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Interest Rate Resets on the Dutch Mortgage Market

How Self-Employment, High LTV and LTI Affect the Choice of Variable Interest Rates

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INTERREST RATE RESETS ON THE DUTCH MORTGAGE MARKET:
how self-employment, high LTV and LTI affect the choice of variable interest rates

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Chapter 1. Executive summary

1.1. The research framework

This Master's thesis focuses on the determinants of choice of the interest rate reset period by Dutch households. The recent subprime mortgage market crisis has shown that the combination of different risky features of a mortgage, which includes also an adjustable interest rate, though for a small group of mortgagors, can originate an economic crisis. In 2009 the Basel Committee on Banking Supervision has issued "*Principles for sound stress testing practices and supervision*", where a special attention was addressed to the weakness of current stress models, since "..especially in stressed conditions, risk characteristics can change rapidly as reactions by market participants within the system can induce feedback effects and lead to system-wide interactions. These effects can dramatically amplify initial shocks".

The level of risk taken on the Dutch mortgage market is under deep scrutiny, both nationally and by the IMF. Classical indicators of risky mortgages are the high "loan to value" and "loan to income" ratios. A less explored indicator concerns interest rate setting behavior and its correlation with the above mentioned ratios. Generally, a fixed interest rate for the whole duration of the mortgage contract is regarded as an expensive option but safe. A variable interest rate is relatively cheaper, but exposes households to interest rate risk when the mortgage interest rate rises. What do households choose and why? What are the main determinants of their preferences? What factors increase the risk exposure and eventually amplify the risk of default?

The main aims of this study are grouped into the following list:

- To link interest rates resets to other risk triggers relevant for risk assessment models, such as stress tests.
- To test the significance of the correlation between LTV-, LTI-ratios, choice of mortgage contract and the exposure to interest rate risk.
- To figure out how exposure to interest rate risk depends on households' characteristics and other observables.
- Try to isolate causality among risk triggers.

Further, I try to elaborate a specific policy recommendation, related to the households' probability of default and their exposure (loss given default - LGD). This issue is highly relevant in the context of the stress test literature where probabilities of default and losses given defaults are taken as orthogonal. However, if we were to find that only households with large risk exposures have high chances to default, the stress stemming out of these tests could be greatly underestimated.

In order to answer the central questions of this Master's thesis I started with a description of the current situation and outlining of relevant problems on the Dutch mortgage market. Chapter II includes the literature review on the core topic. There, I provided comprehensive analysis of risk factors and discussed the influence of risk-aversion and behavior patterns on the choices made by households, as well as shortly outlined why households prefer mortgages with adjustable interest rates (ARM) to the

ones with fixed interest rate (FRM) and under what circumstances. Further, in Chapter III a detailed description of the data and methodology is provided. Chapter IV concentrates on the proposed econometric model and discussion of the main results. Finally, in the conclusion, I give a summarizing assessment and provide tentative answers to the previously discussed research issues.

1.2. The Dutch mortgage market

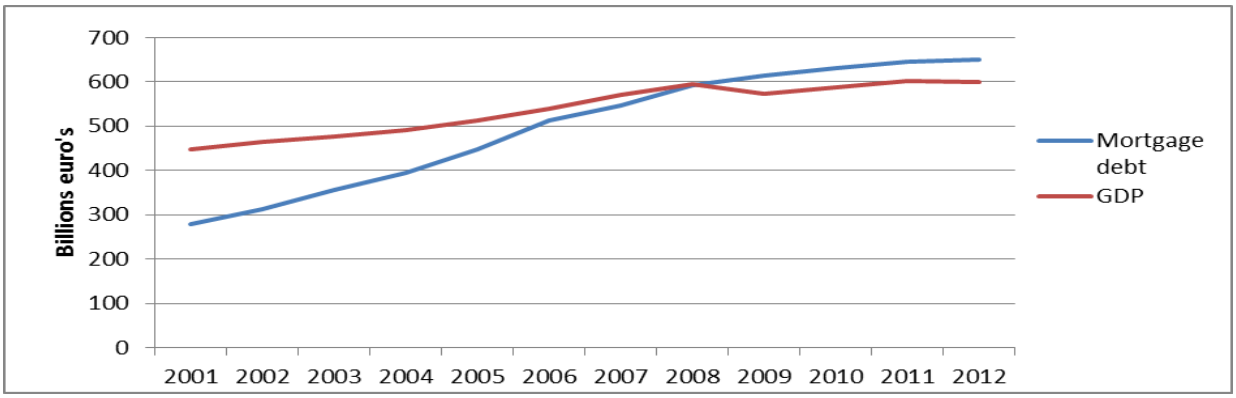
The housing market holds an important position in the real economy: real estate is a major part of household wealth, housing-related expenses contribute to GDP growth in many countries, rental prices are a component of consumer prices, housing taxation can profoundly influence public finances, and the structure of the housing market can have considerable impact on the supply side of the economy. As a consequence, the mortgage market is relevant in this context as well. The financial sector is interrelated with mortgages, where houses are usual collateral for the banks attracting funds, and where mortgage portfolios can form a substantial part of assets.

The mortgage market of the Netherlands is rather complex in comparison with the other countries and has its local flavor. The possibility of tax deduction, the Mortgage Code of Conduct and the National Mortgage Guarantee (NHG) system are the most distinguishing features of the Dutch mortgage market. The recent developments of the Dutch mortgage-interest tax-relief system were motivated by the present crisis, and thus by the increasing mortgage debt and the level of associated risks both for borrowers and lenders.

The sharp fall in house prices during 2009-2012 has profoundly damaged the Dutch economy: it has weakened significantly household financial position and consumer confidence, as well as employment and economic growth in general. Further, the reduction in housing wealth contributed to the downturn in household spending, which has reinforced the current economic slowdown.

Partly due to the Netherlands' generous mortgage tax relief, as well as a number of fancy mortgage products without repayment, created with an aim to maximize tax deductions, the Netherlands' mortgage debt has rocketed up for the last decade and landed up among the world's highest, currently amounting to 108% of GDP according to the Dutch central bank (DNB). Moreover, the mortgage debt burden forms approximately 86% of total household debts, increasing the risk probability of default in case of unpredicted negative changes in household incomes and other critical situations (e.g. divorce or death etc.). Figure 1.1 reveals the high speed of the increasing mortgage debt in comparison to gross domestic product starting from 2001 till 2012.

Figure 1.1. Growth of total mortgage debt vs. GDP



Source: DNB Statistics

Although on the aggregate level, mortgage debt is more than enough offset by available assets, the underlying macroeconomic data show extensive discrepancies between the households in terms of incomes and their ability to repay debts. On a microeconomic level, these differences can induce several types of the risks, e.g. default risk, negative equity risk and credit risk.

The Dutch tax code is the main driver of the choice for specific features of mortgage products that are available on the domestic market. Changes in the tax code have had profound implications for the popularity of different types of mortgages. Interest payments on a mortgage are deductible from income taxes at the marginal tax rate, which varies between 37% and 52%. Interest payments related to the primary home are tax deductible over a maximum period of 30 years. Moreover, repaid mortgage debt is also exempted from wealth taxation.

One of the already mentioned important characteristics of the Dutch mortgage market is a National Hypotheek Garantie (NHG), which is normally offered for those mortgagors who buy their first house given that its price is under the threshold of 350,000 euro. In case of mortgage default and if the house foreclosure value is below the outstanding principal, this insurance would cover the existing difference.

The typical mortgage loan has a duration of 30 years, with an interest rate that is fixed for several years (commonly 5 or 10 years). Usually, interest rates fixed for shorter periods of time are lower in comparison with the interest rates fixed for a longer period (see Table 1.1).

Table 1.1. Current interest rates spread

	NHG	up to 55%*	up to 65%*	up to 85%*	up to 95%*	up to 110%*
ARM	3,00 %	3,00 %	3,00 %	3,20 %	3,50 %	3,70 %
FRM (1 year)	3,10 %	3,10 %	3,10 %	3,30 %	3,60 %	3,80 %
FRM (3 years)	3,30 %	3,30 %	3,30 %	3,50 %	3,80 %	4,00 %
FRM (5 years)	3,45 %	3,45 %	3,45 %	3,65 %	3,95 %	4,15 %
FRM (6 years)	3,85 %	3,85 %	3,85 %	4,05 %	4,35 %	4,55 %
FRM (10 years)	4,40 %	4,40 %	4,40 %	4,60 %	4,90 %	5,10 %
FRM (15 years)	5,00 %	5,00 %	5,00 %	5,20 %	5,50 %	5,70 %
FRM (20 years)	5,30 %	5,30 %	5,30 %	5,50 %	5,80 %	6,00 %
FRM (30 years)	5,60 %	5,60 %	5,60 %	5,80 %	6,10 %	6,30 %

*Market value of the property

Source: ABN AMRO Hypotheken Groep B.V.

This variation is mainly determined by the yield curve on the capital market. In combination with other factors, the type and level of interest rates greatly influence the final choice of a mortgage contract made by the households when deciding how to finance their new property.

The most important mortgage types on the Netherlands market are the interest-only, savings, investment and life insurance mortgages. Quite often the houses are financed by a combination of several products listed above. The savings and interest-only mortgages are the most popular types of mortgage in the Netherlands, representing correspondingly 28% and 35% of all mortgages contracted until 2012 (DNB Household Survey).

