The effect of high loan-to-value ratios on homeowner mobility in the Dutch housing market

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Abstract

This thesis studies the effect of high loan-to-value ratios on homeowner mobility in the Dutch housing market. This thesis contributes to existing literature in several ways. Besides the effect of high loan-to-value ratios on mobility in general, also the effect on tenure choice is studied, which is important as the Dutch owner-occupier and rental markets are heavily regulated. Also, in addition to actual moves, the effects of high loan-to-value ratios on the moving preference formation process are studied. By using data from the DNB Household Survey for the period from 1995 until 2014, the effect of negative home equity as well as a rich set of household characteristic variables on the probability of moving is studied. Different measures for the loan-to-value ratio are used, including household debt and assets as well as own calculated house values using actual house price indices. The results provide no strong evidence for the lock-in hypothesis, which states that homeowners with limited or negative home equity are hampered in the mobility process. However, when the probability of stating moving preferences is studied, it is found that higher levels of the loan-to-value ratio reduce the desire to move significantly. Also, it is found that homeowners are up to 3.54 times more likely to move to the rental market instead to the owner-occupier market, when having extended combined loan-to-value ratios exceeding 90%.

In this thesis data from the DNB Household Survey is used.

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1. Introduction

Dutch homeowners have high loan-to-value ratios compared to other countries. Up to 2005, taking out a mortgage at 110% was not unusual (NVB, 2014). These high loan-to-value ratios are partly the result of fiscal policy which stimulated homeownership and high mortgage loans (Bokeloh and Van Leeuwen, 2012). After the crisis that started in 2008, the Netherlands faced one of the largest drops in house prices and were left with a severe housing crisis. The Dutch government, as a reaction to the recent developments in the housing market, has already put several policy changes in place, such as the reduction of mortgage loans to 100% of home value by 2018 (Rijksoverheid, 2015).

Besides household composition, the capital market plays an important part in the moving decision making process. A couple of important developments took place since the recent financial crisis; limits on loan-to-income and loan-to-value ratios are stricter and forced mortgage pay-off schemes are set in place. Besides these constraints, house prices in the Netherlands dropped severely which lead many homeowners to end up with negative home equity (Conijn and Schilder, 2013). However, as long as homeowners are able to make their mortgage payments, this negative home equity only becomes a problem when a household wants to move (Conijn and Schilder, 2012). In that case, households need other assets to finance a new house, otherwise they become "locked-in".

Using data from the DNB Housing Survey for the period from 1995 until 2014, this thesis explores whether supporting evidence for the lock-in hypothesis can be found, by investigating the effects of high loan-to-value ratios on homeowner mobility in the Dutch housing market. Furthermore, this thesis explores the effect of high loan-to-value ratios on homeowner tenure choice and more specifically, whether households with limited and negative levels of home equity have a higher probability of moving from the owner-occupier to the rental market.

In the United states, evidence for the lock-in hypothesis is mixed. While some studies find significant reductions in mobility due to high loan-to-value ratios, others find no effects or even opposite effects. For example, in one of the earlier empirical studies, Chan (2001) finds that after house prices decline, mobility is significantly reduced especially in the case of high levels of mortgage debt. Also, Ferreira et al. (2010) find that mobility decreases by one third for homeowners facing negative home equity and also more recently, Andersson and Mayock (2014) find similar effects. However, some studies, like those of Coulson and Grieco (2013) and Schulhofer-Wohl (2011), find opposite effects where mobility even increases in case of high loan-to-value ratios. In the Netherlands, research seems to support the lock-in hypothesis, but still more research needs to be done.

As stated by Struyven (2015), the full-recourse setting in the Dutch housing market allows for a different setting than in the United States. Because in some US states there is no or limited recourse, it is possible that mobility increases due to the strategic default channel. When

homeowners have high levels of negative home equity, they can use this channel to default on their mortgage. This of course does have implications for their credit status. Where Andersson and Mayock (2014) and Ghent and Kudlyak (2011) find that mobility can increase with high levels of mortgage debt through the strategic default channel, in the Netherlands this option is not as quickly chosen because lenders can pursue borrowers for the remaining debt. However, Dutch homeowners can voluntarily insure themselves (up to a mortgage amount of €265,000) through the National Mortgage Guarantee Fund (NHG). The NHG guarantee fund protects the borrower from losses in case of unforeseen life effects such as unemployment, death or divorce (NHG, 2015; Bokeloh and Van Leeuwen, 2012). Because of this, it is possible that some people divorce strategically to prevent that they are left with negative home equity.

To test the hypotheses, logit as well as multinomial logit regression models were used to estimate the effect of loan-to-value ratios as well as several household characteristic variables on the probability of moving. The combined loan-to-value ratio as well as the extended combined loan-to-value ratio including households' other debt and assets, are used to estimate the models. In addition, as homeowners' own estimates of house value are given in de DNB Housing Survey, also own calculated house values using actual house price indices are used as a robustness check. This because it is often found that homeowners are subject to loss aversion, especially when they have high loan-to-value ratios (Genesove and Mayer, 2001).

This study contributes to existing literature in several ways. First, the effect of high loan-to-value ratios on tenure choice is studied, as mobility between markets is important in the highly regulated sector of the Dutch housing market. Second, in addition to actual moves, also moving preferences are examined, as De Groot et al. (2011;2013) indicate that these are important to take into account when studying mobility. Finally, the DNB Housing Survey data used in this thesis makes it possible to use of a rich set of (control) variables possibly influencing household mobility. It also enables to study both the period from 1995 until 2008, where house prices were rising to very high levels, as well as the crisis period thereafter in which house prices declined severely.

The results do not show strong evidence supporting the lock-in hypothesis. The coefficient for the negative equity group of homeowners is only significant in two cases. In these two models, households with low loan-to-value ratios are estimated to be between 1.66 and 1.81 more likely to move than households facing negative home equity. The results are not robust to tests including own estimated house values using actual house price indices. The logit models including moving preferences instead of actual moves as dependent variable, do however show significant negative effects of high loan-to-value ratios on the probability of stating a moving preference. Finally, the models estimating the effect of high loan-to-value ratios on tenure choice, show some evidence that households with loan-to-value ratios above 90%, have a higher probability of moving to the rental market and indicate that the odds of moving from the owner

to the rental market, compared to owner to owner moves are 3.54 times higher when having an extended combined loan-to-value ratio exceeding 90%.

The results found in this thesis have several implications for Dutch policymakers concerned with housing market design. While some evidence is provided that negative equity hampers mobility, strong evidence is provided that negative equity reduces moving preferences. As almost half of the actual moves were from the 12% of total households that stated a moving preference, this also points into the direction of hampered mobility. Also, the results concerning tenure choice have implications for housing market policy, as both the rental and owner-occupier markets are heavily regulated in the Netherlands.

This thesis is organized as follows. First, an overview of the existing literature on the topic will be discussed in section 1. In section 2, the hypotheses following from the literature and methodology used to test these hypotheses will be presented. The data used in this research as well as descriptive statistics will be presented and discussed in section 4. The empirical results from the models and robustness checks will be discussed in section 5. Finally, the thesis ends with a discussion and conclusion.

2. Literature

In this section, previous literature on the effect of (high) loan-to-value ratios on homeowner mobility is reviewed in section 2.1. Also, in section 2.2, previous research on the relevance and effects of recourse in mortgage markets is discussed. Finally, literature on homeowner loss aversion and homeowner tenure choice is reviewed in sections 2.3 and 2.4.

2.1 Loan to-value ratios and homeowner mobility

The first body of literature discussed, studies the impact of high loan-to-value ratios on homeowner mobility in the US. In one of the earlier empirical studies, Chan (2001) investigates the effect of falling house prices on mobility and states that a household faced with negative home-equity has limited options available when it wants to move. While facing negative home-equity, households are mainly constraint by the existence of down payments as well as by income qualifications. Defaulting is only an option of last resort as it negatively impacts the borrowers' credit history. In addition, loss aversion results in homeowners fishing for house prices at least equal to the purchase price, which results in hampered liquidity in the housing market. In this study, data on originated mortgages by the Chemical bank from 1989 until 1994 in New York, New Jersey and Connecticut is used. The final sample contains 5,094 non moves and 684 moves. In this research household moves are not directly observable from the dataset. Fixed-rate mortgages are not included in the final sample, otherwise households that simply refinanced their mortgage would have been classified as moves. County level weighted repeat sales price indices are used as a proxy for house values, while outstanding loans are directly observable from the dataset. Comparing a hazard model for the probability of moving including actual house prices with a model excluding house price declines, Chan (2001) finds that, after 3 years mobility would have been 24% higher if house prices had not declined. After 3 years, mobility would have been even 39% higher for households with high original loan-to-value ratios (higher than 80%).

Ferreira et al. (2010) use American Housing Survey data from 1985 until 2007 to study the lock-in effect resulting from negative home equity as well as higher mortgage interest rates. The data used only contains single detached homes, with a homeowner aged between 21 and 59 and located in metropolitan areas. The data does not allow for following households after they have moved, because it is the house, not the household, that is included in the panel. A probit model, including several life-cycle control variables, is used to test the impact of the negative-equity and mortgage rate variables on the mobility rate. Instrumental variables are constructed for the negative equity and mortgage interest rate variables. By using a probit IV regression, the coefficients on the financial variables greatly increase in significance, which indicates large measurement error in the non-instrumented variables. In the probit IV regression, it is found that homeowners facing negative home-equity are one third less mobile and that an increase of $1000 per year in mortgage costs results in a decrease in mobility of 12%.

Andersson and Mayock (2014) study homeowner mobility by differentiating between voluntary and involuntary moves, where involuntary moves are defined as defaults. They use a dataset including information on homeowners in Florida between 1999 and 2011. Their theoretical model predicts an U-shaped relation between equity and mobility, as very high levels of negative equity increase the default decision and very low levels increase the possibility to move voluntarily. Compared to previous studies, they claim that their loan-to-value variable is subject to far less measurement error. Their input is based on third party's estimates of outstanding mortgage debt and (repeat sales) house values, where other research often uses homeowners' own estimates of outstanding mortgage debt and house value. Also, their dataset includes the housing bust, which allows them to study the crisis period as well. They use logit models to analyze general mobility, voluntary mobility and involuntary mobility separately. Also, a multinomial logit is used to differentiate between the decision to either; stay in the current home, sell the current home or default. The loan-to-value ratio is included in buckets ($0.8<LTV<0.95$; $0.95<LTV<1.1$; $1.1<LTV<1.3$ and $LTV>1.3$). The results confirm the existence of an U-shaped relation between equity and mobility. They also suggest that voluntary mobility is only partly offset by involuntary mobility and net mobility is reduced by approximately 25% as a result of negative home equity. The effect is robust to tests using separate subsamples containing either; only single-family dwellings, only homeowners with age below 50 and fixed time and county effects. They also use an instrumental variable regression with an exogenous loan-to-value calculation (using amortization schemes) and find the same results.

In contrast to the results found in these studies, some researchers have found that high loan-to-value ratios do not constrain homeowner mobility or even find that high loan-to-value ratios improve mobility. In his research, Schulhofer-Wohl (2011) uses the same dataset as Ferreira et al. (2010) and finds contradicting results. He finds that negative home equity does not reduce mobility and that it even slightly increases. He ascribes this contradicting result by the fact that Ferreira et al. (2010), deleted some negative home equity household moves from the dataset, namely the cases where a house was left empty or rented out. By recoding these deleted observations as moves, and using a probit model with LTV buckets of lower than 100%, between 100% and 114% and higher than 114%, opposite results are found.

Coulson and Grieco (2013), using data from the Panel Survey of Income Dynamics from 1999 until 2009, also find no support for the equity lock-in hypothesis. The study differentiates between in-state and out-of-state mobility. In their multinomial logit model, renters are used as the base category. A household can either decide to; not move, move within the state or move out of state. The loan-to-value is included in six different buckets, where two indicate underwater households ($1.0<LTV<1.2$ and $LTV>1.2$). They find that extremely underwater mortgages are even slightly more mobile, probably due to the decision to default. The results also indicate that

underwater households are more likely to move out of state than other households. They conclude, that because of this, the often suggested labor market friction due to mobility is smaller than suggested.

In the Netherlands, Conijn and Schilder (2012) study negative home equity by using the Dutch Housing Survey of 2009 containing (cross-sectional) information on Dutch households. They stress that, especially since the financial crisis, the Dutch housing market is "double locked"; both stricter limitations on the loan-to-income and loan-to-value ratio hamper households from moving. Home equity is calculated as the difference between the market value of the house and built up capital, and outstanding mortgage debt. They extrapolate tax assessment values, built up capital and outstanding mortgage debt from 2009 to 2011. By using a logit model to study the chance of having negative home equity, they find that this chance is especially increased when the household is young and the house is bought after 2000. Both the decrease in house prices in this period as well as the short time to be building up capital and pay off the mortgage in combination with low interest rates on capital insurance, probably influence this result. Also, households in urban areas and high income households have a relatively higher probability of having negative home equity. Finally, by interviewing financial advisors, it appears that banks are hardly willing to refinance underwater households.

