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HOUSEHOLD MORTGAGE INTEREST RATE TYPE CHOICE MANAGEMENT IN A FINANCIAL INSTITUTION

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KEY DEFINITIONS AND ABBREVIATIONS

Term	Definition
Borrowing constraints	Consumption level limits set by availability of credit resources
Consumption constraints	Consumption level limits set by income, wealth, and borrowing constraints
Credit risk	The probability that a particular borrower is not able to repay a debt (principal or interest) (Freixas and Rochet, 2008)
Behavioural Theory	A theory of developing models that offer explanation of how agents behave in real life allowing bounded rationality (Simon, 1986; Guiso and Sodini, 2012).
Expected utility theory	Standard economic theory which assumes that people are rational decision makers who compare alternatives based on their probability and utility values
Household	A person living alone or a group of persons sharing the same living accommodation and expenditure, including collective provision of necessities of life (*Statistics Lithuania*). In this dissertation *household* definition is also applied as the meaning of *borrower* – a person who makes decision regarding the mortgage interest rate type choice
Household characteristics	Characteristics describing household's financial position (income, expenditure, assets, liabilities) and socio-demographic position (household size and structure, age, education of the head of the household), and other related factors
Income risk	The probability that nominal interest rates of a loan will increase, but a borrower will not experience nominal income increase (Campbell and Cocco, 2003)
Interest rate gap	The difference between long term interest rates and short term interest rates in percentage points
Interest rate risk	The probability that interest rates will rise or fall in the future and bring losses
Institutional environment	Country specific regulatory, historical, cultural characteristics, financial institution specific characteristics, and available product offering characteristics that have effect on market participants' behaviour
Limited access to credit	Limited availability of credit resources
Loan to value ratio	The relation between the mortgage value and collateralized asset value
Loss aversion	The principle that losses loom larger than corresponding gains. People try to avoid losses and expose themselves to higher risk (Tversky and Kahneman, 1979)
Long Term Fixed Rate Mortgage (LTFRM)	A mortgage contract with long-term fixed interest rate. The period of fixation may vary from longer than one year to the whole life of the mortgage contract. A corresponding term in the related literature is FRM (Fixed Rate Mortgage)

Market conditions	Conditions describing situation in the market: asset price, labour market, inflation, and interest rates
Mortgage	A loan with housing as collateral
Normative Theory	Economic theory of developing models that offer prescriptions of how rational agents should optimally choose when faced with a task (Guiso and Sodini, 2012)
Optimal mortgage	The mortgage interest rate type choice which maximizes household satisfaction with income, and net of mortgage payments (Dokko and Edelstein, 1991). In this research the optimal mortgage choice is referred to the model of J. Y. Campbell and J. F. Cocco (2003)
Payment to income ratio	The relation between mortgage monthly instalments and household's monthly income
Prospect theory	A behavioural theory of decision making under uncertainty which assumes that the decision maker has imperfect information, limited computational ability, and imperfectly defined objectives. The theory was developed by A. Tversky and D. Kahneman (1979, 1992)
Reference point	A benchmark against which potential outcomes are labelled as gains or losses (Tversky and Kahneman, 1979)
Reputation risk	The probability of the reduced operating revenues as clients and trading counterparties shift to competitors, increased compliance and other costs required to deal with the reputational problem (Walter, 2006)
Risk aversion	Attitude towards risk implying that people prefer lower but certain payoffs to higher but uncertain (Mas-Colell, Whinston and Green, 1995)
Short Term Fixed Rate Mortgage(STFRM)	A mortgage contract with short term fixed interest rate. The period of fixation may vary from one month to twelve months. A corresponding term in the related literature is ARM (Adjustable Rate Mortgages)
Wealth risk	The probability that inflation and interest rates in the market will decrease but the fixed rate interest payments will not, and the real value of the obligations will become higher compared to income and assets which probably will decrease due to deflation (Campbell and Cocco, 2003)

INTRODUCTION

Mortgage is the dominating liability item in a household balance sheet. Home ownership increases security of individual homeowners and society as a whole. However, it can easily lead to insecurity if households become over-exposed to financial risks entailed by changing circumstances. Fluctuations in house prices can result in negative equity. Drop in income or increase in interest rate may result in decreased consumption and in extreme cases, may be the reason of default. Recent financial crisis (2007-2008) has shown how problems in mortgage lending and borrowing may destabilize the financial system and the entire economy.