In order to avoid unnecessary risks, the Dutch banks use a prudential approach in underwriting mortgages. All of them are obliged to adhere to the Code of Conduct for Mortgage Financing (Gedragscode Hypothecaire Financieringen - GHF). This code has been in effect since 2007 (with further revision in 2011), and it outlines several important issues. The first is the relationship between the size of debt burden and the disposable income of households. The GHF guidelines prescribe that maximum gross housing costs should form approximately one third of gross income. This number was computed basing on the budget guidelines published by the National Institute for Family Finance Information (NIBUD). As it would be shown later, it is closely related to the measurement of financial situation of households, used in this study.

The second gauge is the Loan-to-Value (LTV) ratio at the time of purchase. Starting from 2011 the LTV was limited to 104% of the market value of the house, plus 2% of transfer tax. The revised version of the Code of Conduct has to a certain extent tightened mortgage lending. Importantly, interest-only mortgages are now only allowed up to 50% of the market value of the house, while previously it was possible to finance the entire purchase in such way.

In February 2013 the Dutch cabinet came with additional measures for the mortgage market. However, the domestic risks from high indebtedness in the housing sector combined with the income instability and personal situation of households continue to be a troublesome issue, which requires close scrutiny and further research.

Chapter 2. Overview of the literature

2.1. Risk and uncertainty: risk attitude and behaviour of households

It is widely assumed that people differ considerably in their attitude towards risks, ranging from cautiousness to risk-seeking and even pleasure in taking a risk. However, according to Rohrmann (2005) there is no persuasive evidence that "...this presumed dimension is a general trait rather than a state or a domain-specific attitude, e.g. distinct for physical, financial, or social risks people may encounter". In what form a person's risk propensity or risk aversion 'comes to life' differs a lot depending on the type of hazard to be handled, such as physical, social or financial risks.

Interest rates reset choices are closely linked to the notion of risk aversion. Therefore, I review in this section some relevant literate on the topic of interest.

There are different ways to measure risk aversion. The most well-known is that of Arrow-Pratt. Kimball (1990) has introduced the concept of prudence to capture the idea of precautionary savings. He measured the intensity of an investor's desire to save under a certain level of risk.

At the same time a lot of researches pledge that the determinants of individual differences in risk attitudes can be various, for example gender, age, level and type of education, social status, wealth level, etc. Guiso and Paiella (2008) argue that relative risk aversion of a person should decline with growth of her wealth. The results of their research also show that risk averse consumers are mostly younger and less educated. Apart from that, risk averse people are less likely to be male, to be married or to live in the more developed regions of the country. Strong differences between risk-loving and more neutral persons also emerge depending on the type of occupation. Finally, they showed that risk-averse households are significantly less wealthy. Cox et al. (2011) also admit that older, wealthier, and more sophisticated households are less risk-averse and, therefore, more often opt for the newer mortgage products with variable interest rates. One of the main reasons is that they apparently also have a better understanding of risks and benefits associated with these products.

Despite these empirical and theoretical evidence, Guiso and Paiella (2008) point out the fact that individual's risk aversion is also influenced by a substantial amount of unexplained heterogeneity. Consumer's attributes and demographic characteristics can be of little help in predicting the degree of risk aversion.

Kiotaki et al. (2011) developed a model assuming that received inheritances can be a key identifier of the households' saving decision, explaining why some tenants decide to save or not. They show that those who were born without any inheritance cannot afford a sufficiently high down payment for buying a house due to liquidity constraints. Risk aversion would force them to rent a house and consume modestly so that to be able to save for a down payment in the future. Neuteboom (2003), however, points out that it's quite difficult to explain the risk-taking behavior of households by just calculating current incomes and actual costs with risks related to mortgage. The researcher should also take into account "...the individual attitude to risk, personal experiences, the institutional context, history, political traditions and the current ideology", as well as such factors as quality of pension program or the social security system. For example, the households that own a house in northwest Europe borrow much more than their southern European counterparts. 'Borrowing much more' in this case is regarded as a synonym for a high risk-taking behavior of the house owners, even though that could be just a result of the lower interest rates. This thus links defaults to exposures.

The elements above are typically also accounted for in the default models. For example, Steeve Assouan (2012) has shown that the probability of default (PD) can be simulated by measuring the effects of macroeconomic shocks based on piecewise approach to the analysis of individual financial soundness indicators. His empirical results show a significant and robust relationship between the portfolio's PD and several macroeconomic variables, including some consumption loan-specific variables, e.g. mortgage interest rate, household/consumer debt ratio, household investments etc.

A calibrated version of Li & Yao (2004) model revealed the joint importance of labor income (a usual trigger in models that measure PD) and house price risks (usual trigger in LGD models) in housing

decisions also linking default to exposures. A higher transitory income risk, temporary labor income risk and a higher house price risk cause delays of home purchases by households and leads to frequent and costly refinancing among young, liquidity-constrained homeowners. A higher permanent income risk induces a household to save more. Mortgage refinancing activities demonstrate a clear pattern – young homeowners refinance to ease liquidity concerns, while old homeowners refinance to defer house selling expenses and avoid higher renting costs.

2.2. Importance of demographic characteristics and financial literacy for mortgage choice

The relationship between the choice of specific mortgage features, such as the time to the next reset, and demographic characteristics is represented in a number of analyses as a function of both borrowing constraints and willingness of a household to withstand interest rate risk. A lot of household characteristics associated with ability to withstand the income risk also reflect a higher socio-economic status, therefore it is often assumed that these households will more likely prefer a contract with variable rates when deciding on type of the mortgage. This concept was proved in Dhillon, Shilling and Sirmans (1987), who found that wealthier households and married households are more likely to choose adjustable-rate mortgages. Phillips and Van der Hoff (1994) show although wealth is roughly equal between households with different mortgage type preferences, the mean income is higher among ARM borrowers than FRM borrowers. Moreover, those who chose ARMs tend to borrow more. Sa-Aadu and Megbolugbe (1995) point out that ARM borrowers are younger than FRM borrowers. However, they have a higher mean income and can expect a steeper future earnings path than FRM borrowers.

Cox, Brounen, Neuteboom (2011) put a special emphasize on the influence of financial literacy and certain demographic characteristic on the process of determining the type of mortgage contract. It was shown that the households with higher levels of literacy and lower risk aversion are more likely to choose interest-only mortgages. They rely more on own knowledge or professional advice. At the same time households with limited literacy levels and lower education tend to rely more on the information in public media when choosing their mortgage.

Finke et al. (2005) stress that if consumers make mortgage choices without full information regarding the related risks and if market interest rates suddenly rise, a possible market inefficiency may eventually lead to increased foreclosures among the most vulnerable homeowners with ARM contracts. In turn, Neuteboom (2003) points out that the lack of a competitive rental sector on the housing market can also force households into a certain risk-taking behavior, which would be in line with the individual knowledge and beliefs.

The findings of Finke et al. (2005) provide enough evidence that financial constraints may force certain families towards mortgage products that provide greater access to homeownership and at the same time add to household portfolio leverage and exposure to interest rate risk, which is perhaps not so obvious to less financially literate consumers. As a result, such mortgage products can exert negative effects on future income, wealth, and creditworthiness of those households.

Van Hemmert (2009) models labor income, housing and mortgages in order to study the life-cycle pattern in households' interest risk management with respect to the optimal mortgage and portfolio choice. He shows that on the asset side of the household balance sheet the investor would prefer to mainly invest in the asset with the highest associated risk premium, which are in most cases stocks. On the liability side of the household balance sheet if the investor has a house he/she would optimally finance it with an adjustable rate mortgage (ARM) and thereby save on the bond risk premium associated with a fixed rate mortgage (FRM). An investor who for any reason chooses to finance his/her house with a FRM would incur relatively large utility losses. On the contrary, Koijen et al. (2008) prove on the theoretical basis that in some cases it is relatively more attractive to choose an FRM, for example, when the nominal bond risk premium is low. In general, the choice between different mortgage types is mainly a choice between different interest rate products and should therefore be analyzed in combination with other financial decisions, in particular the bond portfolio choice.

Summing up, the main factors of impact on the mortgage choice to be named are certain demographic characteristics and reliance on external advise, portfolio preferences, impact of house price expectations and financial situation of the households, as well as households' intention to take more risks in order to improve own current situation or less risk to keep problems manageable.

2.3. Fixed interest rates versus adjustable ones: the main determinants of choice of the households with heterogeneous preferences in different life-setting

For a typical household a home mortgage is quite often the most significant financial contract. Therefore the form of this contract is of great importance. Nowadays everybody has a choice between a fixed-rate (FRM) and an adjustable-rate (ARM) mortgage. Most of the available studies focus on the household's choice between these two types of contracts.

Besides the influence of all relevant mortgage characteristics on the mortgage choice, researches have also examined the household's optimal mortgage decision in the context of a life-cycle model. As mentioned before, Van Hemert (2009) examined the interest rate risk for households using a life-cycle setting and found out that in most cases the ARM is the most preferred contract, with an exception of older risk-averse borrowers who deal with FRM debt. His findings are perfectly in line with those of Campbell and Cocco (2003), who show that households with a risky income and those that are risk-averse are less attracted by an ARM contract since monthly payments are sensitive to changes in the interest rate.

In an environment with uncertain inflation, a nominal FRM has risky real capital value whereas an ARM has a stable real capital value. In most cases ARM is generally more attractive form of mortgage. However, a household with a risky labor income, a high risk aversion, large mortgage, a low probability of moving and a high cost of default, is less likely to prefer an ARM.

When deciding on the type of mortgage, an extremely important consideration is labor income and the associated with it risk. Labor income is doubtless a crucial asset for the majority of households. It is notable that the households with large houses relative to their income, volatile labor income, or high

risk aversion are particularly adversely affected by the income risk of an ARM. In general FRMs protect homeowners against the possibility that the real interest rates will increase, whereas ARMs do not have such option (Campbell and Cocco, 2003).