In another research, Conijn and Schilder (2013) have studied household mobility by using the Dutch Housing Surveys for 2002, 2006, 2009 and 2012. Descriptive statistics provide insight into the trends on the housing market. Several important conclusions can be made. Since the crisis, the housing supply increased and therefore average time on market increased. Actual moves as well as preferred moves within the owner-occupier sector and from the rental sector to the owner-occupier sector have decreased, while mobility seems stable when looking at first-time buyers. Finally, mortgage loans in relation to home value and income have increased over time. Although the reasons for the decrease in transaction volume cannot be directly tested, one of the explanations could be the increase in negative home equity (especially for younger households). By using a simple regression model, it appears that a higher percentage of people facing negative home equity results in lower mobility. However, the coefficient loses significance when time dummies for the survey years are added.

In his recent study, Struyven (2015) investigates the equity lock-in effect in the Dutch housing market empirically by using the Dutch Housing surveys (from 1998 to 2012) in combination with other unique administrative data from Statistics Netherlands. Households are sorted into different purchase cohorts. He finds that households in purchase cohorts around house price peaks, have higher loan-to-value ratios and are less mobile in every year after purchase. He finds that high loan-to-value ratios significantly lower mobility, both within and across local labor markets. Moving from a 90% loan-to-value ratio to a 110% loan-to-value ratio,

mobility is lowered by 30%. When including a financial-assets-to-value ratio, results show that households with relatively high ratios (35% and higher) are no longer hampered when having a high loan-to-value ratio. Besides, Struyven (2015) shows that total net liquid assets (after sale), predict mobility better than loan-to-value ratios alone, which provides further evidence for the importance of including household balance sheet information.

2.2 Recourse

Another field of research focusses on the relevance and effects of recourse in different mortgage markets designs. In the case of a recourse mortgage, lenders can pursue borrowers for the outstanding mortgage debt after foreclosure. Behavior of borrowers towards defaulting therefore varies with recourse. Most European countries have full-recourse mortgages, while some US states have non-recourse mortgages (Campbell, 2012).

In their research, using a sample from US borrowers from Nevada, Arizona, Florida and California, Bhutta et al. (2010) find evidence for both the strategic default channel as the double trigger channel, where the last one states that borrowers only default while facing negative home equity in combination with a liquidity shock (for example a loss in income due to unemployment). Their study focusses on the negative equity threshold level for default of homeowners that bought a house in 2006, right before the crisis. Half of borrowers that face very high levels of negative equity strategically default, while the double trigger channel seems to drive defaults at lower levels of negative equity.

In their research, Ghent and Kudlyak (2011) find evidence for the increased mobility rate for non-recourse situations. They empirically test the effect of recourse on borrower default behavior in US states and find that, on average, the probability of monthly default is 1.32 times higher when the borrower is in a non-recourse state, compared to a full-recourse state. Therefore, they conclude that full-recourse deters some borrowers from defaulting and that defaulting is often strategic instead of involuntary. The results are, however, only significant for high valued properties. For these properties, the probability of default is almost twice as high for non-recourse situations. As mentioned before, also Andersson and Mayock (2014) found evidence for the U-shaped relation between negative equity and mobility in the United States.

In contrast to these findings, Guiso et al. (2013), using survey data from US households, find that strategic default does not depend on whether the state has a recourse or non-recourse setting. They explain this result by stating that households either are not aware of the legal status of the state they live in or simply do not have enough assets to fear pursuing by the bank.

In the Netherlands, mortgage loans are full-recourse. Because of this full-recourse setting, the Dutch housing market offers a good possibility to explore the negative effects of negative home equity, as the housing lock channel is naturally isolated from the strategic default channel (Struyven, 2015).

2.3 Loss aversion

Another body of literature studies the presence of loss aversion in homeowner perception of house values. Besides from the impossibility to refinance a mortgage (at the bank level), homeowners could also be reluctant to sell their house for a price below the original purchase price. It is important to acknowledge the possible presence of loss aversion when studying homeowner mobility, especially when self-estimated market values are used.

In their study using data on Boston condominiums from the early 1990's, Genesove and Mayer (2001) are the first to study the presence of loss aversion in homeowner behavior. In down markets when house prices fall, home equity falls and because of the down payment restriction, homeowners are either forced to move to a lower valued house or not move at all. They find that homeowners with high loan-to-value ratios set a higher asking price, have a longer time on market and receive a higher selling price.

Building on the concept of homeowner loss aversion, Engelhardt (2003) studies the effect of nominal loss aversion and equity constraints on young households' mobility in metropolitan areas in the US. By studying owner-to-owner intra-metropolitan moves, he finds that nominal loss aversion significantly affects mobility, but does not find that negative equity (because of falling house prices) constraints mobility. Four different specifications are used to test these effects. The IV and reduced form models show a 30% to 44% reduction in mobility when a 5% nominal loss occurred. The results of the effect of nominal gains on mobility are significant but mixed.

In the Netherlands, Cruijsen and Van Rooij (2014) provide evidence for the existence of overly optimistic self-estimated market values, by comparing self-reported values with actual house values. Using data from the annual DNB Housing Survey from 2003 until 2012, they find that a large share of households think their house value increased, while it actually decreased. Also, people are more optimistic about the price development of their own house than the overall price development. Regression results provide evidence that two psychological biases drive these optimistic estimates: loss aversion and the endowment effect. The endowment effect arises when people value objects higher once they own them. They find that both high loan-to-value ratios and tenure length increase the prevailed optimism. The degree of overestimation is unrelated to whether a household has moving plans or the head of the household is responsible for finances. In addition, the overestimation is larger in boom periods, lower in urbanized areas and larger for males.

2.4 Tenure choice

Finally, researchers have studied the impact of several life-cycle and financial status variables on household tenure choice. Boehm and Schlottmann (2011) investigate household tenure choice in the US. Using a panel including 5000 households, tenure choice of households in three time

periods are studied, including the 1970s, 1980s and 1990s. They use three sets of variables to predict tenure choice; housing costs and appreciation of house prices, household wealth and income and household characteristics. The focus is on the first set of variables and it is found that these are important in estimating probabilities of all transitions. They also study the impact of a government reduction in the possibility of mortgage interest deductibility and find that its impact differs in all three decades.

In their study of the realization of moving preferences and actual moves in the Netherlands, De Groot et al. (2013) find that 31% of aspiring homeowners actually moved into homeownership, 13% to a rental home and 56% did not move at all. They use data from the Dutch Housing Surveys from 1998 until 2008. Using a logit model, they first test for preferences of aspiring homeowners to move to either the owner-occupier or rental market. Second, they use a multinomial logit regression to test for the probabilities in actual moving behavior. They find that life course characteristics and market conditions are important factors in the moving process. Socioeconomic factors, like insufficient income, and high costs of housing relative to renting were found to hamper the preference formation as well as the realization process.

In sum, findings in literature studying the impact of high loan-to-value ratios on household mobility in the US are mixed. While some studies find large significant negative effects on mobility, others find no such effect or even opposite effects. Studies in the Netherlands seem to support the hypothesis that negative home equity reduces mobility, but the topic still needs to be further explored. In addition, whether a mortgage has full-recourse or not influences the borrowers' decision making. The full-recourse setting of the Dutch housing market allows to study the effects of negative equity in isolation from the strategic default channel. Finally, from the discussed literature, it seems that loss aversion is an important psychological bias that influences homeowner behavior and should be taken into account when studying mobility.

The contribution of this research is to extend the existing literature by gaining more insight into the Dutch housing market in particular, as a large part of the literature focusses on US data. The effects of high loan-to-value ratios are particularly of interest in the Netherlands, as they have the highest loan-to-value ratios compared to other countries and faced one of the largest drops in house prices and a severe housing crisis. With its original structure, due to fiscal policy and high government intervention, the Dutch housing market is an important market to study the effects of high loan-to-value ratios. Furthermore, compared to previous Dutch research from Conijn and Schilder (2012; 2013) and Struyven (2015), this research will also contribute by investigating whether the loan-to-value ratio has an effect on household tenure choice and by taking into account not only actual realized moves, but moving preferences as well.

3. Methodology

In this section, the hypotheses resulting from the previous discussed literature are discussed in section 3.1. The methodology used in this research is discussed in sections 3.2 and 3.3.

3.1 Hypotheses

The main objective of this research is to help understand the effects of high loan-to-value ratios on homeowner mobility. As we have seen in section 2, some researchers have found that negative home equity does not influence homeowner mobility negatively, while others found large negative effects. For example, Andersson and Mayock (2014) found large negative effects in their research where also the crisis period was included. Also in the Netherlands, evidence that supports the homeowner lock-in hypothesis is found by Conijn and Schilder (2012; 2013) as well as Struyven (2015). As also stated before, the full-recourse setting in the Dutch housing market allows for a different setting than in the United States (Struyven, 2015). Where in the US mobility can increase with high levels of mortgage debt through the strategic default channel, in the Netherlands this option is not available. It is therefore expected that the hampering effects of negative home equity on mobility in the Netherlands will be clearer than in the United States. All this results in formation of hypothesis 1 given below.

Hypothesis 1: High loan-to-value ratios lower the probability that a household moves from the owner-occupier sector to either the owner-occupier or rental sector

Although facing negative home equity, some life events force households to move, for example in the case of a divorce or a job loss. These underwater households could then be more likely to move to a rental dwelling. This results in hypothesis 2 stated below.

Hypothesis 2: High loan-to-value ratios make refinancing a mortgage difficult and raise the relative probability to move from the owner-occupier to the rental market

3.2 Models

First, a standard multiple linear regression (OLS) will be used to explore the relation between several household characteristic and locational variables and the combined loan-to-value ratio. The (continuous) combined loan-to-value ratio will be included as dependent variable. The independent variables included in the model are: the age of the homeowner, tenure length, time dummies (pre-crisis, after-crisis), location (urban, suburban), size of household, employment, income, marital status and whether the house was bought after 2005. The multiple linear regression model is defined in model (1) below.

$$Y_i = \beta_0 + \beta_1 X_{1i} + ... + \beta_k X_{ki} + \varepsilon_i \quad (1)$$

To test hypothesis 1, a logit regression will be used. The dependent variable in the regression is the binary variable whether a household moves in the subsequent year or not. Because the dependent variable (someone did or did not move) is binary, the nonlinear logit regression is used. This way, predicted values will range between 1 and 0 and can be interpreted as probabilities. The logit model (logistic cumulative probability distribution) used is defined in model (2) below.

$$Pr(Y=1|X_1, ..., X_k) = F(\beta_0 + \beta_1 X_1 + ... + \beta_k X_k) = \frac{\exp\{X_i'\beta\}}{1 + \exp\{X_i'\beta\}} \quad (2)$$

In this model, the coefficients (β) show the probability that a household with that characteristic moved. X_i is a vector of covariates and β a vector of coefficients. The main explanatory variable on the right hand side (X_1), is the loan-to-value ratio. The loan-to-value ratio of households will be included in buckets. Two sets of models will be tested, one where the combined loan-to-value ratio (CLTV) is used and one where the extended combined loan-to-value ratio (ECLTV) will be used.[1] A significant negative coefficient on the high loan-to-value buckets will show the probability of a move is reduced and will therefore support hypothesis 1. Several household characteristic and locational control variables will also be added. Control variables that will be added are: the age of the homeowner, tenure length, time dummies (pre-crisis, after-crisis), location (urban, suburban), a change in the size of the household, employment status, gross household income and a change in marital status. It is expected that younger households, households in the pre-crisis period, households in (very) highly urbanized areas, households with higher incomes and paid jobs and households who face a change in size or marital status, have a higher probability of moving.

As indicated by De Groot et al. (2013; 2011), stated preferences to move are important to take into account in the mobility process. Therefore in this research, preferences will also be taken into account. It could be for example, that a household indicates that it has a (strong) preference to move, but does not move at all in the following years. When looking at homeowners it could be that the height of the loan-to-value plays a role in the realization of the stated preference.

In the DNB Housing Survey, respondents can indicate whether they are; actively looking for a new home, considering to move to a new home, or not considering to move at all. The first

[1] Detailed information on the construction of the (extended) combined loan-to-value ratio can be found in section 4.1.

two categories are used to indicate a preference to move. A third set of models will be tested where these indicated preferences are used. A subsample from the dataset is constructed where only observations from households are included that stated a preference and observations from those households three years after the stated preference. The possible mobility hampering effect of high loan-to-value ratios can be possibly tested for more clearly in this subsample as the advantage of also taking preferences into account, is that people who just moved to an owner-occupied dwelling and at the same time have higher loan-to-value ratios, are automatically excluded from the model.