When deciding on a mortgage, a borrower must make assessments of the current household situation and of the future household and macroeconomic conditions. Then, a borrower should choose from a menu of loan characteristics. The typical mortgage contract is characterized by loan amount, underlying collateral (housing) value, loan maturity date, repayment schedule, delinquency penalties, and most importantly for the purposes of this research, interest rate term. A long term fixed rate mortgage (LTFRM) contract requires a constant stream of payments which is invariant to changes in the level of market interest rate for a long period. However, there is a risk related with the inflation rate over the life of the interest rate term. If inflation decelerates or the economy experiences deflation, then interest rate in the market decreases, mortgage fixed rate payments' real value increases. On the other hand, a short term fixed rate mortgage (STFRM) requires a borrower to pay a floating nominal interest rate. Payments have a relatively stable real value since most inflation upside and downside shocks are compensated by variation in the nominal interest rate. However, the nominal stream of payments is subject to significant uncertainty. If interest rate increases but a borrower does not experience income growth, significant risk to consumption arises.

For a financial institution, the consequences would be poor in case of LTFRM and increasing market interest rate. The cost of funds, which depends on the level of the short term interest rate, may rise above the interest rate income determined by the contractual interest rate of the loan. However, financial institutions have acess to various means of insurance against interest rate risk. Yet, if market interest rate decreases due to deflation, household income will probably decrease. If house price also declines far enough, the household cannot refinance to a cheaper STFRM and

may end in default. In case when a borrower has chosen a STFRM and interest rate change coincides with household income change, both parties do well. But if market interest rate increases, while household income does not, both sides of the contract would do poorly. Thus, for a financial institution, interest rate risk is related with credit risk. Existing research proposes that STFRM must be considered riskier than LTFRM. The underlying assumption is that if income constraints are not binding, a household will choose to minimize not only costs but also uncertainty. However, if income constraints matter, the household will minimize current costs and stay uninsured against interest rate shocks. Long term rate is usually higher, so constrained households will opt for a cheaper STFRM. Increasing competition, increasing market share, and increasing appetite for profits enhance risk appetite. Institutional arrangements, such as securitization, minify the importance of credit risk. However, borrower defaults may incur reputation losses for a financial institution. It is in people's expectations that being a better informed party, financial institution must share the responsibility for borrower's sub-optimal choice which may lead even to the loss of home.

Therefore, both contract parties, households and financial institutions, should be concerned with appropriate household mortgage interest rate term choice, though the decision regarding mortgage interest rate type choice is on the side of a borrower. The goal of household mortgage interest rate type choice management is to prevent household's over-exposure to interest rate shocks. To reach the goal, financial institutions should be able to identify the most vulnerable households, to determine market conditions under which household risk aversion decreases, and take preventive or corrective actions to influence the specified households' choice under the market conditions that increase risk appetite.

Research background

L. Guiso and P. Sodini (2012) claim that "despite its importance, optimal mortgage decision making has received surprisingly little attention in the academic literature" (p.111). Literature on mortgage interest rate type choice emerged in the US in 1980s when financial deregulation and liberalization paved the way for major changes in mortgage markets: securitisation and emergence of new mortgage instruments with different interest rate terms. These mortgage market innovations were in the focus of researchers analysing household behaviour and its effects on

housing demand. The scholars were seeking to identify determinants of probability that households choose short term or long term interest rate for their loans.

The first optimal mortgage choice theories model mortgage demand under uncertainty where borrowers are risk averse, household's utility function includes wealth and its variance, interest rates and inflation are stochastically determined. The mortgage choice is examined in the context of relevant covariances between income, interest rates, and asset prices without labour income risk and borrowing constraints (Baesel and Biger, 1980; Statman, 1982; Alm and Follain, 1987; Brueckner and Follain, 1988; Stanton and Wallace, 1998; Szerb, 1996).

Only recently, J. Y. Campbell and J. F. Cocco (2003) and O. van Hemert (2009) proposed more realistic models that take into account household characteristics and pricing conditions that are salient to mortgage type choice. J. Y. Campbell and J. F. Cocco (2003) claim that households who face current borrowing constraints should prefer STFRM since it is more likely to cost less. LTFMR should be preferred by those who plan to buy large houses relatively to their mean labour income, those with highly volatile income, and those with high risk aversion. R. Koijen et al (2009) model shows that households should choose STFRM over LTFRM if long term bond risk premium is higher than the difference between the volatility of real interest rate and the inflation risk, adjusted by household's risk aversion. The normative optimal mortgage choice models provide benchmarks to evaluate how efficient households are in choosing their mortgage types. Deviations from the normative recommendations could simply be mistakes and be potentially corrected with financial education, product innovation, or professional advice. Alternatively, they could be the result of behavioural biases and challenge the normative models.