Cox et al. (2011) indicate that ARMs have a higher repayment risk in comparison with traditional contracts. However, the availability of the government guaranteed insurance on the Dutch mortgage market gave the households a possibility to hedge the repayment risk. As a result, this might swap the choice of mortgage-type at the expense of risk aversion.

The current level of savings and mobility of a household also affect the form of the optimal choice of mortgage type. If a household can predict with high probability that it would move in the near future, or if it is currently constrained in borrowing, the most appropriate mortgage is more likely to be the one with the lowest interest rate at that moment. Unconditionally, this is the ARM, because the FRM's incorporate a positive term premium and the cost of the FRM prepayment option. Tyson and Brown (2000) say that: "Many homebuyers don't expect to stay in their current homes for a long time. If that's your expectation, consider an ARM. Why? Because an ARM starts at a lower interest rate than a fixed-rate loan, you should save interest dollars in the first two years of holding your ARM."

Campbell and Cocco (2003) also dispute over the influence of impatience. They show that unwillingness to wait would force the investors to accumulate a smaller buffer-stock of liquid financial assets, therefore they default more often and are more severely affected by the income risk of ARMs and the wealth risk of nominal FRMs. This type of households particularly benefits from the postponed payments of an inflation-indexed FRM with constant real payments. The cash-flow risk in ARM payments also implies that the proportion of households who choose to default on each loan tends to be higher under an ARM than under a FRM.

Finke et al. (2005) draw the conclusion that households suffering from financial instability choose often adjustable-rate contracts without sufficient wealth, human capital or current income, neglecting protection against possible interest rate volatility. There could be a couple of possible reasons for such a situation: one is that these choices are a rational acceptance of risk weighed against the benefits of homeownership. However, many of those pregnable households are also less able to assess in a correct way the risks associated with ARMs, so that they expose themselves to a greater threat of future financial problems they would like to deal with even not realizing it. Nowadays the popularity of mortgage instruments that postpone principal payment to later periods reflects an increasing trend towards resource-constrained homeowners.

Chapter 3. Methodology and data

3.1. Data and summary statistics

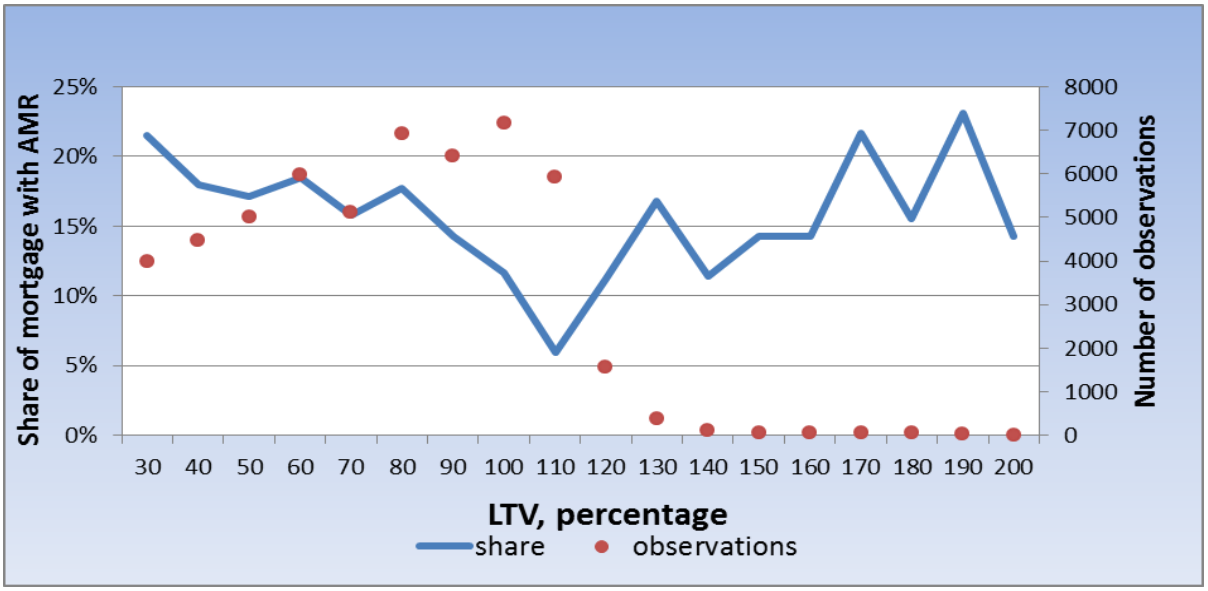
I use the data of DNB Household Survey (DHS) over 1993 - 2012, provided by CentER Data research institute of the University of Tilburg. The data are collected through the internet panel (CentERpanel) and available on yearly basis. The complete data panel comprises information on work, pensions, housing, mortgages, income, possessions, loans, health, economic and psychological concepts, as well as personal characteristics of about 2000 Dutch households each year.

Apart from that, I also work with the RMBS data included in the DNB loan level dataset (LLD). The dataset comprises about 80% of all mortgages in the Netherlands. The data are not publicly available, and were collected in the fall of 2012. This is an administrative dataset that contains information on original (household income, employment, age, municipality, principal) and current (property valuation, outstanding mortgage etc.) mortgage characteristics.

My aim is to test the significance of the correlation between the exposure to interest rate risk and other risk triggers, such as self-employment, loan-to-value and loan-to-income ratios. The LTV- and LTI-ratios give an indication of the costs, which households would face financing their own home. High LTV-ratio implies a higher chance of a remaining mortgage debt after a drop in house prices combined with the sale of a house. This also indicates the potential loss for mortgaging banks and does therefore often enters LGD models.

According to CBS statistics, the average level of LTV in the Netherlands is 70%, while for starters this ratio is much higher (108% in 2011). Further, figure 3.1 depicts the correlation between LTV and the share of mortgages with variable interest rates.

Figure 3.1. LTV-ratio and the share of mortgages with AMR



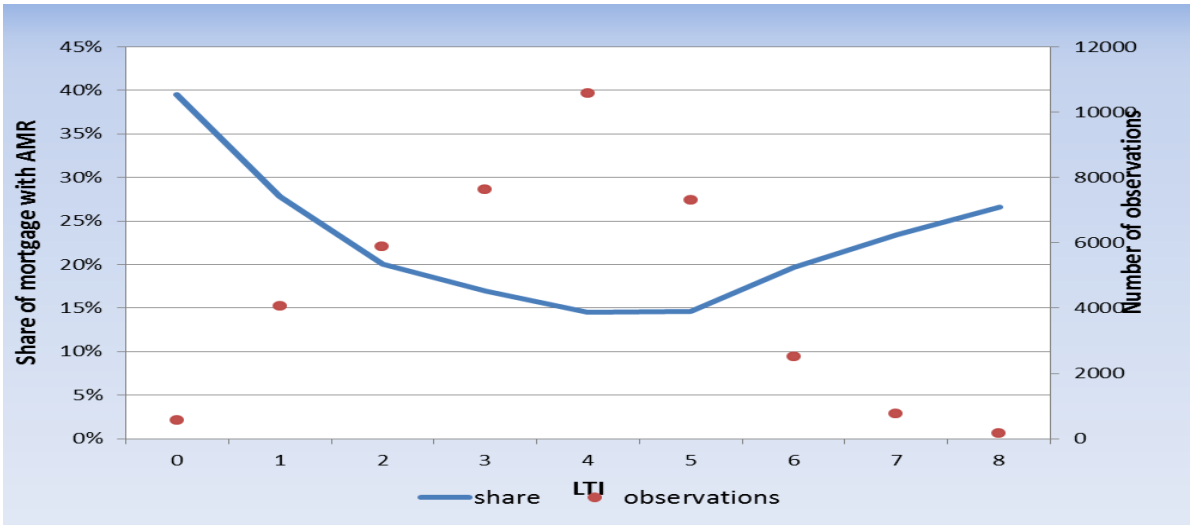
Source: DNB Loan-Level Data, own estimations

As it can be clearly seen, the form of the graph has a U-shape, which means that households with a very low or a very high LTV-ratio tend more to choose the ARMs. Households that cannot provide a down-payment will take a mortgage with the high LTV. In order to lower monthly payments they may also choose a contract with variable interest rate. This explains the right hand side of the graph. The high share of ARM among low LTV's on the left hand side could be explained by cohort effects. Those with low LTV (older cohorts) resort the last years of their mortgage to the variable rates because their value at risk is low so that they can try to gamble.

Sample size drops at higher LTV's. One of the possible explanations of such tendency is the Code of Conduct for banks, which has limited the level of LTV-ratio to 106% from 2011 and on, helping both lenders and borrowers to avoid the higher risk exposure. As a result, all present in the dataset mortgages with LTV-ratio higher than 106% were the most probably issued long time ago and later recontracted with the aim of refinancing, which has increased their LTV's.

Almost the same relationship can be observed between the share of ARM contracts and LTI-ratio, represented by Figure 3.2. Basically, households with higher LTI-ratio choose less often a variable interest rate contract. Apart from that, it is also worth mentioning that the mortgages with high loan-to income dependency (more than 5.5) can be rarely observed on the Dutch mortgage market due to their high riskiness. The uncertainty of economic crisis and instability of current incomes force households with higher LTI-ratio to protect themselves against a possibility of default caused by the partial or total loss of incomes in the future by choosing safer contracts with fixed interest rates. The same as in the case with low LTV's, the households with lower LTI-ratios can afford more gambling by choosing an ARM. It should be noted that the LTI measure in this study is unconventional. Banks do not retain information on current income, but only on income at origination. As a result, the loan is updated but the level of income is not.