In addition to the logit model, also use will be made of the multinomial logistic regression model defined below. The model allows to differentiate between a move to either the owner-occupier sector or the rental sector and therefore it will be used to test hypothesis 2. The model is given below.

$$\text{Log}\frac{(\pi(j))}{(\pi(0))} = \beta_0^{(j)} + \beta_1^{(j)}X_1 + ... + \beta_k^{(j)}X_k \quad (3)$$

In this model, the dependent variable could take three values which identify the situations "did not move", "moved from the owner-occupier to the owner-occupier market" or "moved from the owner-occupier to the rental market". These take on the values 0, 1 and 2, instead of only 0 and 1 in the previous model. With k=3, the model estimates 2 (k-1) logit regressions, as two groups are compared to the omitted group (where *j* defines the group and 0 the reference group) (Theil, 1969). Again household characteristic and locational control variables, as discussed in the previous model, will be included. To estimate this model, renters are excluded from the dataset.

Finally, for all models in this study, no differentiation will be made between mortgage types and therefore all mortgages are included in the estimated models. Even though the survey asks people to fill in their build up capital in case of insurance-related and savings mortgages, not enough information about this variable is available and will therefore not be taken into account.

3.3 Robustness

Some issues with using data from the DNB Household Survey result from the fact that the loan-to-value ratio has to be calculated using homeowners' estimations of home value. As mentioned before, it is often found that homeowners are subject to loss aversion, especially when they have high loan-to-value ratios (Genesove and Mayer, 2001). Also, using data from the DNB Housing Survey, Cruijsen et al. (2014) find that homeowners' value estimates in the dataset are too

optimistic. Although the calculation is based on households' (imprecise) valuations, this problem is partly resolved as households' base their moving decision on their own perception of the loan-to-value ratio (Coulson and Grieco, 2013). However, a regression will be run where the loan-to-value ratio is based on a proxy for the actual market value.

A set of logit models will be estimated including an (extended) combined loan-to-value ratio based on house value calculated manually. This is done by using a general house price index from Statistics Netherlands for the period from 1995 until 2014. For the years 1985 until 1995, transaction price data from NVM-brokers is used, where the median house transaction value for this period is given and transformed into index numbers. The house value per survey year (House $value_{it}$) is estimated using equation 4 below.

$$\text{House value}_{it} = \text{Purchase price}_{i,t\text{-}d} * \frac{\text{Index}_t}{\text{Index}_{t-d}} \quad (4)$$

Purchase price is the price the house was bought for at date t-d and filled in by respondent i, where t is the survey year an d the tenure duration in years. The purchase price is then multiplied by the house price index number for survey year t divided by the house price index number at purchase date t-d. Note that, as also mentioned by Cruijsen et al. (2014), house depreciation and maintenance are not taken into account here.

Finally, following the study of Engelhardt (2003), a set of logit models will be estimated, also including a dummy that indicates whether the homeowners' own estimate of house value is below the original purchase price. This coefficient should capture some of the effects of loss aversion, as homeowners will probably be more reluctant to move when they face a nominal loss.

4. Data and descriptive statistics

In this section, the data sources used and construction of variables are discussed in section 4.1. In section 4.2, descriptive statistics about the dataset are presented.

4.1 Data and variables

In this study, data from the DNB Housing Survey (DHS) is used. The survey gathers information annually on approximately 2000 households, called the CentERpanel. The CentERpanel is an probability-based internet panel that represents the Dutch speaking population. The data are divided into six modules, covering; personal characteristics, employment, living conditions, mortgages, pensions, income, wealth and economic and psychological concepts.

In this study, the DHS waves for the years 1995 until 2014 are used. For each year, the six modules, as well as the aggregated data on income and wealth are collected. From 2001 on, also the datasets including sample weights are collected. The datasets are appended for every one of the modules separately. For each individual module, the variables of interest are kept. Every module includes a household specific identification number as well as a household member identification number.

Before merging the individual modules, moves are identified using the third module. The third module, including accommodation and mortgage data, is the main module of interest for this research. Before moves can be identified, households that are only included in the panel for one year are dropped. Also, observations where current tenure status (renter or owner-occupier) is missing are dropped. Now moves can be identified by using the information from which year the household moved into the current home. When the answer to this question relative to the previous panel-year changed, and is equal to the current-panel year or the year before, a move is identified. Also pre-moves (the year before the move occurred) are identified. Finally, the data from the other modules is merged into the appended data from the third module. Because not all observations are matched, some of the identified pre-moves and moves are dropped.

The main explaining variable of interest, the loan-to-value ratio, is constructed using the accommodation and mortgages module. Every household fills in an estimate of the current market value of the accommodation, as well as the current outstanding mortgage balance. The loan-to-value ratio can be calculated using different definitions. These are given below.

The most common definition of the loan-to-value ratio, is simply the outstanding loan balance divided by the value of the collateral. Another definition is called the combined loan-to-value ratio, and takes into account all outstanding loan balances and divides them by the value of the collateral:

$$\textit{Combined loan-to-value ratio} = \frac{Mortgage\ balance\ on\ all\ outstanding\ mortgages\ combined}{Estimated\ market\ value}$$

Finally, an extended version of the loan-to-value can be calculated, which also takes into account other debt and assets. Again the balance is divided by the value of the collateral:

$$\text{E}\textit{xtended combined loan-to-value ratio} = \frac{Outstanding\ mortgage\ balances + other\ debt - other\ assets}{Estimated\ market\ value}$$

In this study, the combined loan-to-value ratio will be used, as the dataset includes information on outstanding debt on all mortgages on the house (with a maximum of five mortgages). Also, the extended version of the combined loan-to-value will be used, which takes into account other debt and assets of the household, as Stein (1995) and Struyven (2015) showed that these are important factors. The information for other debt and assets can be collected from the fifth module including possessions and loans.

The combined loan-to-value ratios are calculated using self-estimated current market values of the house and the combined outstanding mortgage balance. When there is no mortgage on the house (answer to "any mortgage on accommodation" is "no"), the CLTV variable is set to zero. CLTV ratios higher than 2.5 (250%) are set to missing. Missing values for the CLTV variable are observed when the household is either a renter, the market value or mortgage balance data is missing, or the CLTV is set to missing because it was considered an outlier.

For the extended CLTV ratio, other household debt and liquid assets are calculated. For the calculation of other assets, the following components are taken into account: checking accounts, savings accounts, deposit accounts, deposit books, stocks and shares, put and call options and "other" savings and investments. For the calculation of other debt, the following components are taken into account: private loans, extended lines of credit, finance debts, credit card debts and "other" outstanding debt and loans. Family loans and study loans are not taken into account. The total amount of outstanding mortgages is then adjusted for liquid assets and debt per household. Dividing this number by the estimated market value of the house gives the extended CLTV ratios. When either household debt or household assets exceed €1,000,000, the extended CLTV ratio is set to missing. Finally, when the extended CLTV ratio exceeds 2.5 or -2.5, the extended CLTV ratio is set to missing and when there is no mortgage on the house (answer to "any mortgage on accommodation" is "no"), the extended CLTV variable is set to zero.

For the robustness test, the models use CLTV and ECLTV ratios with as denominator the calculated market value of the house using actual general house price indices. Data from Statistics Netherlands as well as NVM-brokers are used in these calculations. The same methods, as described above, are used in calculating the CLTV and ECLTV ratios.

The (extended) CLTV ratio is included in the models in four different buckets. The

buckets are the same as in the study of Struyven (2015), except that, instead of two, there is just one group that indicates negative equity. The buckets include: CLTV ratios lower than or equal to 0.5, CLTV ratios higher than 0.5 and lower than or equal to 0.9, CLTV ratios higher than 0.9 and lower than or equal to 1 and CLTV ratios higher than 1. The latter bucket indicates households with negative home equity.

More detailed information about the DNB Housing Survey and handling of the data is given in appendix A.

Compared to many previous studies, the DNB Housing Survey data used here makes it possible to use of a rich set of control variables possibly influencing household mobility. The variables used to control for other influences on homeowner mobility in the model include age, tenure length, time, location, size of household and change in size of household, employment status, income (in euro's), marital status and change in marital status. Age (using birth year), time (in years), tenure length, location, size of household, employment status and marital status can directly be observed from the different modules. For age, also dummy variables indicating different age groups (age$\leq$35, 35<age$\leq$55, age>55) are created. Time dummies are included to indicate pre-crisis and after-crisis periods (2007 and before, and after 2007). For location, dummy variables are created indicating either very high urbanized, high urbanized, moderate urbanized, low urbanized and very low urbanized areas. For employment status, variables are created indicating whether the respondent has a paid job, lives of social security or has no paid job or social security income. A change in the size of a household is identified by dummy variables indicating a positive change or a negative change. A change in marital status is identified when either the respondent changes from married to not married or from not married to married between subsequent years (no differentiation between them, as both are expected to increase the chance of a move). Income is included as total gross household income (in euro's).

For the years 2001 until 2014, probability weights for households included in the dataset are given. These weights take into account the Dutch income distribution from the Central Bureau of Statistics as well as the division between tenants and owners. The method used is developed by Rob Alessi (DNB Housing Survey, 2015). By using the sample weights, representativity of other variables is, however, not necessarily improved.

For the years 1995 until 1999, no sample weights are calculated as the required information from the Central Bureau of Statistics is unavailable for this period. However, the datasets contain a variable indicating whether the household is representative of the Dutch population (the "nationwide" panel) or the household is a high-income household. Using this variable, an approximation for the sample weights over this period is estimated. The method for this calculation is given in appendix A.

4.2 Descriptive statistics

The descriptive statistics for the variables used to estimate the models are presented in table 1. The first column shows the number of observations for which the variable is observed. The mean, standard deviation and minimum and maximum observations are given for owner-occupiers and renters separately. In the full (non-weighted) sample, 891 moves and 931 pre-moves are identified. Because of lost observations during the merging of the modules, not all moves and pre-moves are kept and therefore the numbers deviate. On average, renters move more than owner-occupiers. Also, owner-occupiers are older and stay longer in their current accommodation, the average household size is larger than the households size of renters and gross household income is almost €20,000 higher. The number of renters is larger compared to the number of owner-occupiers for very high urbanized and high urbanized areas. In the sample, 726 observations of negative home equity households are observed.

Table 1 Descriptive statistics of variables (non-weighted)

		Owner				Renter			
Variable	Obs	Mean	SD	Min	Max	Mean	SD	Min	Max
Moved	891	0,030	0,17	0	1	0,042	0,20	0	1
Pre-move	931	0,023	0,15	0	1	0,060	0,24	0	1
Age	26,367	52,76	13,85	21	94	50,93	16,33	19	102
Tenure length	26,310	15,45	11,74	0	82	12,94	11,28	0	75
Married	16,740	0,745	0,44	0	1	0,391	0,49	0	1
Δ Married	607	0,021	0,14	0	1	0,026	0,16	0	1
Household size	26,366	2,63	1,29	1	9	1,90	1,11	1	9
Δ HHsize (pos)	788	0,032	0,17	0	1	0,025	0,16	0	1
Δ HHsize (neg)	616	0,025	0,16	0	1	0,020	0,14	0	1
Paid job	15,654	0,625	0,48	0	1	0,525	0,50	0	1
Social Security	2,849	0,091	0,29	0	1	0,146	0,35	0	1
No job	7,864	0,284	0,45	0	1	0,329	0,47	0	1
Urban vhigh	4,399	0,112	0,32	0	1	0,292	0,45	0	1
Urban high	6,604	0,234	0,42	0	1	0,289	0,45	0	1
Urban mod	5,738	0,239	0,43	0	1	0,170	0,38	0	1
Urban low	5,409	0,232	0,42	0	1	0,141	0,35	0	1
Urban vlow	4,161	0,181	0,38	0	1	0,105	0,31	0	1
Gross income	24,388	39894	28882	0	575255	22222	19724	0	250000
lnGross income	24,388	9,421	3,117	1	13,263	8,245	3,611	1	12,429

Total number of observations in dataset is 26,367 from 1995-2014. For dummy variables, number of observed values for outcome "1" are shown. Descriptive statistics are shown for owners and renters separately. *Source:* DNB Housing Survey 1995-2014.