Empirical research resultsprovides controversial evidence and interpretation on household characteristics and interest rate type choice preferences. B. Coulibaly and G. Li (2009), D. Bergstresser and J. Beshears (2010), M. Finke et al (2005), S. Damen and E. Buyst (2013) find that high mortgages compared to income encourage STFRM choice. Part of the researchers (Coulibaly and Li, 2009; Begstresser and Beshears, 2010) relate large mortgages to income only with the temporary income constraints and find households' behaviour consistent with normative recommendations. Others (Finke et al, 2006; Damen and Buyst, 2013) warn that current constraints may also signal about the future constraints, and thus

the choice of STFRM is sub-optimal. The different interpretations arise because of the blurred boundary between current constraints and future constraints. From the existing empirical research, little is evident about the effect of the future constraints' predicates, such as labour income volatility and differences in risk attitudes. To investigate future constraints influence on household mortgage interest rate type choice, the research should be performed in the environment of future constraints, as stated in J. Y. Campbell and J. F. Cocco: "states of the world with low income and low house prices"(p.1452).

Empirical research on market conditions' influence on mortgage interest rate type choice provides evidence that housing prices (Furlong and Takhtamanova, 2012), income (Goldberg and Heuson, 1992), and higher anticipated inflation (MacDonald and Winson–Geideman, 2012) have a positive influence upon STFRM choice. Evidence on interest rate indicators' influence is divergent: some authors find that high level of interest rates encourages choice of STFRM (Jones et al, 1995; Leece, 2001; Vickery, 2007); others (Dhillon et al, 1987) find high level short term interest rate's influence negative. Large interest rate differential between long term interest rate and short term interest rate has a positive influence upon STFRM choice (Brueckner and Follain, 1988; Coulibaly and Li, 2009; Moench et al, 2010). Yet, it is not clear if households assess the differential as an over-priced insurance against potential interest rate increase, or their decision is based on the relative current price of the two mortgage instruments (Leece, 2008).

Standard economic theory models are dominated by a straight assumption that people behave rationally. However, it is obvious that most people are not. For a household, the decision of optimal mortgage interest rate type choice is extremely complex. Ordinary households may be not capable of doing complex calculations; they may have no solid appreciation of their risk, nor may know that they ought to reduce their risks. The normative theory of finance underwent a fundamental transformation with the development of behavioural finance which "corrects a major error in most mathematical finance: the neglect of the human element" (Shiller, 2003, p. 13) by including the application of principles of psychology and insights from other social sciences to finance. So far, behavioural finance research is most often related with investor behaviour and its influence on financial markets. Borrowing behaviour and decisions are less researched (Tufano, 2009; Zinman, 2014). Borrowing

research from behavioural point of view is related with over-indebtedness, over-excessive credit card borrowing, payday borrowing (Bertrand and Morse, 2011), simultaneous saving and borrowing puzzle (Basu, 2008), strategic default behaviour (Skiba and Tobacman, 2008; Gerardi and Li, 2010; Agarwal et al, 2013; Dobbie and Song, 2013). Research of household borrowing decisions shows that households may have time-inconsistent preferences (Laibson et al, 2003; Heidhues and Koszegi, 2010; Meier and Sprenger, 2010); price perceptions may tilt toward making borrowing look deceptively cheap (Gabaix and Laibson, 2006; Stango and Zinman, 2009; Bertrand and Morse, 2011), expectations about various future parameters may tend toward optimism (Brunnermeier and Parker, 2005; Skiba and Tobacman, 2008; Iossa and Palumbo, 2010; Hyytinen and Putkuri, 2012; Mann, 2013).

The most of the household mortgage interest rate type choice empirical research is still concentrated in the US. However, the US mortgage market is specific and remarkably different from other countries. The evidence from other countries is still scarce and often limited by the mature markets: D. Leece (2000, 2001), D. Miles (2004) and P. M. Bacon and P. G. Moffat (2011) investigate UK mortgage market; S. Damen and E. Buyst (2013) – Flanders region (Belgium); P. Zocchi (2013) – Italian, M. Mori et al (2010) – US, Germany and Japan; M. Lea (2010) and M. Ehrmann and M. Ziegelmeyer (2013) – Euro area countries. IMF Global Financial stability Report (2011) and A. Bardhan et al (2011) tap the dominant mortgage features in emerging markets. The most recent research is related with the institutional environment – with demand of different interest rate type mortgages in different countries (Lea, 2010; Badarinza et al, 2013; Campbell, 2013). Research in different institutional and economic settings enables identifying market conditions' influence on mortgage interest rate term choice better.

The current level of the scientific research of the optimal mortgage choice brings the two main questions of this dissertation:

1. What factors and how influence household mortgage interest rate type choice?
2. When should a financial institution intervene to influence household mortgage interest rate type choice decision?

The goal of the research is to develop a model of household mortgage interest rate term choice management in a financial institution.