Figure 3.2. Share of mortgages with interest rate reset interval less than 2 years



Source: DNB Loan-Level Data, own estimations

Apart from the already mentioned factors, the choice of interest rate can depend on the type of mortgage contract itself. Table 3.1 presents an illustration of such correlation since the distribution pattern is obviously not uniform. For example, 26% of investment mortgages and 34% of linear

mortgages have a variable interest rate, while the relevant figure for the contracts combined with saving deposits is only 10%. Therefore, this relationship deserves an extra attention in further research.

Table 3.1. Relationship between the type of contract and the share of mortgages with interest rate reset interval less than 2 years

Type of contract	Share of mortgages with reset interval < 2	Share of this type of mortgage
Annuity	19%	4.7%
Linear	35%	1.8%
Bullet	25%	63.4%
Bullet + Savings deposit	10%	12.0%
Bullet + Life insurance	19%	11.3%
Bullet + Investment portfolio	26%	6.9%
Other	65%	0.1%
Total	22%	100%

Source: DNB Loan-Level Data, own estimations

Another possible determinant of the risk exposure and the mortgage choice is the occupation of the household members. Table 3.2 shows that self-employed individuals are more in favor of the ARM contracts in comparison with the other groups that have small or uncertain source of incomes. Therefore, one can predict that such households would be influenced by a higher risk exposure.

Table 3.2. Correlation between occupation and the share of mortgages with ARM

Employed or full loan is guaranteed	79%
Unemployed	1%
Self-employed	8%
Student	0%
Pensioner	4%
Other	8%

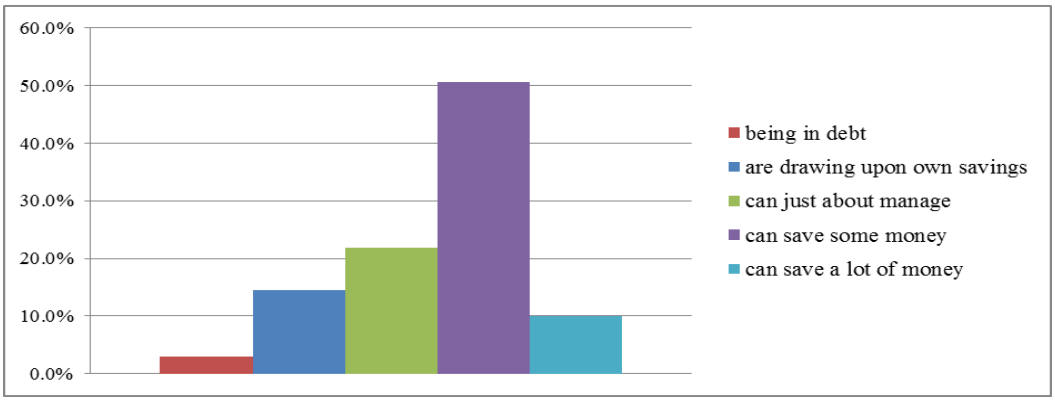
Source: DNB Loan-Level Data, own estimations

The DHS dataset is more suitable for my further research as it contains some clues about PD's and not only about LGD. Therefore, the variables of main interest were extracted from the DHS questionnaire dedicated to housing and mortgages, including the information regarding current and previous property (type of the house, its initial value, time of purchase), either the household is a tenant or a homeowner, as well as mortgage information (type, origination year and maturity of mortgage, initial interest rate, fixed interest rate period, remaining sum of principal, size and frequency of installment payments). The detailed descriptive statistics of the data is available in Appendix I.

The DHS data also provides information on particular personal characteristics of the households. Bearing in mind the most important factors that might influence the risk attitude of a household and the level of possible risks outlined in the literature overview, the updated data panel was complemented by the information about age, occupation, area of living and work/unemployment characteristics of the households, as well as by observable income and subjective assessment of households of their expected incomes. The main clue to the probability of default is a variable "FINSITU", which provides information on financial problems of the households. Figure 3.3 gives an indication of the size of each

group depending on the current financial situation of households. It is easy to see that the biggest group of mortgagors (50,5%) can save some extra money, however, approximately 36% of households are spending almost all their income or even previous savings to cover own expenses. In case of adverse circumstances they can potentially experience more problems due to the higher risk exposure. The share of households with debts is 3.05% of the whole sample.

Figure 3.3. Distribution of households w.r.t. their financial situation



Source: DNB Household Survey, own estimations

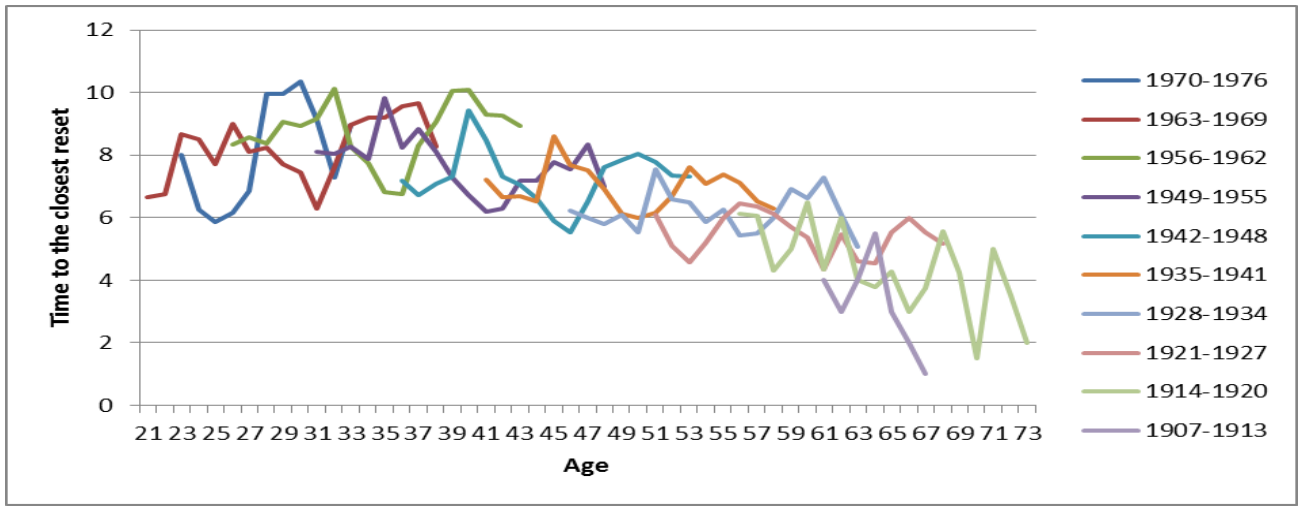
The additional estimations show that about 95% of all households in the sample satisfy the income requirements based on the NIBUD norm. The most households that exceed the expenditure limits represent the group of individuals being in debt. Moreover, the distribution of related variable ("compliance to NIBUD") has the same pattern as the variable "FINSITU", presented in the Figure 3.3.

I have also retained in the analysis some auxiliary variables that will be used as instruments. I am going to claim that the interest rate resets and LTV-ratio may be endogenous (both may depend on risk aversion, which is unobserved) and therefore need instruments to account for this. The variables used for this purpose are "HEALTH" (evaluation of own health), "SMOKING" (indicator of smoking), "DRINKING" (frequency of alcohol consumption), "HPI" (house price index) and its first difference ("delta_hpi").

Some of the variables were not initially present in the original dataset and were constructed separately, including TTCR and ARM. The data regarding HPI starting from 1995 were obtained from CBS (Statistics Netherlands). The missing information over the earlier period of 1993-1994 had been reconstructed from the separate datasets published on the website of NVM (The National Association of Brokers).

The variable "TTCR" represents the time left to the next interest rate reset for all mortgage contracts in the sample, basically giving a possibility to distinguish between mortgage contracts with long reset periods (FRM) and the ones with more frequently adjusted rates. At the first glance Figure 3.4 suggests that the specification of the intervals between interest rate resets has a hump shaped form w.r.t. age: the time interval between interest rate reset increases up to the age of 39 and gradually declines afterwards. This is no surprise as most mortgages are truncated at a duration of 30 years.

Figure 3.4. Time to the closest interest rate reset for the households by age and cohort

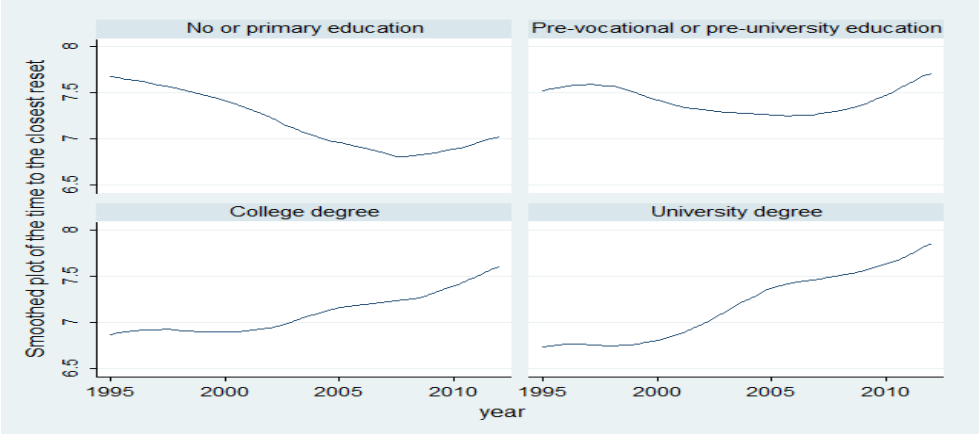


Source: DNB Household Survey, own estimations

The vertical divergence between the curves indicates the differences in time to the closest reset between cohorts at the same age. Those differences are sometimes large, indicating strong cohort effects. For instance, for all households of which the head was born between 1956 and 1962, the time to closest reset was approximately 9.4 years at the age of 40. This rate has fallen down to 6 years for those born between 1949 and 1955 at the same age. So, there is a difference in intervals between interest rate resets of more than 3 years between two adjacent cohorts.