Table 2 presents the mean combined loan-to-value ratios for different categories, for owner-occupiers in the pre-crisis period (1995-2007) and after-crisis period (2008-2014) separately. Households have lower mean CLTV ratios right before and right after they moved in the after-crisis period, compared to the pre-crisis period. This could indicate that loan-to-value ratios are more strictly taken into account when a household wants to move. Also, after a household moved, it seems like the borrowed amount is lower than in the pre-crisis period. Younger households have higher CLTV ratios, both before and after the crisis, than people of the age between 35 and 55 and people older than 55. For all three age classes, CLTV ratios are higher for the after-crisis period. High income households have higher CLTV ratios than low income households, as would be expected. Relative differences between the time periods are however minimal. People with paid jobs have the highest CLTV ratios compared to the other two employment status classes, in both time periods. People enjoying social security however, have lower CLTV ratios in the after-crisis period. CLTV ratios are highest for very high urbanized areas both in the pre-crisis as well as in the after-crisis period. There is no difference between low urbanized areas and very low urbanized areas in both time periods.

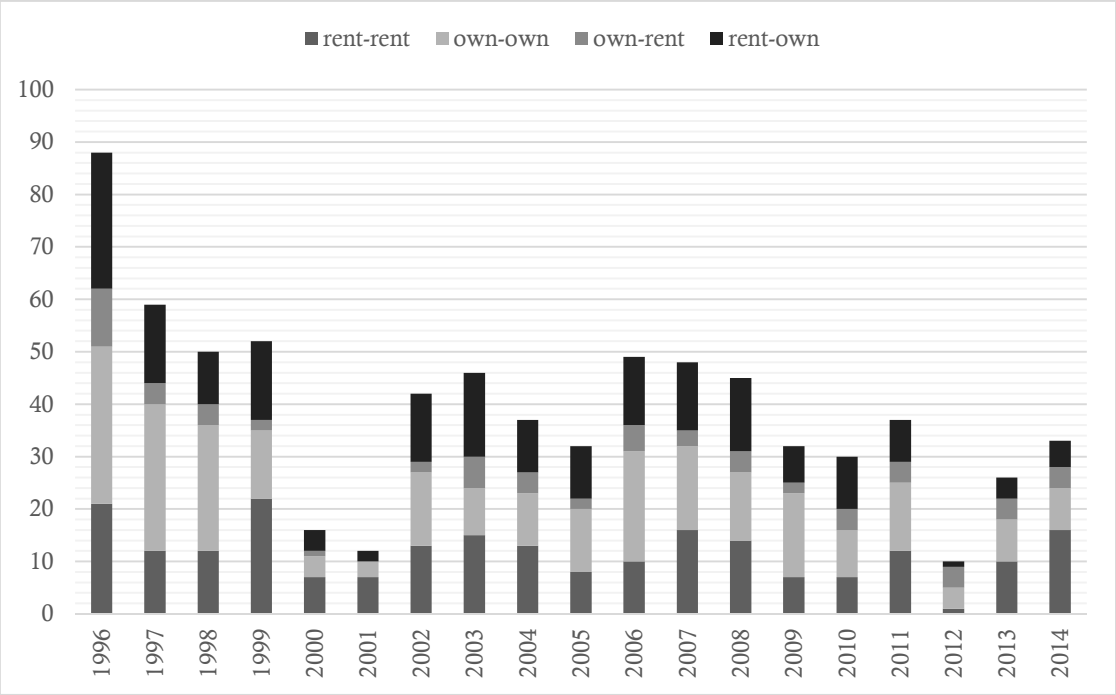
Table 2 Mean CLTV ratio per category (non-weighted)

	Pre-crisis (1995-2007)				After-crisis (2008-2014)			
	Mean	SD	Min	Max	Mean	SD	Min	Max
Moved	0,58	0,37	0	2,15	0,54	0,42	0	1,15
Pre-move	0,48	0,35	0	1,92	0,45	0,39	0	1,13
Age≤35	0,60	0,36	0	2,29	0,78	0,43	0	2,39
35<age≤55	0,44	0,29	0	2,50	0,50	0,39	0	2,37
Age>55	0,22	0,25	0	2,46	0,24	0,27	0	1,88
High income	0,43	0,30	0	2,29	0,42	0,39	0	2,39
Low income	0,37	0,32	0	2,50	0,34	0,36	0	2,29
Paid job	0,46	0,32	0	2,50	0,48	0,40	0	2,39
Social sec.	0,30	0,27	0	2,41	0,22	0,26	0	1,60
No job	0,23	0,27	0	2,38	0,23	0,26	0	1,88
Urban vhigh	0,46	0,34	0	2,41	0,50	0,43	0	2,39
Urban high	0,42	0,33	0	2,46	0,38	0,38	0	1,89
Urban mod	0,38	0,32	0	2,38	0,33	0,35	0	1,95
Urban low	0,35	0,30	0	2,50	0,32	0,35	0	1,80
Urban vlow	0,35	0,30	0	2,14	0,35	0,35	0	2,01

Total number of owner-occupiers in dataset is 18,197 from 1995-2014. *Source:* DNB Housing Survey 1995-2014.

Figure 1 shows the distribution of the four different kind of moves per year over the total time period. These moves include; from owner-occupier to the owner-occupier sector, from the rental to the owner-occupier sector, from the owner-occupier to the rental sector and from rental tot the rental sector. The year 1995 is not included, as moves could not be identified from 1994 to 1995. The number of moves from the rental to the owner-occupier sector is the lowest for almost every year. The lowest number of total moves are observed in the years 2001, 2002 and 2012.

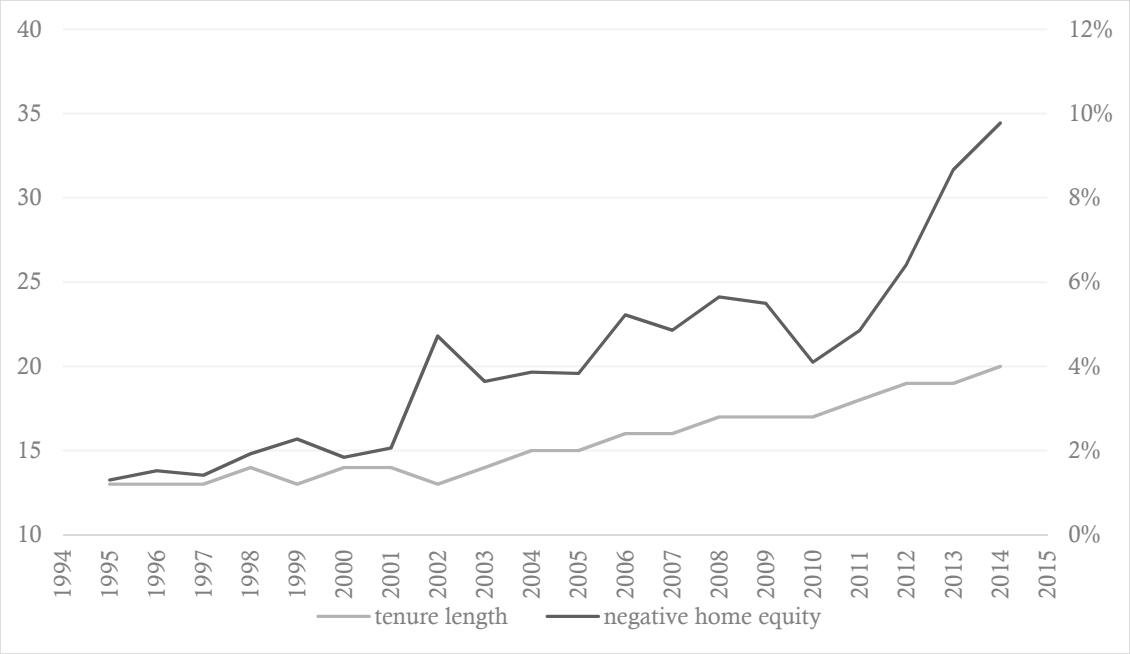
Figure 1 Absolute number of moves per year



Total number of matched pre-moves and moves in dataset is 744. Moves are classified as; renter to renter, owner to owner, owner to renter and renter to owner moves. *Source:* DNB Housing Survey 1995-2014.

Figure 2 illustrates the percentage of households with negative home equity for each year over the period from 1995 to 2014. This percentage seems to have a slightly upward trend from 1995 until 2009, then declines from 2009 until 2010 and sharply increases from 2010 on. This sharply upward trend is as would be expected, because of the relatively high mortgage loans and declining house prices in this period. However, the trend did not set in from 2008, but seems to lag the beginning of the crisis. The average tenure length of owner-occupiers is also shown in this figure, to illustrate that the upward trend of negative equity does not seem to come from a decrease in tenure length (as people who live in their houses for a shorter time are expected to have higher mortgage balances).

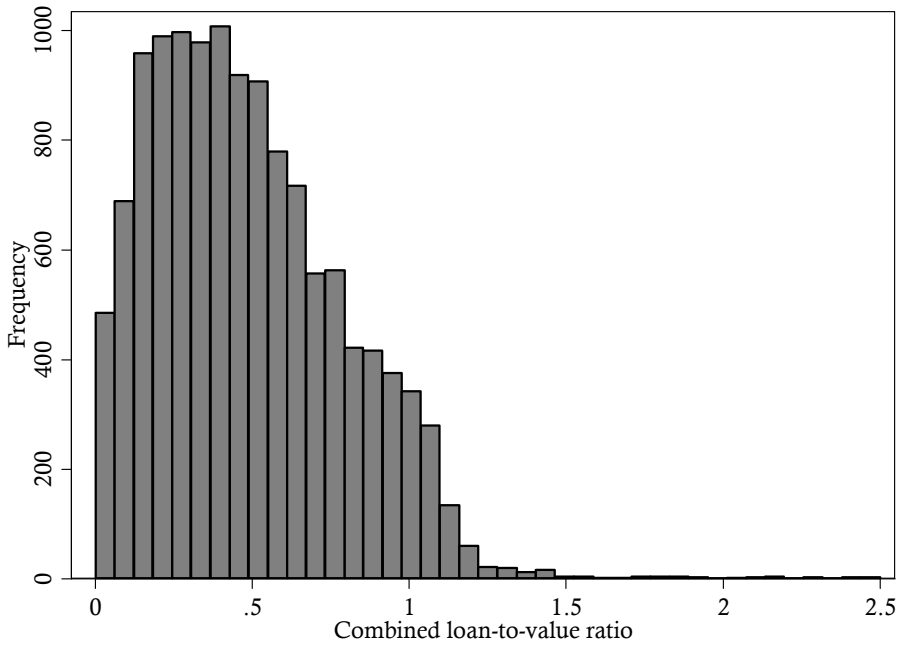
Figure 2 **Percentage of homeowners with negative home equity and average homeowner tenure length per year**



Total number of observations in dataset is 26,367 from 1995-2014.Total number of households with negative home equity over entire period is 726. These are households with loan-to-value ratios higher than 100%. Average tenure length is measured in years (left axis). Percentage of households with negative home equity is calculated by dividing number of households by total number of homeowners for each year (right axis). *Source:* DNB Housing Survey 1995-2014.

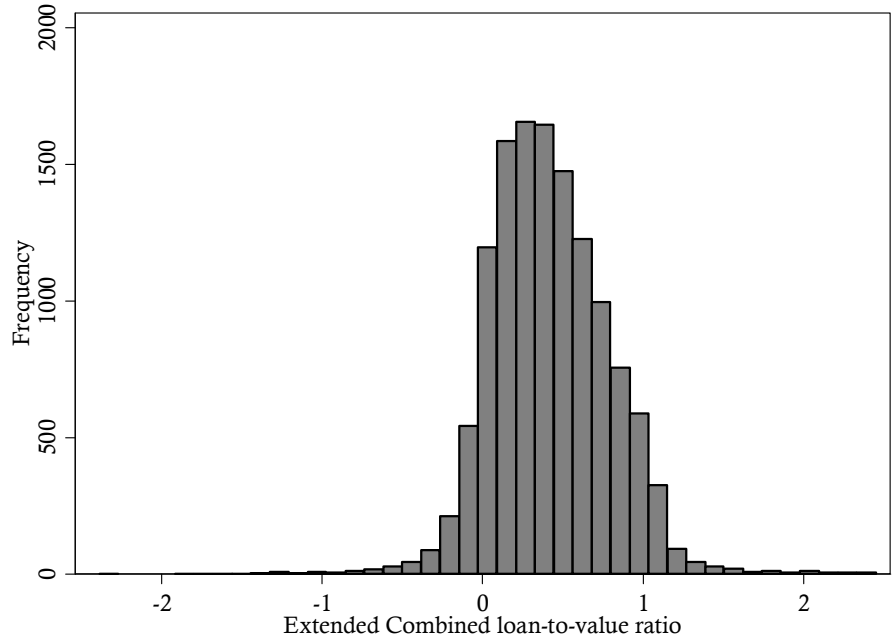
Figure 3 and figure 4 show the distribution of the (extended) CLTV ratio over the entire period from 1995 until 2014. (Extended) CLTV ratios of zero, where the household does not have a mortgage on the house (anymore) are excluded. In figure 4, the number of CLTV ratios which are zero is 3711, therefore the distribution shown is based on 12,704 observations. The highest frequency of households has a CLTV ratio around 0.4 (40%, which is somewhat lower for the ECLTV ratio. (Extended) CLTV ratios of higher than 1.5 (150%) are uncommon. In total, 726 observations of CLTV ratios above 1 are observed and 713 observations of extended CLTV ratios are observed. In figure 5, the number of extended CLTV ratios which are zero is 3,687, therefore the distribution shown is based on 12,700 observations. The distribution of the (extended) CLTV ratio per time period (pre-crisis and after crisis) are shown in figures 5a, 5b, 6a and 6b in appendix B, respectively appendix C. For both the extended CLTV and CLTV ratios, a rightward shift in the distribution can be seen in the crisis period compared to the pre-crisis period, as can also be seen in the sample of Andersson and Mayock (2014).

