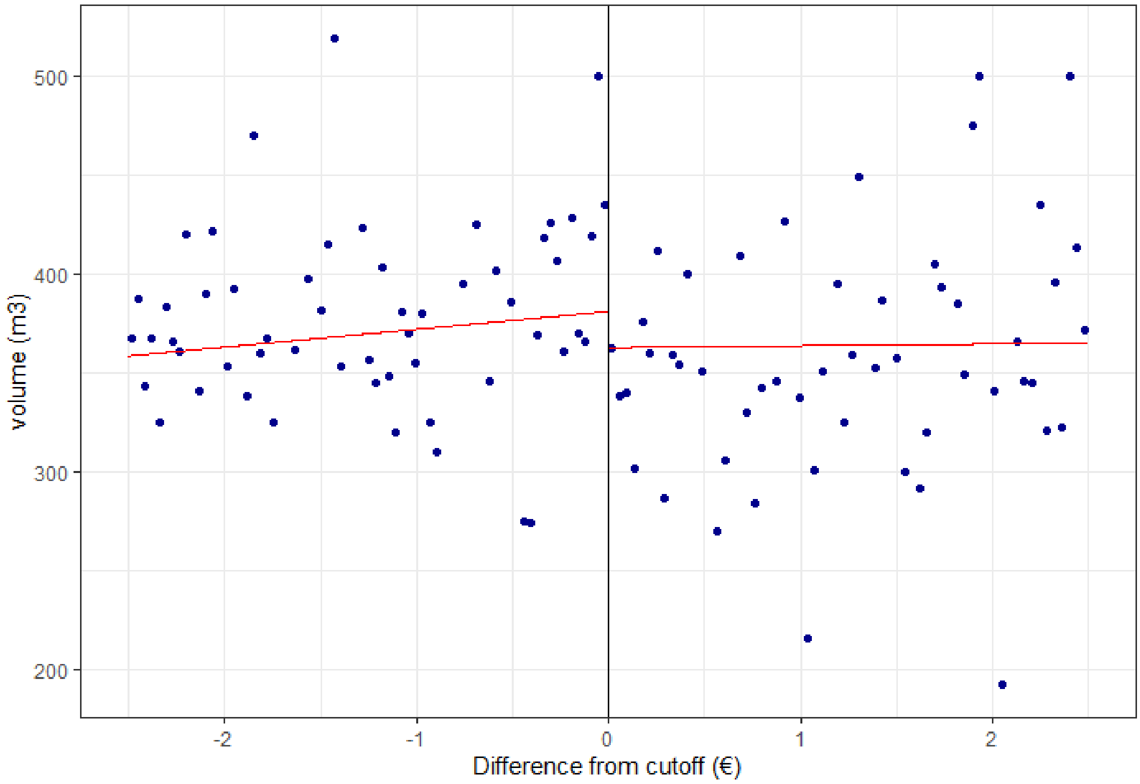

Figure 9