Figure 3.5 suggests that the time to closest interest rate reset becomes shorter over time for households where the head has no or just primary education. This can be explained due to the lack of necessary knowledge, vital for correct risk assessing in the recent unfavorable environment. In combination with the desire to limit own expenses, such households might choose for ARM at the same time undertaking greater risks. An alternative explanation of such a phenomena could be the fact that the people with low education level had more possibilities to buy a house in the past, when prices were lower. Low-educated people are nowadays more often tenants rather that homeowners due to the higher budget constraints, resulting in the low possibilities to obtain a mortgage from the bank. The DHS provides the evidence that 27,8% of households from the sample are tenants. Moreover, 57% of all tenants are low-educated with average net income of about 18000 euro (2.5 times less compared to the households with own house).

Figure 3.5. Time to the closest interest rate reset for the households by level of education



Source: DNB Household Survey, own estimations

Different data quality aspects such as completeness, accuracy, representation or appropriateness need to be assessed in order to ensure that the model development is reliable from both quantitative and qualitative perspective. The initial panel included 103947 observations in total (on the individual level), allowing to perform a complex empirical analysis. However, the design of data didn't completely correspond to the purposes outlined in this thesis and therefore required some extra manipulations. The available data were aggregated at household level, allowing to obtain a more suitable dataset. Moreover, such a transformation gave a possibility to omit most of the incorrect and/or missing information, unavailable at individual level. As a result, the panel has shrunk to 18986 observations.

3.2. Methodology

The following paragraph describes the main steps of the analysis, as well as the challenges that arise in this context.

The analysis addresses the following issues:

1. Endogeneity: ARM choices could be determined by high LTV's, but at the same time both LTV and ARM could be determined by unobserved factors;
2. Relation between ARM choice and observable risk triggers;
3. Likelihood of becoming a high-risk household when ARMs are chosen (with and without endogeneity problem), which is closely connected to the correlation links between PD and ARM.

The empirical model analyzes the causal effect of the level of LTV on the choice of mortgage contract with variable interest rate, alongside with the possibility for the households to end up in a high-risk group experiencing difficulties in the mortgage repayment. I treat the two models as disjoint.

The aim of the estimations is to show whether one may expect difference in the probability of default when it is affected by the ARM choice, and when the ARM choice is endogenous to the LTV-ratio. In this way I link the PD and LGD through the choice for an ARM (while in stress tests normally the ARM does not depend on LTV).

The first part of the model focuses on the choice of contract with either adjustable or fixed interest rate. Since the dependent variable of interest (ARM) is a binary one, I use for estimation of different specifications a probit model.

During the first stage, four different sub-models are estimated and analyzed in order to test the robustness of the specification. I started with the traditional Binary Probit specification. Next, I included the Probit Regression for panel data and the Probit Regression with instrumental variables. IV-probit fits models with dichotomous dependent variables and endogenous regressors. It is normally used to fit a probit model when at least one or more regressors are correlated with the error term. The fourth model is a variation of iv-probit model with artificially replicated two separate steps (OLS at the first step is used to instrument LTV, predicted values of which are plugged in the Probit regression for ARM at the second step).

The basis probit model is specified in the next way:

$$Y_{it}=\Phi(\beta_0+\beta_1 X_{it}),$$

where Y_{it} is equal to 1 if ARM is chosen, and X_{it} - is a vector of independent explanatory variables. I separated the explanatory variables in two groups: first of all the mortgage related characteristics (type of mortgage, year of mortgage origination, mortgage rate, NHG, balance value of the house, LTV and LTI) and then - individual characteristics (composition of the household and number of dependent children, age of the main representative and year of birth cohort, gender, education, employment status, influence of financial advice, total gross incomes and allocation of households, i.e. region, province). All explanatory variables are included basing on the arguments discussed in the Chapter 2, especially those of Guiso and Paiella (2008).

The probit model for panel data has the same specification, however, it takes also into account the random effects, giving a possibility to control for some random changes due to the cluster structure of the available data. The IV-probit specifications require an instrument. The choice of instrument and its validity will be discussed in detail separately.

In the second stage I would like to study the probability of default. However, this information is not directly available. As earlier mentioned, the variable FINSITU (financial situation) is highly related to the households with incomes below the NIBUD norm, forming the pool of households at risk of default. This variable orders households from those making debt to those saving money. In the modeling of FINSITU I look at the triggers that change the financial situation of households depending on their individual characteristics and stress factors. The main aim is to predict the most undesirable outcome out of the 5 ordered outcomes of the variable FINSITU (that is the state where households are making debts because they cannot come around with their income). Since the dependent variable of interest (financial situation) is a categorical one, I decided to use as a model for prediction purposes the ordered probit regression, which extends the classic probit model to the multiple ordered categories.

The benchmark model is defined by the next equation:

$$\Pr [FINSITU= j \,|X_{it}] = \Phi(\beta_1 X_{it} +\varepsilon_{jt}),\ \ j=1,..,5,$$

where ε_{jt} is correlated with the categorical cut-off values and X_{it} is the vector of relevant explanatory variables. The set of covariates consists of the household characteristics (number of dependent children in the household, age, gender and education of the main representative, his/her employment status, i.e. permanent job contract and self-employment, the influence of financial advice, total net income of the household etc.). Moreover, the main contribution of this analysis is that I also use ARM as an explanatory variable for financial situation, both observed and predicted by the previous models values. This gives further a possibility to compare the different outcomes when endogeneity between ARM and LTV is taken into account. The full specification of the model is presented in Appendix III.

Further, in order to gauge the impact of changes in LTV on the financial situation of households, I have tested four additional sub-models where I increased the LTV-ratio (by decreasing the value of

property by 10%). I also plugged in the financial situation model the predicted values of ARM for both current and stress scenarios in which ARM in the first stage has already reacted to changes in LTV as determined in the instrumented version of the ARM model.

Chapter 4. Econometric analysis

4.1. Comparison of different model specifications

In this section I describe the results of the different probit estimations for the ARM choice (Table A2 in Appendix II) and those of the ordered probit model (Table A3.1, A3.2 and A3.3 in Appendix III) for the categorization of the financial situation of households.

The results of the standard probit (Model 1), panel probit (Model 2) and instrumented probit (Model 3 and Model 4) specifications are reported in the first, second, third and fifth columns of Table A2 correspondingly. The standard probit model shows that most of the mortgage and household characteristics are statistically significant, namely, the type of mortgage, year of its origination, interest rate, balance value of the house, NHG coverage, composition of the household and the number of cohabiting children. The gender of the borrower (being a female vs. male) is negatively correlated with the choice in favor of ARMs in Model 1 and Model 2, as well as the quantity of children, composition of the household and age (the last coefficient is insignificant). However, the marginal age-time effect is neutralized by the larger positive cohort-time effect. The coefficient related to the age in Model 3 and Model 4 becomes positive and highly significant. These results prove that when the head of the household gets older he/she is more prone to choose a mortgage contract with variable interest rate. It is worth mentioning that the joint test on the cohort dummies always delivers a low F-statistic, below standard levels. The additional specifications show that older respondents are more likely to have short interest rate reset periods thus switching more easily to ARMs, which replicates the pattern earlier shown in Figure 3.4. This can be interpreted either as a result of declining risk-aversion or as a consequence of their lower risk exposure.

Gender plays an important role in the choice of mortgages with short interest rate reset periods. Models 1 and 2 report a negative correlation between being a female and the choice of ARM (0.34% and 0.75% lower compared to males correspondingly). This suggests that females as more risk-averse and caring about the future stability individuals stop more often their choice at FRMs, which goes perfectly in line with the arguments expressed in the articles of Guiso and Paiella (2008) and Campbell and Cocco (2003).

Education is positively related to the choice of adjustable interest rates, however, the coefficient becomes negative and insignificant in the iv-probit specifications. When we compute robust standard errors by looking at clustering, the standard errors suggest a significant positive effect of education (1.5 times stronger magnitude in comparison with Model 1) on the probability of choosing an ARM (approximately 0.16% higher in comparison with the lower level of education).

The results of Model 3 and Model 4 prove that the composition of household and the number of dependent children also play an important role for the final decision regarding the length of interest rate reset period. The coefficients related to the composition form of households are negatively related to the choice of ARM, showing that a family of two members is less likely to get an ARM compared to a single person. The presence of children in the family can slightly influence the choice of the main borrower in favor of ARM, however, the magnitude of the effect caused by the number of cohabiting children is much smaller compared to those represented by the coefficients related to family composition with the presence of children. This result can be explained by the intention of borrowers to insure themselves against possible income risk. On the contrary, Dhillon, Shilling, & Sirmans (1987) have shown that households with co-borrowers and married couples may have the greatest probability of taking out ARMs compared to singles, but they didn't take into consideration couples with children or other cohabiting members.

The issue of households with self-employed representatives remains at the first stage of the analysis controversial, since there is a visible positive correlation with the choice of ARM, however, the corresponding coefficients are not significant in all four models. This result may be caused by too high dispersion of the sample stemming from the fact that it is much more difficult to get the mortgage for self-employed borrowers so that their share in the whole dataset is relatively small. A p-value of >0.05 only signifies that the evidence is not adequate to reject the null hypothesis that there is no difference between being self-employed and its alternative, while it does not imply that the two possibilities are equivalent. The quantitative analysis shows the opposite evidence, corroborating the assumption that self-employed (with uncertain incomes) would prefer relatively cheaper contracts with variable interest rates.