Figure 3 Distribution of the combined loan-to-value ratio



Total number of observed CLTV ratios is 16,415. Observations where the CLTV ratio is zero are excluded. Number of CLTV ratios of zero is 3711 (22.6%). Distribution is therefore based on 12,704 (77.4%) observed CLTV ratios. *Source:* DNB Housing Survey 1995-2014.

Figure 4 Distribution of the extended combined loan-to-value ratio



Total number of observed ECLTV ratios is 16,387. Observations where the ECLTV ratio is zero are excluded. Number of ECLTV ratios of zero is 3,687 (22,5%). Distribution is therefore based on 12,700 (77,5%) observed ECLTV ratios. *Source:* DNB Housing Survey 1995-2014.

Finally, table 3 shows the percentage of respondents with a moving preference per age, income, tenure length, CLTV, time and tenure type category. In total, over the whole 1995-2014 period, 3,119 people indicated to have a (strong) moving preference. People below the age of 36 have more preferences to move compared to the other age groups. Also, people with average tenure lengths (from 4 years till 11 years) have more preferences compared to the other groups. It seems that people before the crisis more often stated a moving preference than in the crisis period. Also, renters far more often state a preference than homeowners. For the CLTV categories, the percentages do not seem to differ much, however they are slightly higher for the 0.5<CLTV≤ 0.9 and CLTV>1.0 groups. Finally, for the high and low income categories, the percentages do not seem to differ much.

Table 3 Percentage of moving preferences per category (non-weighted)

	% moving preference		% moving preference
Age		*CLTV*	
Age ≤ 35	25.5	CLTV ≤ 0.5	7.6
35 < age ≤ 55	11.3	0.5 < CLTV ≤ 0.9	9.3
Age > 55	7.3	0.9 < CLTV ≤ 1.0	7.8
		CLTV > 1.0	8.4
Income			
High income	11.7	*Time*	
Low income	11.9	Pre-crisis	13.3
		Crisis	8.6
Tenure length			
Tenure length ≤ 3	12.1	*Tenure*	
3 < tenure length ≤ 7	17.2	Renter	20.7
7 < tenure length ≤ 11	15.3	Owner	7.8
11< tenure length ≤ 15	11.9		
Tenure length > 15	7.8		

In total, 3,119 people indicated to have a (strong) preference to move. This is 11.83% of the total dataset.
Source: DNB Housing Survey 1995-2014.

5. Empirical results

In this section, the empirical results of the models used are presented and discussed. The first model, discussed in section 5.1, examines the relation between different household characteristics and the height of the combined loan-to-value ratio. Next, the (logistic) models studying households mobility are discussed in section 5.2 and the mobility models including moving preferences in section 5.3. Finally, the robustness tests are presented in section 5.4.

5.1 Combined loan-to-value ratios

Table 4 shows the output for the multiple linear regression models, which explore the relation between several household characteristics and locational variables and the combined loan-to-value ratio. The first two models include age, tenure length and a crisis dummy as explanatory variables, where the first model includes age as dummies and the second one includes age as a continuous variable. Age, tenure length and time are important in explaining the height of the CLTV ratio and have highly significant coefficients in all three models. The results show that young people and people below the age of 55 have significantly higher CLTV ratios than people above the age of 55. Also, the longer people live in their house, the lower the CLTV ratio is. The results are in line with findings of Conijn and Schilder (2012), who also find that younger people and people who live in their house for a shorter time have higher loan-to-value ratios. Finally, CLTV ratios are higher in the crisis period, which was already indicated by the CLTV distributions shown in appendix B.

The third model also includes household characteristic variables including; marital status, employment status, urbanization dummies, households size, whether the house is bought after 2005 and gross household income (in thousands). Besides age, tenure length and crisis, the coefficients for married, social security, very high and high urban areas, bought after 2005 and income are significant in explaining the loan-to-value height. Married people have significantly lower ratios, people with social security have significantly lower ratios than people without a job, urban areas have significantly higher ratios and high income households have significantly higher ratios. The results for income and urbanization are also in line with findings of Conijn and Schilder (2012).

5.2 Mobility models

Table 5 shows the output for the first set of models. These models include buckets for the combined loan-to-value ratio, where the CLTV>1.0 bucket indicates negative equity. Model 4 does not include probability weights, model 5 includes the given (by DHS) probability weights for the years 2001 until 2014 and model 6 includes those weights and self-estimated weights together.

In all three models, the coefficient for the $0.5<CLTV\leq0.9$ bucket is positive, which indicates that this group is more mobile than the $CLTV\leq0.5$ group. It could be for example that

the latter group includes people that are in a life phase where they already found the house they want to stay in for a long time (and paid off more on their mortgage), or the group could be more risk-averse. However, the coefficients are not significant. For the 0.9<CLTV≤1.0 and CLTV>1.0 buckets, the coefficients are negative in all three models, which indicates less mobility compared to the CLTV≤0.5 group. The coefficients, and therefore the difference compared to the reference group, for the negative equity households are larger for the CLTV>1.0 group in all models. These results are in line with the expectation of hypothesis 1.

Table 4 Combined loan-to-value ratio regressions

	Dependent variable is the combined loan-to-value ratio (CLTV)		
	(1)	(2)	(3)
Constant	0.3901	0.8880	0.8335
	(0.0062)***	(0.0100)***	(0.0211)***
Age ≤ 35	0.2777		
	(0.0100)***		
35 < Age ≤ 55	0.1552		
	(0.0053)***		
Age		-0.0077	-0.0077
		(0.0002)***	(0.0003)***
Tenure length	-0.0084	-0.0075	-0.0064
	(0.0002)***	(0.0002)***	(0.0002)***
Crisis	0.0569	0.0611	0.0321
	(0.0053)***	(0.0053)***	(0.0055)***
Married			-0.0159
			(0.0067)**
Paid job			0.0054
			(0.0072)
Social security			-0.0188
			(0.0077)**
Very high urban			0.0741
			(0.0094)***
High urban			0.0361
			(0.0072)***
Urban			0.0087
			(0.0071)
Low urban			-0.0052
			(0.0071)
Bought after 2005			0.1055
			(0.0146)***
Household size			-0.0046
			(0.0025)*
Gross hh income (in thousands)			0.0010
			(0.0001)***
R^2	0.2469	0.2538	0.2776
N	16,388	16,388	15,299

Total number of observed CLTV ratios is 16,415. Robust standard errors are given in parentheses. Significance levels are indicated by stars; *** at 1%, ** at 5% and * at 10%. Results are based on non-weighted variables. *Source:* DNB Housing Survey 1995-2014.

The coefficient for negative equity is however only significant one time (at 5%), in model 5 which includes probability weights and covers the 2001-2014 period. This model does however show the highest value of the pseudo-R^2 of 10.41%. In this model the coefficient indicates that the odds of moving are 1.81 higher for the CLTV≤0.5 group, than for the negative equity group.

The coefficients for the renter group are positive and highly significant in all models, which is in line with previous research that shows renters are more mobile than homeowners (Coulson and Grieco, 2012). For the control variables, the coefficients for the age≤35 group, change in marital status and gross household income are highly significant in all three models. Young people have a higher probability of moving. The results for a change in marital status and households income are in line with findings of Ferreira et al. (2010), who also find that higher incomes and changes in marital status have a higher probability of moving. The coefficient for the crisis period is significant and negative in all three models, which indicates lower mobility in the 2008-2014 period than in the 1995-2007 period. The significance in the latter two models is however only at 5%. Positive changes in households size and living in (very) high urbanized areas also seem to positively influence the probability of moving and are significant in all three models, however only at the 1% level in the first model. Finally, employment status and negative changes in households size show insignificant coefficients in all three models and therefore do not seem strong predictors for the probability of moving. No significance for negative changes in household size are also found by Ferreira et al. (2010) and by Coulson and Grieco (2012) for out of state moves.

Table 6 shows the output for the second set of models. These models include buckets for the extended combined loan-to-value ratio, where the ECLTV>1.0 bucket indicates negative equity. Model 7 does not include probability weights, model 8 includes the given (by DHS) probability weights for the years 2001 until 2014 and model 9 includes those weights and self-estimated weights together.

Again, in all three models, the coefficient on the 0.5<ECLTV≤0.9 bucket is positive, which indicates that this group is more mobile than the ECLTV≤0.5 group. However, the coefficients are not significant in these models either. For the 0.9<ECLTV≤1.0 and ECLTV>1.0 buckets, the coefficients are again negative in all three models, which indicates less mobility compared to the ECLTV≤0.5 group. Just like in the previous set of models, the coefficient for negative equity is only significant one time (but now at 10%), in model 8. But also here, this model shows the highest value of the pseudo-R^2 of 10.43%. In model 8, the coefficient indicates that the odds of moving are 1.66 times higher for the ECLTV≤0.5 group, than for the negative equity group. The coefficient on the 0.9<ECLTV≤1.0 group is however significant at the 10% level in all three models, which is different from the previous set of models, where there was

Table 5 Logit regression models including the CLTV ratio

	Dependent variable is the binary variable *probability to move*		
	(4) no weights 1995-2014	(5) given weights 2001-2014	(6) estimated weights 1995-2014
Constant	-4.6488	-4.7608	-4.7150
	(0.2295)***	(0.3237)***	(0.2453)***
0.5<CLTV≤0.9	0.0648	0.1418	0.0719
	(0.1255)	(0.1840)	(0.1358)
0.9<CLTV≤1.0	-0.0435	-0.1449	-0.1373
	(0.2339)	(0.2814)	(0.2465)
CLTV>1.0	-0.3204	-0.5916	-0.3661
	(0.2439)	(0.2994)**	(0.2583)
Renter	0.8190	0.8144	0.7874
	(0.0976)***	(0.1272)***	(0.1010)***
Age ≤ 35	1.3342	1.5742	1.3957
	(0.1343)***	(0.1794)***	(0.1410)***
35 < Age ≤ 55	0.2637	0.2114	0.2810
	(0.1211)**	(0.1593)	(0.1220)**
Tenure length	-0.0138	-0.0148	-0.0147
	(0.0048)***	(0.0056)***	(0.0046)***
Crisis	-0.2432	-0.2274	-0.2022
	(0.0925)***	(0.1082)**	(0.0978)**
Change marital status	0.7081	0.7282	0.6622
	(0.1830)***	(0.2451)***	(0.2046)***
Positive change hh size	0.4311	0.3730	0.4534
	(0.1581)***	(0.2281)	(0.1803)**
Negative change hh size	0.2939	-0.1048	0.1054
	(0.2450)	(0.3314)	(0.2793)
Social Security	0.0358	0.0982	0.0500
	(0.1418)	(0.1930)	(0.1535)
No job	0.0132	0.0722	0.0404
	(0.1113)	(0.1600)	(0.1167)
Very high urban	0.3882	0.3416	0.3665
	(0.1376)***	(0.1789)*	(0.1462)**
High urban	0.4269	0.2490	0.4199
	(0.1302)***	(0.1756)	(0.1392)***
Urban	0.2398	0.1962	0.2545
	(0.1379)*	(0.1908)	(0.1483)*
Low urban	0.1613	0.2151	0.1643
	(0.1453)	(0.1949)	(0.1547)
lnGross household income	0.0463	0.0612	0.0528
	(0.0127)***	(0.0186)***	(0.0136)***
Pseudo R^2	0.0836	0.1041	0.0854
N	22,624	14,612	22,624

The combined loan-to-value ratio is included in buckets. The CLTV>1.0 bucket indicates negative home equity observations. Robust standard errors are given in parentheses. Significance levels are indicated by stars; *** at 1%, ** at 5% and * at 10%. *Source:* DNB Housing Survey 1995-2014.

no significance. Apparently, when other household debt and assets are taken into account, this group is significantly hampered in the moving process. This could be due to down payment requirements, moving costs or costs of mobilizing other equity (Struyven, 2015; Stein, 1995). However, it would be expected that the ECLTV>1.0 group would be even less mobile, which is not the case here. A possible explanation for this could be that this group includes more risk-takers, people who borrow more but also don't mind moving and be left with negative home equity.

The coefficients for the renter group are again positive and highly significant in all models. Overall, the control variables seem robust to either using the ECLTV or the CLTV ratio. The coefficients for the age≤35 group, change in marital status and gross household income are highly significant in all three models and show the same signs as in the previous set of models. The coefficient for the crisis period is negative in all three models again, with same levels of significance. Positive changes in households size and living in (very) high urbanized areas also seem to positively influence the probability of moving in these models and are significant in all three models. Finally, employment status and negative changes in households size show insignificant coefficients in all three models and therefore do not seem to influence the probability of moving here either.

Overall, the largest difference between the models including the CLTV and the models including the ECLTV ratio, is that the coefficients for the 0.9<ECLTV≤1.0 group are larger than the coefficients for the ECLTV>1.0 group in the latter set of models and that these coefficients are all significantly negative at the 10% level.

5.3 Mobility models and moving preferences

Table 7 shows the logit regressions models for the subsample where household moving preferences are taken into account. Two models are estimated, both without probability weights, because those are based on the whole dataset and this subsample only includes part of the data. In model 11 all years are used and in model 12 the years from 2001 until 2014 are used, which is the same period as where normally the weights would be given.

Compared to the previous two sets of models, a lot of the coefficients change sign and lose significance, while others suddenly are highly significant. None of the CLTV buckets coefficients are significant. Also the coefficient for the 0.9<CLTV≤1.0 group is suddenly quite large and positive, which would indicate higher mobility compared to the CLTV≤0.5 group. Also the crisis dummy, change in households size and degree of urbanization coefficients lose significance, while the social security and no job groups are significantly more mobile than people with paid jobs. The results are probably due to the fact that the models are based on only a few observations, compared to the observations from the previous models. This because only households who stated a preference and a maximum of three years after is included. This can also

Table 6 Logit regression models including the ECLTV ratio

	Dependent variable is the binary variable *probability to move*		
	(7) no weights 1995-2014	(8) given weights 2001-2014	(9) estimated weights 1995-2014
Constant	-4.6413	-4.7395	-4.7106
	(0.2291)***	(0.3215)***	(0.2443)***
0.5<ECLTV≤0.9	0.0572	0.1282	0.0570
	(0.1264)	(0.1865)	(0.1383)
0.9<ECLTV≤1.0	-0.5717	-0.6716	-0.6088
	(0.3076)*	(0.3757)*	(0.3245)*
ECLTV>1.0	-0.1253	-0.5067	-0.0969
	(0.2287)	(0.3066)*	(0.2445)
Renter	0.8070	0.7976	0.7833
	(0.0953)***	(0.1244)***	(0.0988)***
Age ≤ 35	1.3454	1.5757	1.4028
	(0.1345)***	(0.1798)***	(0.1415)***
35 < Age ≤ 55	0.2699	0.2115	0.2865
	(0.1212)**	(0.1593)	(0.1223)**
Tenure length	-0.0137	-0.0149	-0.0144
	(0.0048)***	(0.0056)***	(0.0046)***
Crisis	-0.2463	-0.2318	-0.2075
	(0.0921)***	(0.1078)**	(0.0972)**
Change marital status	0.7159	0.7299	0.6679
	(0.1830)***	(0.2451)***	(0.2046)***
Positive change hh size	0.4256	0.3701	0.4465
	(0.1581)***	(0.2289)	(0.1806)**
Negative change hh size	0.2912	-0.1048	0.1018
	(0.2450)	(0.3313)	(0.2795)
Social Security	0.0364	0.0987	0.0508
	(0.1418)	(0.1931)	(0.1535)
No job	0.0083	0.0722	0.0362
	(0.1115)	(0.1601)	(0.1171)
Very high urban	0.3855	0.3401	0.3601
	(0.1376)***	(0.1788)*	(0.1459)**
High urban	0.4270	0.2449	0.4178
	(0.1302)***	(0.1755)	(0.1390)***
Urban	0.2426	0.1934	0.2557
	(0.1379)*	(0.1907)	(0.1481)*
Low urban	0.1612	0.2132	0.1628
	(0.1453)	(0.1948)	(0.1546)
lnGross household income	0.0461	0.0611	0.0525
	(0.0126)***	(0.0186)***	(0.0136)***
Pseudo R^2	0.0840	0.1043	0.0857
N	22,599	14,602	22,599

The extended combined loan-to-value ratio is included in buckets. The ECLTV>1.0 bucket indicates negative home equity observations. Robust standard errors are given in parentheses. Significance levels are indicated by stars; *** at 1%, ** at 5% and * at 10%. *Source:* DNB Housing Survey 1995-2014.

Table 7 Logit regression models for the preferences subsample

	Dependent variable is the binary variable *probability to move*	
	(11) no weights 1995-2014	(12) no weights 2001-2014
Constant	-2.9053	-2.7383
	(0.3101)***	(0.3854)***
0.5<CLTV≤0.9	-0.0342	-0.0810
	(0.1777)	(0.2297)
0.9<CLTV≤1.0	0.4495	0.4427
	(0.3356)	(0.3772)
CLTV>1.0	-0.0355	-0.4333
	(0.3215)	(0.3795)
Renter	0.2709	0.3407
	(0.1323)**	(0.1647)**
Age ≤ 35	0.7141	0.9369
	(0.1794)***	(0.2189)***
35 < Age ≤ 55	0.0585	0.0191
	(0.1639)	(0.2051)
Tenure length	-0.0250	-0.0309
	(0.0071)***	(0.0084)***
Crisis	0.0030	-0.0700
	(0.1201)	(0.1314)
Change marital status	0.5572	0.6679
	(0.2393)**	(0.2617)**
Positive change hh size	0.2859	0.0945
	(0.1966)	(0.2384)
Negative change hh size	0.0891	-0.1815
	(0.3333)	(0.3841)
Social Security	0.4712	0.3993
	(0.1863)**	(0.2279)*
No job	0.5081	0.5330
	(0.1470)***	(0.1921)***
Very high urban	0.2587	0.1552
	(0.1892)	(0.2289)
High urban	0.3795	0.2564
	(0.1832)**	(0.2249)
Urban	0.2250	0.1342
	(0.1904)	(0.2351)
Low urban	0.3905	0.4563
	(0.2009)*	(0.2433)*
lnGross household income	0.0388 (0.0157)**	0.0397 (0.0206)*
Pseudo R^2	0.0412	0.0680
N	4,038	2,570

The combined loan-to-value ratio is included in buckets. The CLTV>1.0 bucket indicates negative home equity observations. Robust standard errors are given in parentheses. Significance levels are indicated by stars; *** at 1%, ** at 5% and * at 10%. *Source:* DNB Housing Survey 1995-2014.

be seen from the lower pseudo-R^2 values. Besides these problems, another problem arises, which has to do with the preference formation process itself. When a household already does not state a preference, because he expects that moving is not possible, for example because of negative equity, these households are excluded from the constructed subsample.

This could be a possible explanation for the change in coefficients and significance in models 11 and 12, compared to the previous mobility models. Where De Groot et al. (2013; 2011) only look empirically at households that already stated a preference, it could be important to look at the factors that drive the moving preference formation itself within an empirical framework.

To get more insight into the formation of moving preferences, the logit models as in table 5 are used again, but instead of the probability to move, the probability of having a moving preference is included as dependent variable. The results are shown in table 8.

For all three models, the coefficients for the 0.5<CLTV≤0.9 group, the 0.9<CLTV≤1.0 group and CLTV>1.0 group are negative and significant. This is a strong indicator for hampered mobility compared to the CLTV≤0.5 group. The coefficient for the negative equity group is significant at the 1% level in all three models. The coefficient is largest for the negative equity group in model 14, and just slightly lower than the coefficient for the 0.9<CLTV≤1.0 group in models 13 and 15. Compared to the models including actual moves, a change in marital status is less important for having a moving preference than an actual move itself. For preferences, a change in household size seems to be a better predictor, with positive (and often significant) coefficients in all models. The coefficients for the social security and no job groups are significantly negative at 1% in all models, indicating that these households are less likely to have a moving preference than people with jobs. Tenure length and income do not seem to significantly influence the possibility of having a moving preference and do not have significant coefficients. Just as in the models in table 5, renter, age, crisis and urbanization are (strong) predictors of the probability of having a preference and show the same signs. However, the coefficients for the 35<Age≤ 55 group, crisis dummy and very high urbanized, high urbanized and urbanized groups are more significant here. Finally, model 15, including own estimated and given weights together has the highest value of the pseudo-R^2 of 9.17%. In this model, all coefficients on the CLTV buckets are significantly negative at 1%. In this model the coefficient for the negative equity group is largest and indicates that the odds of having a moving preference are 1.89 times higher for the CLTV≤0.5 group, than for the negative equity group.

In total, 429 pre-moves out of the total 931 pre-moves are from households that stated a preference, while households stating a moving preference only represent 12% of total observations.

Table 8 Logit regression models including moving preferences and the CLTV ratio

	Dependent variable is the binary variable *probability of* ***preference*** *to move*		
	(13) no weights 1995-2014	(14) given weights 2001-2014	(15) estimated weights 1995-2014
Constant	-2.7306	-2.6955	-2.6839
	(0.1219)***	(0.1727)***	(0.1275)***
0.5<CLTV≤0.9	-0.1608	-0.1911	-0.2036
	(0.0715)**	(0.1011)*	(0.0766)***
0.9<CLTV≤1.0	-0.6540	-0.4563	-0.6625
	(0.1646)***	(0.1951)**	(0.1750)***
CLTV>1.0	-0.6034	-0.6253	-0.6384
	(0.1532)***	(0.1722)***	(0.1598)***
Renter	0.8499	0.7121	0.7964
	(0.0528)***	(0.0704)***	(0.0552)***
Age ≤ 35	1.1052	1.1333	1.1223
	(0.0777)***	(0.1096)***	(0.0829)***
35 < Age ≤ 55	0.2453	0.2039	0.2757
	(0.0653)***	(0.0907)**	(0.0698)***
Tenure length	0.0003	-0.0005	-0.0021
	(0.0025)	(0.0030)	(0.0024)
Crisis	-0.2482	-0.2143	-0.2682
	(0.0518)***	(0.0629)***	(0.0552)***
Change marital status	0.1929	0.2756	0.2210
	(0.1358)	(0.1663)*	(0.1431)
Positive change hh size	0.3178	0.2215	0.3333
	(0.1092)***	(0.1520)	(0.1192)***
Negative change hh size	0.2426	0.3143	0.2728
	(0.1483)	(0.1853)*	(0.1718)
Social Security	-0.3901	-0.4013	-0.4536
	(0.0816)***	(0.1125)***	(0.0892)***
No job	-0.4631	-0.4909	-0.4922
	(0.0649)***	(0.0949)***	(0.0705)***
Very high urban	0.5034	0.4979	0.4968
	(0.0775)***	(0.1085)***	(0.0832)***
High urban	0.3161	0.2378	0.3131
	(0.0744)***	(0.1052)**	(0.0801)***
Urban	0.3953	0.4023	0.4236
	(0.0760)***	(0.1105)***	(0.0824)***
Low urban	0.0129	0.0037	-0.0151
	(0.0826)	(0.1173)	(0.0888)
lnGross household income	0.0028	0.0050	0.0027
	(0.0067)	(0.0103)	(0.0073)
Pseudo R^2	0.0888	0.0842	0.0917
N	22,624	14,612	22,624

The combined loan-to-value ratio is included in buckets. The CLTV>1.0 bucket indicates negative home equity observations. Robust standard errors are given in parentheses. Significance levels are indicated by stars; *** at 1%, ** at 5% and * at 10%. *Source:* DNB Housing Survey 1995-2014.

The models were also estimated using ECLTV ratios instead of CLTV ratios and show the same results. The coefficients for both the 0.9<CLTV≤1.0 group and negative equity group are highly significant (at either the 1% or 5% level) and show negative signs in all three models.

Overall, these models provide evidence for the fact that people already take into account their financial position at the preference formation stage and that therefore (some of) these households were excluded from the dataset in the models in table 7.

5.4 Multinomial mobility models

The results from the multinomial regression models are shown in table 9. The models include a dummy that indicates whether the household has a higher (extended) CLTV ratio than 0.9. First of all, because when using the original (extended) CLTV buckets from table 5 and table 6, the number of observations for owner to rental moves for the negative equity dummy are below 10. Second, because in the previous logit models the coefficients for the 0.9<(E)CLTV≤1.0 category were also negative and often significant. Also, no probability weights are used in the models, as it is important to include as many observations as possible since the number of observations for the owner to rental moves is only 70. Control variables for which there were less than 10 observations of an owner to renter move are excluded from the model.