Inclusion of the LTV and LTI ratios into probit regressions imposes some important econometric issues due to potential endogeneity of the loan size and incomes. The loan limits are often defined on individual basis and therefore depend on observable and unobservable borrower characteristics. It is possible that some unobservable characteristics might be correlated with the error terms in model defining equations. Models 1 and 2 show that the coefficients which correspond to LTV are both insignificant and the direction of correlation with the dependent variable is negative (contradicts to what was expected).

4.2. Instrumental variables

As it was already mentioned, the specification above may not satisfy the assumption of exogeneity. Therefore, I resort to an instrumental variable approach in order to solve this problem. It is possible that LTV and ARM are affected by unobserved variables. In order to find a solution of this issue I use an instrument, i.e. a variable that explains LTV's but does not explain ARM. The ideal instrument must fulfill thus two conditions. The first is relevance (it explains LTV's), the second is exogeneity (does not affect ARM). These are testable implications.

I instrumented LTV using the annual percentage change of house price index (HPI). This macro indicator was chosen as a best possible variant among other alternatives (the state of health, smoking

habits and frequency of drinking) as it satisfies two main requirements of being a good instrument, mentioned above. The corresponding coefficient of the first step regression is significant and suggests that an increase of HPI by 10% would cause a decline of LTV by 0.05%. The Wald statistics rejects the null hypothesis that the regression equation is underidentified or weakly identified, since the result of Wald test on exogeneity is 28.38. The estimates confirm the positive significant association between the choice of ARMs and the level of LTV.

The change in house prices has a direct influence on the LTV-ratio. If the prices for available property increase or fall down, households would have respectively a lower or higher LTV-ratio, since they would need to pay more/less in comparison with the previous year in order to buy a house of the same quality. At the same time changes in HPI are not correlated with the error term of regression as this index have no influence on the household choice between variable and fixed interest rates, defined by other individual specific factors. Here, it is assumed that the choice for ARM is determined by the level of the index at the time of the rest and not by its change over time.

The other candidate variables for being an instrument ("HEALTH", "SMOKING" and "DRINKING") were rejected due to a possible correlation both with LTV (via the link "worse health – lower incomes – less chance to get a bigger loan") and the choice of ARM (via the link "worse health – less risk-aversion – higher probability of ARM choice").

The results of Model 3 show an improvement in the standard errors of the variables of main interest (LTV and LTI) at the 1% level of significance. An increase of LTI by 1% decreases the probability of choosing an ARM by 0.56%. The marginal effect from the rise of LTV by 1% has an opposite direction: the probability to choose an ARM would grow up by 4.34%. It also appears that the magnitude of the marginal effect of the changes in LTI and LTV in the iv-probit specification is about 10 to 20 times stronger in comparison with the benchmark probit estimates.

Model 4 generally replicates the results of Model 3: its first step is absolutely identical to those of the benchmark iv-probit specification, while all coefficients of the second step has a bit higher magnitude, e.g. the marginal effect from the rise of LTV by 1% is an increase in probability of choosing ARM by approximately 6.9%. The main advantage of Model 4 is that it allows to obtain reliable predictions for the dependent variable changes under different scenarios.

Essentially, the results presented above are plausible, so I use them to run some illustrative within sample simulations in order to predict the probability of worsening financial status of the households under certain abnormal circumstances, i.e. under the presence of exogenous shock/stress (a rise of LTV by 10%, which is simulated as a decrease of the property value by 10%).

4.3. Ordered probit regression

In the ordered probit model the dependent variable is the variable "FINSITU". Positive coefficients of the right hand side variables mean a positive effect on increasing the probability of a better financial situation, while a negative coefficient increases the probability of lower outcomes.

The estimation results of the ordered probit regression show that the coefficients of almost all explanatory variables are significant with the exception of the covariates as permanent employment contract and region. The variable defining the choice of ARM is negatively correlated with the probability to avoid financial troubles. Basically, it shows that the borrowers with ARM contracts would be more adversely affected compared to those who have FRM's (the probability of getting into troubles increases by 0.089). The analysis of the model results also confirms that the variable "self-employment" is significant. In case of 10% decrease of the property value, the probability of getting the worst outcome would be by 0.009 higher for the self-employed borrowers. This proves that self-employed are more likely to have financial problems compared to other groups.

Table A3.3 in Appendix III depicts the fact that the choice of ARM in combination with other parameters can rise or diminish the probability to obtain a certain outcome. For example, the probability of getting into financial troubles (Outcome 1) is the highest for a self-employed female with the ARM contract. On the contrary, male employees with FRMs or ARMs are the least probable candidates for such a result (given all other parameters are equal). The similar pattern is observed in the probabilities of obtaining Outcome 2 and Outcome 3. The correlation between the probability of having a better financial position and the choice of ARM, gender and being self-employed has an opposite direction if to look at Outcomes 4 and 5. Here, the most probable candidates to join those low-risk groups are males with FRMs who are not self-employed.

Further, the financial situation of households also depends on age, gender and education, as well as on location, number of children, total income and reliance on the financial advice of parents. All these variables have significant coefficients with negative sign, except for education, income and financial advice, which are positively related to the probability of being in better financial situation (for more information see Appendix III). Interpreting this outcome, we can say that the older single women with children are associated with the higher risk exposure and financial instability. At the same time, the high-educated men with higher incomes are less often in financial troubles. Finally, the borrowers who take into account an advice of own parents are also relatively more resilient to stress, which repeats the results of Cox et al. (2011), who showed that such borrowers are in most cases in favor of FRM's.

In order to test the goodness of model specification, I included several additional specifications of the core model defining the financial situation of households (see Table A3.1 in Appendix III for additional information). Taking as a basis Model 2.1, I have estimated its bootstrapped version (Model 2.2) with robust standard errors, as well as an extra specification (Model 2.3) with corrected standard errors considering the cluster nature of the dataset. The results of Model 2.2 and Model 2.3 delivered the same significant coefficients as Model 2.1. The only exception is the coefficient corresponding to ARM, which became less significant ($p<0.1$). Moreover, the variable "financial advice" has lost its explanatory significance.

A separate test on the significance of all parameters in Model 2.1 has showed that the hypothesis that all parameters are jointly equal to zero is rejected (χ^2 is bigger than the corresponding critical values within 99% confidence interval). Further, the coefficients of the variables of main interest (LTV, LTI and ARM) are confirmed to be jointly significant as well.

Apart from that, I conducted the test on the significance of the predictions obtained with the help of Model 2.1 by bootstrapping the average value of the probability of each outcome. This exercise has returned significant values of all predictions after 100 replications. Moreover, this test also makes evident that the model specification is good. The results of the test (see Table A3.4, Appendix III) show that all predicted probabilities are statistically highly significant.

The outcome of the model used during the second stage shows that the variables of main interest, namely ARM, LTV and LTI, are positively correlated with the probability of getting into financial troubles. The households, who have higher LTV- and LTI-ratios accompanied by the mortgage contracts with variable interest rate and frequent time resets, are more exposed to the additional exogenous risks, e.g. the decrease of incomes, which in turn might push them faster into financial problems and move to the high-risk group.

4.4. Interpretation of the outcome of intra-sample simulations

As it was already mentioned, I experimented with several sub-models in order to evaluate the effect of a negative shock, caused by a sudden fall of 10% in house prices. Using Model 4 from the first stage of the analysis, I obtained the predicted probabilities of choosing ARM in the current situation without stress. It is worth mentioning that the simulated increase of LTV has raised the probability of choosing ARM by a borrower by 65% (from 10% to 16%) compared to the predicted outcome in normal case and the real values (see Table A4.1 in Appendix IV for more detailed information). These results confirm the notion that the changes in LTV's exert a profound influence on the choice of mortgage contracts with variable interest rates.

Further, these predicted values were inserted in 4 separate specifications of the model describing the changes in the financial situation of households in place of the real values of the corresponding variable (ARM). The outcomes of all simulations are presented in Table A4.2 in Appendix IV.

Table A4.2 shows that we can distinguish two types of the effect caused by the manipulations with LTV on different stages – direct and indirect. The direct effect is defined as an influence of LTV change on the financial situation of households, while indirect effect is measured via the observed changes in preferences for ARMs due to the change of LTV.

Comparing the model results, we can see that the magnitude of the above mentioned effects is relatively small, however, the difference in probabilities of getting into financial problems between the benchmark case and the stress scenario is about 3.2% (an increase of the predicted probability of getting into debts from 0.025 to 0.026). If to take into account both direct and indirect effects of the rising LTV (when the parameters in the first stage model are changed respectively as well), the magnitude of existing effect becomes larger. The probability of moving into the group with indebtedness problems increases with 4.7% compared to the benchmark and by 1.3% if to compare with the case when only a direct effect plays role.

The increase of LTV influences not only the probability of being a high-risk household (category 1 in the ordered probit model) but those with potential financial problems (category 2) who can now

more easily fall into debts. Also the higher categories (those who manage to save) are affected. The group of borrowers on the edge of financial problems (category 2) who are already drawing up own savings will grow by a percentage between 1.8% or 2.5% depending on whether the shock is only simulated in the first stage or in both stages. Recall that the shock to LTV in the first stage only updates ARM, therefore the effect of LTV on financial situation only passes through this channel. In the second stage we can also allow a direct effect of LTV shock on financial situation. Apart from that, the reduction in the probability of belonging to the highest saving group (category 5) is predicted to be approximately 3% (from 6.34% to 6.3%) in the most adverse scenario in contrast to the normal case and 2.1% when LTV increases only at the second stage (causing only the direct effect).