In both models, the coefficient for the (E)CLTV > 0.9 group is positive for the no moves group relative to the base category of owner to owner moves and the coefficient is also positive for the owner to renter moves relative to the base category of owner to owner moves. The results are in line with expectations of hypothesis 2, which stated that high levels of equity force (some) households that need to move, to move to the rental market. The coefficients are however only significant in model 17 which includes extended CLTV ratios, at the 10% and 1% level respectively. This model does have a slightly higher pseudo-R^2 of 3.28%. In model 17, the coefficient for the ECLTV > 0.9 group for the owner to renter group, indicates that the odds of moving from the owner to the rental market, compared to moves from owner to owner are 3.54 times higher when having an ECLTV ratio exceeding 0.9.

Table 9 Multinomial logit regression model results

Dependent variable is the *probability to move* (base outcome: own to own)				
	(16) no weights 1995-2014		(17) no weights 1995-2014	
	move type		move type	
	no move	own to rent	no move	own to rent
Constant	5.3326	0.1526	5.3427	0.1380
	(0.3955)***	(0.7241)	(0.3960)***	(0.7254)
(E)CLTV > 0.9	0.1782	0.7374	0.4316	1.2636
	(0.2287)	(0.4663)	(0.2549)*	(0.4628)***
Age ≤ 35	-1.4790	-1.2238	-1.5440	-1.3619
	(0.2303)***	(0.5024)**	(0.2301)***	(0.5033)***
35 < Age ≤ 55	-0.4513	-0.7522	-0.4831	-0.8042
	(0.1853)**	(0.3764)**	(0.1861)***	(0.3776)**
Tenure length	0.0007	-0.0040	0.0007	-0.0031
	(0.0080)	(0.0158)	(0.0080)	(0.0158)
Crisis	0.3593	0.3448	0.3385	0.3174
	(0.1661)**	(0.3324)	(0.1648)**	(0.3297)
Very high urban	-0.4347	-0.3568	-0.4199	-0.3555
	(0.2633)*	(0.5371)	(0.2649)	(0.5374)
High urban	-0.5575	-0.4325	-0.5631	-0.4397
	(0.2210)**	(0.4459)	(0.2209)**	(0.4457)
Urban	-0.2586	-0.4082	-0.2593	-0.4044
	(0.2300)	(0.4693)	(0.2300)	(0.4693)
Low urban	-0.1163	-0.5726	-0.1183	-0.5711
	(0.2412)	(0.5096)	(0.2412)	(0.5096)
LnGross hh income	-0.0493	-0.0703	-0.0482	-0.0692
	(0.0280)*	(0.0514)	(0.0279)*	(0.0514)
Pseudo R^2	0.0310		0.0328	
N	15,300		15,275	

Results based on homeowners only. The (extended) combined loan-to-value ratio is included in buckets. The CLTV≤0.9 bucket is used as reference group. Robust standard errors are given in parentheses. Significance levels are indicated by stars; *** at 1%, ** at 5% and * at 10%. *Source:* DNB Housing Survey 1995-2014.

5.5 Robustness

The results for the models including CLTV ratios using own-calculated home values following the method explained in section 3.3, are shown in table 10. Besides a different measure for the CLTV ratios, the models shown here are identical to the models used for the output in table 5.

The number of observations used is less than in the first set of mobility models because less market values were used due to missing values for either the purchase price of the house or the year of purchase. However, the pseudo-R^2 in each of the models is higher compared to the results in table 5.

While the 0.9<CLTV≤1.0 group showed a negative sign in all three models in table 5, the coefficients for both the 0.5<CLTV≤0.9 group and 0.9<CLTV≤1.0 group are positive and insignificant in almost every one of the models shown in table 10. Although the coefficient for the negative equity group does show a negative sign in all three models, they are not significant.

Overall, the control variables seem to show the same signs and significance levels compared to the models from table 5. The coefficients for renters, young people, tenure length, a change in marital status and gross household income are all positive and significant at the 1% level. The coefficients for the crisis dummy and positive change in households size also seem to influence the probability of moving, but are not significant (at the 1% level) in all three models.

Although the results are not shown here, the models including the ECLTV ratios from table 6 were also estimated using own calculated home values. Again, the coefficients for the 0.9<ECLTV≤1.0 and negative equity groups show negative signs. However, the coefficients are small and lose significance in all three models.

Finally, the models from table 5 are estimated again, but now including a dummy variable for whether the households' own estimate of house value is below the original purchase price. The dummy, in line with coefficients used in the study of Engelhardt (2003), should capture some of the effects of loss aversion, as some homeowners probably do not want to move when this is the case. The output from these models is shown in table 11.

The coefficient for the loss aversion dummy is negative and significant at the 5% level in all three models. This is in line with expectations, as homeowners probably want to avoid a possible loss and therefore are reluctant to sell their house for a lower value than the original purchase price. Including this dummy in the models, the negative equity coefficient loses significance. The results found here are in line with findings of Engelhardt (2003) and Genesove and Mayer (2001). Overall, the control variables show the same coefficient signs and levels of significance.

The results found in the previous sets of mobility models in table 5 and table 6, do not seem robust to the inclusion of own estimated house values for calculating loan-to-value ratios, as well as the inclusion of a dummy that captures part of the loss aversion effects on mobility.

Table 10 Logit regression models including alternative house value calculations

	Dependent variable is the binary variable *probability to move*		
	(18) no weights 1995-2014	(19) given weights 2001-2014	(20) estimated weights 1995-2014
Constant	-4.6030	-4.9016	-4.6787
	(0.2601)***	(0.3503)***	(0.2822)***
0.5<CLTV≤0.9	0.0466	0.0991	-0.0039
	(0.1921)	(0.2094)	(0.1986)
0.9<CLTV≤1.0	0.2345	0.1017	0.0287
	(0.2838)	(0.3001)	(0.2904)
CLTV>1.0	-0.1750	-0.0822	-0.1501
	(0.2379)	(0.2804)	(0.2690)
Renter	0.8623	0.9375	0.8024
	(0.1190)***	(0.1448)***	(0.1242)***
Age ≤ 35	1.3152	1.5914	1.3997
	(0.1489)***	(0.1883)***	(0.1558)***
35 < Age ≤ 55	0.2933	0.2700	0.2937
	(0.1366)**	(0.1686)	(0.1374)**
Tenure length	-0.0199	-0.0171	-0.0196
	(0.0056)***	(0.0063)***	(0.0053)***
Crisis	-0.2399	-0.1929	-0.2034
	(0.1006)**	(0.1154)*	(0.1074)*
Change marital status	0.7151	0.7423	0.6739
	(0.1977)***	(0.2546)***	(0.2236)***
Positive change hh size	0.4661	0.4192	0.4867
	(0.1723)***	(0.2335)*	(0.2000)**
Negative change hh size	0.1767	-0.1792	0.0108
	(0.2749)	(0.3670)	(0.3152)
Social Security	0.0629	0.0954	0.0799
	(0.1561)	(0.2040)	(0.1687)
No job	0.0455	0.1092	0.0871
	(0.1255)	(0.1684)	(0.1320)
Very high urban	0.2426	0.3305	0.2514
	(0.1512)	(0.1894)*	(0.1598)
High urban	0.2811	0.2661	0.2966
	(0.1455)*	(0.1866)	(0.1555)*
Urban	0.1391	0.2097	0.1745
	(0.1563)	(0.2044)	(0.1688)
Low urban	0.0250	0.2293	0.0755
	(0.1666)	(0.2105)	(0.1781)
lnGross household income	0.0556	0.0598	0.0612
	(0.0139)***	(0.0191)***	(0.0150)***
Pseudo R^2	0.0918	0.1070	0.0906
N	15,875	12,285	15,875

The combined loan-to-value ratio (using own-calculated home values) is included in buckets. The CLTV>1.0 bucket indicates negative home equity observations. Robust standard errors are given in parentheses. Significance levels are indicated by stars; *** at 1%, ** at 5% and * at 10%. *Source:* DNB Housing Survey 1995-2014, CBS Netherlands house price index, NVM Brokers transaction prices.

Table 11 Logit regression models including loss aversion dummy

	Dependent variable is the binary variable *probability to move*		
	(21) no weights 1995-2014	(22) given weights 2001-2014	(23) estimated weights 1995-2014
Constant	-4.6263	-4.7255	-4.6923
	(0.2299)***	(0.3241)***	(0.2454)***
0.5<CLTV≤0.9	0.0604	0.1410	0.0662
	(0.1256)	(0.1844)	(0.1359)
0.9<CLTV≤1.0	-0.0492	-0.1498	-0.1418
	(0.2339)	(0.2815)	(0.2464)
CLTV>1.0	-0.2358	-0.4823	-0.2733
	(0.2461)	(0.3079)	(0.2649)
Renter	0.7996	0.7810	0.7647
	(0.0979)***	(0.1277)***	(0.1012)***
Loss aversion	-0.7741	-0.9667	-0.8825
	(0.3931)**	(0.4538)**	(0.4180)**
Age ≤ 35	1.3307	1.5695	1.3940
	(0.1344)***	(0.1796)***	(0.1411)***
35 < Age ≤ 55	0.2600	0.2070	0.2787
	(0.1212)**	(0.1593)	(0.1221)**
Tenure length	-0.0144	-0.0155	-0.0151
	(0.0048)***	(0.0057)***	(0.0046)***
Crisis	-0.2131	-0.2052	-0.1789
	(0.0931)**	(0.1086)*	(0.0983)*
Change marital status	0.7061	0.7254	0.6607
	(0.1830)***	(0.2454)***	(0.2048)***
Positive change hh size	0.4305	0.3727	0.4536
	(0.1582)***	(0.2284)	(0.1805)**
Negative change hh size	0.2980	-0.1001	0.1095
	(0.2449)	(0.3311)	(0.2791)
Social Security	0.0340	0.0963	0.0485
	(0.1418)	(0.1930)	(0.1534)
No job	0.0161	0.0753	0.0430
	(0.1113)	(0.1600)	(0.1167)
Very high urban	0.3870	0.3414	0.3661
	(0.1376)***	(0.1789)*	(0.1462)**
High urban	0.4282	0.2504	0.4212
	(0.1302)***	(0.1757)	(0.1393)***
Urban	0.2404	0.1974	0.2548
	(0.1379)*	(0.1909)	(0.1483)*
Low urban	0.1595	0.2121	0.1633
	(0.1453)	(0.1950)	(0.1547)
lnGross household income	0.0462	0.0611	0.0527
	(0.0127)***	(0.0186)***	(0.0137)***
Pseudo R^2	0.0843	0.1052	0.0860
N	22,624	14,612	22,624

The combined loan-to-value ratio is included in buckets. The CLTV>1.0 bucket indicates negative home equity observations. Robust standard errors are given in parentheses. Significance levels are indicated by stars; *** at 1%, ** at 5% and * at 10%. *Source:* DNB Housing Survey 1995-2014.

6. Discussion

The results in this thesis do not seem to provide strong evidence for the existence of the lock-in hypothesis, like is found in the Netherlands by Struyven (2015) and in the US by Chan (2001), Ferreira et al. (2010) and Andersson and Mayock (2014). However, as the coefficient for the negative equity group is negative in all estimated models, contradicting evidence for the hypothesis, as in the study of Schulhofer-Wohl (2011), has also not been found. It was expected that the homeowner lock-in effect would be more profound in the Dutch housing market than in the US, as in the Netherlands the full recourse structure of the housing market ensures that the housing lock channel is isolated from the strategic default channel.

The results could be subject to either issues that resulted from the DNB Housing Survey itself or the several assumptions that were made in this research. First, the datasets used contained many values that were filled in incorrectly by the participants. Also, for several variables, like house values, outstanding mortgage balance and capital insurance amount, the dataset contained many missing values. For these reasons, not that many observations were included in the models. For example, in the models where preferences were used instead of actual moves, the results were highly significant, possibly because there were simply more observations for preferences than actual moves.

Second, the findings could be the result of one out of many assumptions that were made in this research. First of all, probability weights calculated by the DNB Housing Survey were only included from the year 2001 and on. Assumptions for the other years had to be made, which could be more imprecise. For the models including DHS probability weights, significant reductions in mobility were found, which could be the result of the period for which these weights were calculated (from 2001 until 2014). The mortgage market in the Netherlands changed a lot over the twenty years that were included. In addition, although there are a lot of different mortgage types in the Netherlands, no differentiation between mortgage types had been made. Also for the inclusion of debt, assets and own calculated house values, several assumptions had to be made.

Finally, although the models themselves included a rich set of control variables, endogeneity issues between variables possibly influenced the results as well. Especially the interactions between moves, age, tenure length and the height of loan-to-value ratios are sensitive to the form in which they are included in the several models. In addition, although the DHS Housing Survey allows to follow households over time, the panel was too unbalanced to use panel regression models and therefore the data had to be treated as cross-sectional.

Future research could be extended by adjusting mortgage balances for capital insurance and by differentiating between mortgage types. Also, a dataset including more observations for moves and therefore different kind of moves between markets, could help improve results.

7. Conclusion

This thesis explores whether Dutch homeowners facing high loan-to-value ratios become locked-in, which is indicated by a lower probability of moving. Furthermore, this thesis explores the influence of high loan-to-value ratios on tenure choice and whether homeowners facing high loan-to-value ratios have a higher probability of moving to the rental market. The effects of high loan-to-value ratios on mobility are particularly of interest in the Netherlands, as they have the highest loan-to-value ratios compared to other countries and faced one of the largest drops in house prices and were left with a severe housing crisis.

To test the hypotheses, logit as well as multinomial logit regression models were used to estimate the effect of loan-to-value ratios as well as several household characteristic variables on the probability of moving. The combined loan-to-value ratio as well as the extended combined loan-to-value ratio including households' other debt and assets, are used to estimate the models. In this thesis, data from the DNB Housing Survey, including information on household personal characteristics, employment, living conditions, mortgages, pensions, income, wealth and economic and psychological concepts, for the period from 1995 until 2014 is used. This dataset allowed for the use a rich set of (control) variables.

No strong evidence supporting the lock-in hypothesis is found. Although the coefficient for the negative home equity group of homeowners is negative in all the estimated models, the coefficient is only significant in two cases. In these two models, households with low loan-to-value ratios are estimated to be between 1.66 and 1.81 more likely to move than households facing negative home equity. The results are not robust to tests including either own estimated house values using actual house price indices or a loss aversion dummy indicating whether the homeowners' estimate of house value is below the original purchase price. The logit models including moving preferences instead of actual moves as dependent variable, do however show significant negative effects of high loan-to-value ratios on the probability of stating a moving preference.

The models estimating the effect of high loan-to-value ratios on tenure choice, show some evidence that households with loan-to-value ratios above 90%, have a higher probability of moving to the rental market. The results from the models including extended combined loan-to-value ratios, indicate that the odds of moving from the owner to the rental market, compared to owner to owner moves are 3.54 times higher when having an extended combined loan-to-value ratio exceeding 90%.

The results found in this thesis have several implications for Dutch policymakers concerned with housing market design. While some evidence is provided that negative equity hampers mobility, strong evidence is provided that negative equity reduces moving preferences. Also, the results concerning tenure choice have implications for both the Dutch rental and owner-occupier markets, as these are highly regulated.

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Appendix A: description of data and data preparation

DNB Housing Survey

The DNB Housing Surveys data is coordinated and implemented by CentERdata at Tilburg University. Households without a computer or internet, are provided with easy internet or computer access. From 1993, economic data from the CentERpanel is gathered, with as main purpose to study the determinants of household saving behavior. The data are divided into six modules, covering personal characteristics, employment, living conditions, mortgages, pensions, income, wealth and economic and psychological concepts. The DNB Housing Survey is one of the few panel datasets in Europe that allows to analyze financial situation and economic behavior in detail.

Combined loan-to-value ratio

For estimated house values, because some years include values in thousands and some years did not, all reported estimates below one thousand are multiplied by one thousand. Next, to limit the number of missing values, some missing values are replaced by their current assessed tax-value or purchase price (up to two years ago). Values reported for the answer "I don't know" (-9, 9999, 99999, 999999, etc.) are set to missing. Finally, estimated market values below €30,000 and above €2,000,000 are set to missing.

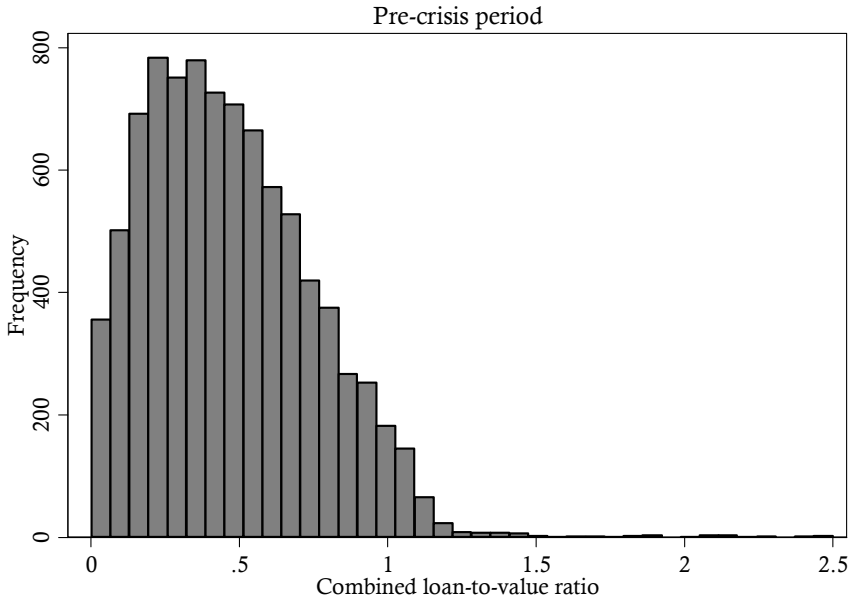
For the outstanding mortgage debt, the combined values for all mortgages are included. Before combining the outstanding balances, values reported for the answer "I don't know" (-9, 9999, 99999, 999999, etc.) are set to missing for each mortgage separately. To limit the number of missing values, the outstanding mortgage balance has been set to the beginning mortgage balance when the mortgage is interest-only. Again, all reported values below one thousand are multiplied by one thousand. No values exceed €2,000,000. The combined outstanding mortgage balance variable is now created.

Estimation of sample weights

For the years 1995 until 1999, sample weights are estimated by using the indication of whether a household is included in the "nationwide" or "high income" panel. The high income panel includes households from the 10^{th} income decile and the nationwide panel includes households from the first nine income deciles. Probability weights are created by making sure the high income households in the dataset represent 10%, while the nationwide households represent 90% of the dataset each year. So, the probability weight appointed to the high income households times the number of high income households should represent 10% of the sample each year. The same holds for the nationwide households.

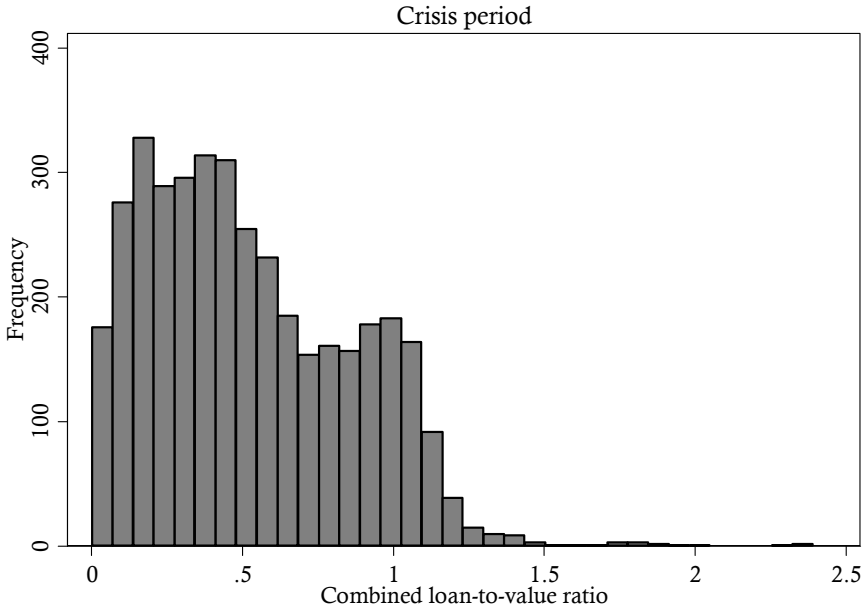
Appendix B: distribution of the CLTV ratio per time period

Figure 5a Distribution of the combined loan-to-value ratio in the pre-crisis period



Total number of observed CLTV ratios in this period (1995-2007) is 10,874. Observations where the CLTV ratio is zero are excluded. Number of CLTV ratios of zero is 2,012 (18.5%). *Source:* DNB Housing survey 1995-2014.

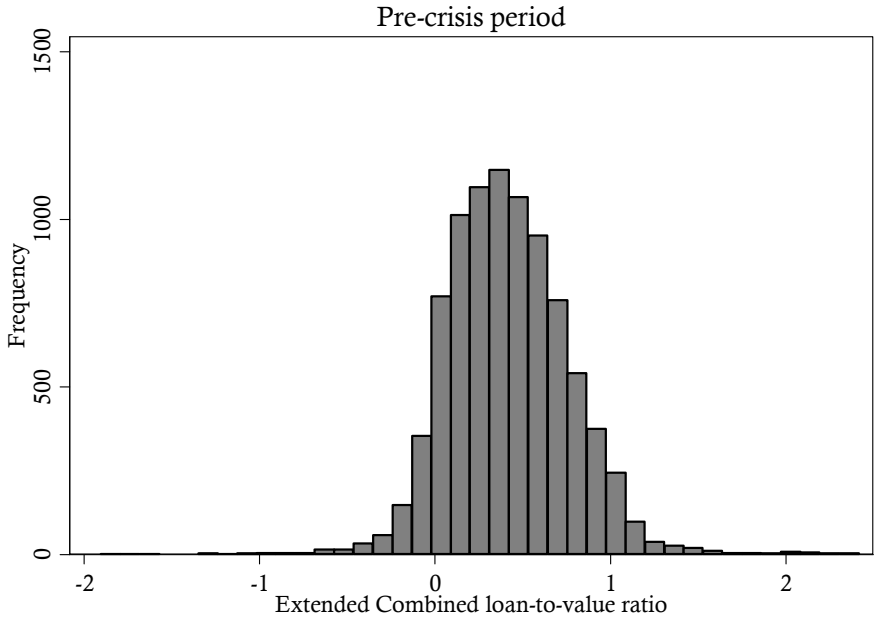
Figure 5b Distribution of the combined loan-to-value ratio in the crisis period



Total number of observed CLTV ratios in this period (2008-2014) is 5,541. Observations where the CLTV ratio is zero are excluded. Number of CLTV ratios of zero is 1,699 (30,7%). *Source:* DNB Housing survey 1995-2014.

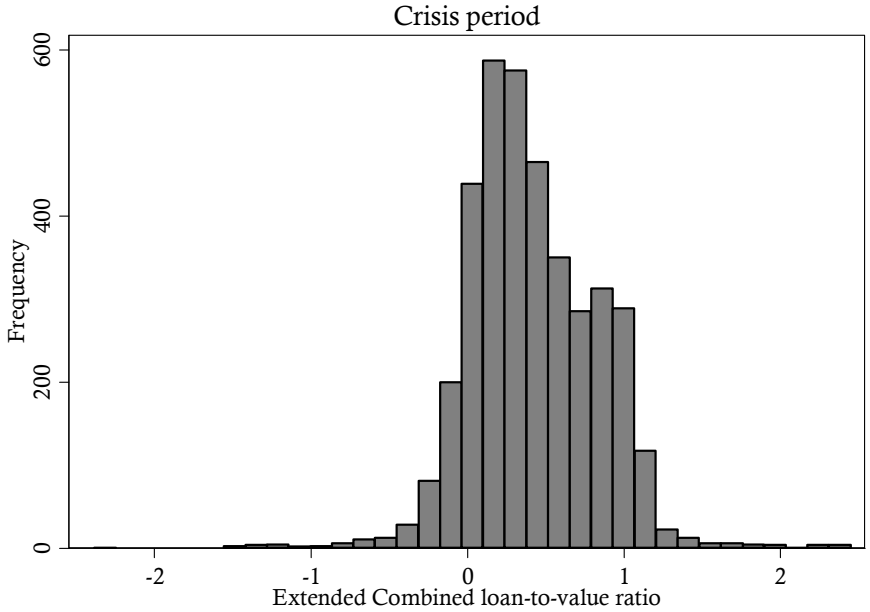
Appendix C: distribution of the extended CLTV ratio per time period

Figure 6a Distribution of the extended CLTV ratio in the pre-crisis period



Total number of observed ECLTV ratios is 10,852. Observations where the ECLTV ratio is zero are excluded. Number of ECLTV ratios of zero is 1,998 (18,4%). *Source:* DNB Housing survey 1995-2014.

Figure 6b Distribution of the extended CLTV ratio in the crisis period



Total number of observed ECLTV ratios is 5,535. Observations where the ECLTV ratio is zero are excluded. Number of ECLTV ratios of zero is 1,689 (30,5%). *Source:* DNB Housing survey 1995-2014.