The cumulative change in the probabilities of belonging to one of the 5 ordered groups in FINSITU model, equals 0.2% in the normal case and 8.6% if we were to account for a 10% shock in LTV at the second stage. When LTV increases also in ARM model, the cumulative change in probabilities is 3.4% or 12% (a pure direct effect or its combination with an indirect influence correspondingly).

Therefore, all performed simulations show that the fluctuations of LTV's can cause changes in financial situation of households, especially for those who belong to the high-risk group, with the highest probability of default. Beside there is a notable difference when the model does or does not account for the indirect effect of LTV on ARM.

Conclusions

The results confirm that conditional on socioeconomic and demographic characteristics of households, the probability that borrowers will choose an ARM increases with the growth of absolute loan amount and the loan-to-value ratio. The LTV and LTI indicators, which can be associated with the individual exposure to income and capital risk, have the expected sign and are statistically significant. Capital risk seem to be more important for borrowers with stable high incomes and low LTV's, so that they are more likely to choose an ARM. Conversely, borrowers wanting to have an insurance against income risk and related LGD are less likely to take an ARM. When the loan-to-income ratio increases, such borrowers would prefer a contract with a fixed interest rate.

The outcome of benchmark model proves the assumption that more educated people have more knowledge and relevant information, which plays in favor of the ARMs. Older applicants are more likely to choose an ARM as well, since they are usually wealthier and can afford extra risk exposure without getting into troubles. However, such characteristics as gender, education and self-employment are all insignificant explanatory variables for the choice of contract when the model is corrected for internal endogeneity, caused by intra-correlation of LTV and some unobserved characteristics. It seems that when making context-specific financial decisions, mortgagors make choices with respect to their individual financial and life-cycle positions, and therefore appropriately adjusted model shows no support for viewing either high educated or self-employed people are more or less risk averse than any other member of the sample group.

The main risk determinants with regard to PD depend greatly on the same households' characteristics and other observables, that influence the choice of interest rate reset frequency, including LTV and LTI. Moreover, the main results of the performed analysis declare that the choice of ARM can itself have a significant negative influence on the financial situation of the high-risk borrowers. Apart from that, among the other important factors that define PD are gender, age and education of the borrower, as well as his/her financial literacy and income.

Summing up, I can conclude that the increase of LTV cause a multidirectional effect on the choice of mortgage contracts with different interest rate reset periods by households, as well as on their financial prosperity and stability. The results of the empiric analysis has also shown that mostly the households with large risk exposures have high chances to default, while the rest groups are relatively well insured against such risk. The fact that obtained results report relatively small magnitude of the joint effect does not allow us to assume that it would remain the same on a large scale. As a consequence, the stress stemming out of the recent stress tests is with high probability underestimated due to the limited approach. It is, therefore, of great importance to include the most of discussed in this study risk evolving parameters into the stress test models used by the central banks for the risk assessment, since it will give a possibility to define more precisely the high-risk groups and thus to conduct more reliable evaluation of the PD's and a risk exposure (LGD) for the banking system and economy in general.

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APPENDICES

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Appendix IV. Comparative statistics and probabilities of a certain outcome in different simulation submodels

Appendix I.

Table A1. Descriptive statistics of the dataset

Variable	Label	Obs	Mean	Std. Dev.	Min	Max	Explanatory notes
age_h	Age	17207	49.44412	12.74706	21	92	
yobgr	Age cohorts	17184	4.05057	1.85123	0	10	a cohort adherence depends on the year of birth of a respondent
sex	Gender (fitted)	16097	1.07635	0.265565	1	2	1 - male, 2 - female
edu_h	Education	17207	2.56971	0.8333167	1	4	1 - no or primary education, 2 – pre-vocational, pre-university or other type of training/education of the similar level, 3 – college degree, 4 – university degree.
regio_h	Region	17183	3.135599	1.416189	1	5	1- three biggest cities, 2 – North, 3 - South, 4 - East, 5 - Other West.
prov_h	Province	17192	7.756747	2.929818	1	12	official list of provinces
woonvorm_h	Composition of the household	18795	2.365257	0.7812011	1	5	1 – a single borrower, 2 – a borrower with partner, 3 – a borrower with partner and children, 4 – a single borrower with children, 5 – other.
aantalki_f	Number of children	15942	0.923159	1.162341	0	7	
btot_f	Total gross incomes	18986	62870.49	71831.17	0	2869246	annual, in thousands euro
ntot_f	Total net incomes	18986	43024.18	51170.98	-13460	2431699	annual, in thousands euro
vastebaan_f	Permanent job	18986	0.7557147	0.4296739	0	1	0 - temporary contract, 1- permanent employment
selfemp_f	Self-employment	18986	0. 0961761	0.2948404	0	1	1 - self-employed, 0 - otherwise
mor_origin_h	Year of mortgage origination	18984	1991.192	9.843269	1930	2012	
mor_life_h	Duration of the mortgage	18791	23.64057	12.96384	1	97	in years
mortgrate_h	Mortgage rate	17079	6.289536	1.604937	1	30	
NHG	NHG	18985	0.3493811	0.4767871	0	1	1 - yes, 0 – no
hyp_type	Type of mortgage	16341	3.452053	1.556046	1	5	1 – annuity mortgage, 2 – traditional mortgage, 3 – investment mortgage, 4 – savings mortgage, 5 – interest-only mortgage
aftrek	Tax deduction	7262	2540.029	2751.755	10.08008	99040.2	in thousands euro per year
bal_mor_h	Balance value of the mortgage	16433	99716.67	212591.7	4.537802	9573000	in thousands euro
bal_hou_h	Balance value of the house	18985	195986.5	133327.3	0	2722681	in thousands euro
pay_mor_h	Annual mortgage payments	16717	6753.123	6991.92	2	543000	in thousands euro per year
lti	LTI	13202	1.528914	1.255819	0.020861	7.5	loan-to-income
ltv1	LTV	15898	0.4838339	0.2889919	2.25E-06	2	loan-to-value ratio
advies	Financial advise	18986	0.193985	0.3954277	0	1	1 - advise from parents, friends or acquaintances, 0 - other
health_h	Evaluation of own health	15505	2.178846	0.6994516	1	5	1- excellent, 2 - good, 3 - fair, 4 - not so good, 5 - poor
smoking_h	Indicator of smoking	15505	2.797162	0.4696047	1	3	1 - yes (every now and then), 2 - yes (every day), 3 - no
drinking_h	Alcohol consumption	15505	1.953241	0.2111293	1	2	1 - more than 4 alcoholic drinks a day, 2 - less than 4 drinks a day
hpi	House Price Index	17183	68.85095	27.53066	28.8	106	HPI=100 in 2010
delta_hpi	% change in HPI	17192	6.85153	5.974356	-7	20.9	annual percentage change of the House Price Index
ttcr	Time to the closest IR reset	13792	7.34056	5.704678	0	30	in years
ARM	ARM	15669	0.1715489	0.3769999	0	1	0- FRM, 1 - ARM
compl_nibud	Compliance to the NIBUD norm	14318	0.9485962	0.2208277	0	1	0 - no, 1 -yes
finsitu_h	Financial situation	12947	3.499498	0.9615964	1	5	1 – being in debt, 2 – are drawing upon their own savings, 3 – can just about manage, 4 – can save some money, 5 – can save a lot of money.

Appendix II.
Table A2. Comparative results of the regression models defining ARM

	Model 1	Model 2	Model 3		Model 4	
	Probit	Probit (panel)	IV-probit		Probit	OLS
VARIABLES	ARM	ARM	ARM	ltv	ARM	ltv
Year of mortgage origination	-0.0134***	-0.0178***	-0.0330***	0.00540***	-0.0522***	0.00540***
Mortgage rate	-0.257***	-0.425***	-0.183***	0.00387*	-0.290***	0.00387*
NHG	-0.281***	-0.357***	-0.197***	0.00384	-0.313***	0.00384
Balance value of the house	-5.89e-07***	-5.55e-07	2.70e-06***	-6.95e-07***	4.29e-06***	-6.95e-07***
Composition of the household (1=single)						
2.with partner	-0.238***	-0.215	-0.280***	0.0305***	-0.444***	0.0305***
3. with partner and children	-0.168	0.102	-0.387***	0.0644***	-0.614***	0.0644***
4.single with children	0.235	0.878*	-0.568***	0.161***	-0.902***	0.161***
5.other	-0.427	-0.0722	-0.555***	0.0649**	-0.877***	0.0649**
Type of the mortgage (1=annuity mortgage)						
2.traditional mortgage	-0.352***	-0.536**	-0.617***	0.0892***	-0.979***	0.0892***
3.investment mortgage	0.0599	-0.269	-0.600***	0.147***	-0.955***	0.147***
4.savings mortgage	-0.258***	-0.736***	-0.542***	0.0878***	-0.858***	0.0878***
5.interest-only mortgage	-0.247***	-0.476***	-0.397***	0.0542***	-0.629***	0.0542***
Age	-0.00178	-0.00301	0.0360***	-0.0114***	0.0570***	-0.0114***
Gender	-0.341***	-0.745**	-0.0850	-0.0280***	-0.132	-0.0280***
Education	0.0998***	0.156**	-0.0148	0.0172***	-0.0234	0.0172***
Self-employment	0.0597	0.113	0.0621	-0.00590	0.0981	-0.00590
Financial advise	0.00152	-0.0202	-0.00744	0.00162*	-0.0120	0.00162*
Year of birth cohorts						
1970-1976	0.143	0.146	0.330	-0.0271	0.524	-0.0271
1963-1969	0.300	0.719	0.532**	-0.0303	0.842**	-0.0303
1956-1962	0.445	0.758	0.579**	-0.00156	0.920***	-0.00156
1949-1955	0.658*	1.229	0.499*	0.0666**	0.793**	0.0666**
1942-1948	0.609	1.235	0.309	0.123***	0.492	0.123***
1935-1941	0.852**	1.675*	0.381	0.162***	0.607	0.162***
1928-1934	0.680	1.367	0.109	0.220***	0.177	0.220***
1921-1927	0.864*	1.850	0.0855	0.268***	0.138	0.268***
1914-1920	1.894***	4.507***	0.759	0.287***	1.206*	0.287***
1907-1913	0.924	2.312	-0.525	0.454***	-0.828	0.454***
Region	-0.00932	0.000779	0.0289**	-0.0108***	0.0460**	-0.0108***
Province	-0.0136***	-0.0134*	-0.00785***	-0.000768**	-0.0124***	-0.000768**
Number of children	-0.0305	-0.118	0.0926***	-0.0254***	0.147***	-0.0254***
Total brutto incomes	-4.60e-07	-5.74e-07	-6.03e-06***	1.30e-06***	-9.56e-06***	1.30e-06***
LTI	-0.0619**	-0.0973*	-0.561***	0.118***	-0.891***	0.118***
LTV	-0.0858	-0.231	4.341***		6.891***	
% change in HPI				-0.00511***		-0.00511***
Constant	27.52***	35.89***	63.21***	-9.965***	99.98***	-9.965***
Observations	6,838	6,838	6,838	6,838	6,838	6,838
Number of households		2,403				

Level of significance:*** p<0.01, ** p<0.05, * p<0.1

Wald test of exogeneity for iv-probit = 28.38 (Prob > chi2 = 0.0000)

Appendix III. Results of the ordered probit regression defining financial situation of the households

Table A3.1. Composition of the second stage models

	Model (2.1)	Model (2.2)	Model (2.3)
	oprobit	**bootstrap**	**cluster**
	Financial situation	Financial situation	Financial situation
ARM	-0.0888**	-0.0888*	-0.0888*
Number of children	-0.324***	-0.324***	-0.324***
Age	-0.0172***	-0.0172***	-0.0172***
Gender	-0.257***	-0.257***	-0.257***
Education	0.137***	0.137***	0.137***
Self-employment	-0.160***	-0.160***	-0.160**
Permanent job	0.00666	0.00666	0.00666
Financial advise	0.00945*	0.00945**	0.00945
Region	0.000116	0.000116	0.000116
Province	-0.00444***	-0.00444***	-0.00444**
Total net incomes	1.17e-06***	1.17e-06***	1.17e-06**
LTV	-0.295***	-0.295***	-0.295***
LTI	-0.128***	-0.128***	-0.128***
Constant (cut1)	-3.518***	-3.518***	-3.518***
Constant (cut2)	-2.457***	-2.457***	-2.457***
Constant (cut3)	-1.776***	-1.776***	-1.776***
Constant (cut4)	-0.0979	-0.0979	-0.0979

Note: *based on 6685 observations, confidence interval: *** p<0.01, ** p<0.05, * p<0.1*

Table A3.2. Marginal effects for different outcomes (based on model 2.1)

Dependent variable Financial situation	**Marginal effects outcome 1**	**Marginal effects outcome 2**	**Marginal effects outcome 3**	**Marginal effects outcome 4**	**Marginal effects outcome 5**
ARM	0.0048**	0.0156**	0.011**	-0.0154**	-0.0157**
Number of children	0.0175***	0.057***	0.039***	-0.056***	-0.057***
Age	0.00092***	0.003***	0.0021***	-0.003***	-0.003***
Gender	0.0139***	0.045***	0.031***	-0.045***	-0.045***
Education	-0.0074***	-0.024***	-0.0166***	0.024***	0.024***
Self-employment	0.0087***	0.028***	0.0194***	-0.0279***	-0.028***
Permanent job	-3.60E-04	-0.00117	-0.0008053	0.0012	0.0012
Financial advise	-0.00051*	-0.00166*	-0.0011*	0.0016*	0.0017*
Region	-0.0000063	-0.0000204	-0.0000141	0.0000202	0.0000206
Province	0.00024***	0.00078**	0.00054**	-0.00078**	-0.00078**
Total net incomes	-0.06e-06***	-0.2e-06***	-0.14e-06***	0.2e-06***	0.2e-06***
LTV	0.0160***	0.0518***	0.0357***	-0.051***	-0.052***
LTI	0.0069***	0.0224***	0.0155***	-0.022***	-0.023***

Note: *based on 6685 observations, Outcome 1 is the most adverse outcome and Outcome 5 is the best possible outcome*

Table A3.3. Probabilities of certain outcome given the values of mortgage contract choice, gender and self-employment status (other parameters fixed at means)

Combination of factors	Outcome 1	Outcome 2	Outcome 3	Outcome 4	Outcome 5
FRM, male	0.0158***	0.123***	0.204***	0.556***	0.102***
FRM, male, self-employed	0.0234***	0.154***	0.226***	0.521***	0.076***
FRM, female	0.029***	0.174***	0.237***	0.496***	0.063***
FRM, female, self-employed	0.0417***	0.210***	0.253***	0.450***	0.046***
ARM, male	0.0197***	0.139***	0.216***	0.538***	0.087***
ARM, male, self-employed	0.029***	0.172***	0.237***	0.498***	0.064***
ARM, female	0.0357***	0.194***	0.247***	0.471***	0.053***
ARM, female, self-employed	0.0502***	0.230***	0.259***	0.422***	0.038***

Note: *based on 6685 observations, confidence interval: *** p<0.01, ** p<0.05, * p<0.1*

Table A3.4. Bootstrap check (based on Model 2.1)

Predicted outcome	Observed coefficient
Outcome 1	0.0253***
Outcome 2	0.139***
Outcome 3	0.201***
Outcome 4	0.525***
Outcome 5	0.110***

Note: *results are based on 100 replications, sample size - 6685 observations*

Appendix IV. Comparative statistics and probabilities of a certain outcome in simulated models

Table A4.1. Predicted values of ARM under normal and stress scenario

Variable	Mean	Std. Dev.	Min	Max
ARM (real)	0.1001755	0.3002558	0	1
ARM (normal)	0.1002847	0.0853128	0.0009355	0.7525354
ARM (stress)	0.1651045	0.1024805	0.0002138	0.788008

Note: *based on 6685 observations*

Table A4.2. Probabilities of different outcomes

Model ARM	Model FINSITU	Variable	Mean	Std. Dev.	Min	Max	Marginal effect	Partial effect
Real values of ARM	Real values of ARM							
		nm1	0.0253697	0.0288438	0.0000339	0.3317111		
		nm2	0.1393073	0.0716708	0.0017023	0.4043317		
		nm3	0.2011337	0.0446993	0.0107512	0.2664064		
		nm4	0.5246897	0.0825337	0.0942056	0.5984251		
		nm5	0.1094997	0.0641785	0.0014202	0.7136803		
Normal scenario	***Normal scenario***							
Predicted values of ARM	Real values of LTV	nn1	0.0253177	0.0286729	0.0000242	0.333714	-0.2%	
		nn2	0.1392873	0.0714629	0.0013176	0.4043508	0.0%	
		nn3	0.2011913	0.0447325	0.0087982	0.2664064	0.0%	
		nn4	0.524739	0.082194	0.0932982	0.598425	0.0%	
		nn5	0.1094648	0.0642001	0.0013948	0.7400504	0.0%	
Normal scenario	***Stress scenario***							
Predicted values of ARM	Property value	ns1	0.0261708	0.029536	0.0000247	0.3414855	3.4%	
	decreased by 10%	ns2	0.1418168	0.0722674	0.0013369	0.4043484	1.8%	
		ns3	0.2027728	0.0443913	0.0088989	0.2664064	0.8%	
		ns4	0.5220819	0.0838205	0.0898559	0.5984251	-0.5%	
		ns5	0.1071577	0.0634545	0.0013007	0.7386083	-2.1%	
Stress scenario	***Normal scenario***							
Predicted values of ARM	Real values of LTV	sn1	0.0256445	0.0289867	0.0000245	0.3360209	1.3%	1.3%
when property value		sn2	0.1402918	0.0717244	0.0013289	0.4043617	0.7%	0.7%
decreased by 10%		sn3	0.201853	0.0445388	0.0088571	0.2664064	0.3%	0.3%
		sn4	0.5237255	0.0827941	0.0922633	0.5984251	-0.2%	-0.2%
		sn5	0.1084852	0.0637802	0.0013661	0.7392063	-0.9%	-0.9%
Stress scenario	***Stress scenario***							
Predicted values of ARM	Property value	ss1	0.0265076	0.0298594	0.0000249	0.3438129	4.7%	1.3%
when property value	decreased by 10%	ss2	0.14283	0.0725279	0.0013483	0.4043302	2.5%	0.7%
decreased by 10%		ss3	0.2034241	0.0441947	0.0089584	0.2664064	1.1%	0.3%
		ss4	0.5210424	0.0844194	0.0888489	0.5984251	-0.7%	-0.2%
		ss5	0.1061959	0.0630414	0.0012738	0.7377618	-3.0%	-0.9%

Note: *The sample includes 6685 observations, nm1-nm5 are predicted probabilities of different outcomes based on the real values of ARM, where nm1 is a probability of the worst outcome and nm5 – a probability of the best outcome correspondingly. The rest of predicted values in other simulation sub-models are defined using the same principle.*