To reach the goal the following research **tasks** do become necessary:

1. To outline factors influencing household mortgage interest rate type choice
2. To provide alternative explanation of household's financial decision making based on the descriptive behavioural theories
3. To disclose inter-relation between a financial institution and a household in the household mortgage interest rate type choice
4. To develop a conceptual model of household mortgage interest rate type choice management
5. To test the model empirically in the Lithuanian mortgage market
6. Based on the theoretical and the empirical research results, to provide recommendations for a financial institution regarding household mortgage interest rate type choice management

Research methodology

Following an in-depth literature review, this research provides conceptual model of household mortgage interest rate type choice management in a financial institution. The model combines normative theories of the optimal mortgage choice and behavioural theories. At the core of the model lies decision making under uncertainty based on the behavioural Prospect Theory (Tversky and Kahneman, 1979, 1992). According to this theory, households set reference points and label the potential outcomes of their decisions as gains or losses in relation to some reference point. The labelling influences household's risk aversion – it decreases with the attempts to avoid losses. Households may have heterogeneous reference points. In this research, reference points are related to household characteristics. The model also assumes that households may form non-rational expectations regarding future household and market situation. Expectations' formation is related to household characteristics and market conditions. The influence of the factors outlined in the normative literature of the optimal mortgage choice – household characteristics and market conditions – is hypothesized based on the insights from the behavioral finance theories. Predictions based on the behavioral theories do not always match normative theories' predictions. To validate the model and to test the hypotheses related to household characteristics, analysis of the Survey of Households with Housing Loans data is performed. To test the hypotheses related to market conditions, time-series data of new lending volumes and interest rate is performed.

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For the purposes of data assessment, correlation analysis, regression analysis – logit and Tobit – performed with SPSS 21.0 are employed.

Research setting

The empirical research is conducted in the Lithuanian mortgage market. Lithuanian mortgage market represents an emerging market characterized by low and volatile income, low savings, and volatile asset prices and interest rates. Households may choose whether to borrow in national currency (Litas) or foreign currency (mostly Euro). Interest rate volatility is higher for the loans in national currency (Litas), but probability of divergence of income and interest rate is higher when loans are taken in foreign currency. Prior to 2013, there was no personal bankruptcy legislation – all loans were recourse loans. In case of financial trouble, the house or apartment had to be sold at a price not lower than the outstanding loan. Otherwise, any remaining loans continued to be the borrower's liability. Thus, households have no incentives for strategic default. This setting reveals a clearer relationship between household characteristics and interest rate choice. Lithuanian mortgage market is different than well-established mortgage markets in the institutional setting. Mortgage lending history is rather short. The main mortgage providers do not provide a variety of loans: do not offer teaser interest rates nor deferred payment periods. Mortgage innovations that increase the distance between a borrower and a lender are not present. There are no securitization activities and no sub-prime loan markets in the Lithuanian mortgage system. Refinancing activities are not widespread. Thus, financial institutions are concerned about credit quality and have tools to control it. These entire conditions signal about binding constraints which were outlined as the main prerequisite of the normative recommendation to choose LTFRM (Campbell and Cocco, 2003).

Research is performed analyzing the *Survey of Households with Housing Loans* (the Survey) data and time-series data of new lending volumes and interest rates. The Survey was carried by the Bank of Lithuania in 2009-2012 (four waves). The bank surveyed more than 3,700 households with loans originated in 1990-2012. Time-series data contains monthly volumes and interest rate of new lending in 2004-2013. The data is available in the web page of the Bank of Lithuania.

Structure of the dissertation

Following the goal and the tasks of the dissertation, it consists of the three main parts. The first part reviews the literature. The literature review presents and discusses previous research of household mortgage interest rate type choice: the normative theories of the optimal mortgage choice and the empirical evidence. Household behaviour deviations from normative predictions lead to behavioural theories which are also presented and discussed. The literature review also includes discussion of the financial institution's role in household mortgage interest rate risk and mortgage type choice management.

Based on the reviewed literature, the second part of the dissertation develops the conceptual model of household mortgage interest rate type choice management. The model includes influencing factors outlined in the optimal mortgage choice literature and predictions of the influence thet are based on the previous empirical findings and explained by behavioural theories. This part presents hypotheses to validate the proposed model and to compare which model – normative or the proposed (behavioural approach based) – better predicts household's behaviour. The part concludes with the methodological assumptions for the model testing.

The third part is devoted to the empirical testing of the conceptual model of household mortgage interest rate type choice management. This part provides the rationale for the research setting – Lithuanian mortgage market, describes the institutional background, presents the sample and the limitations of the data, and describes the measurement indicators. Next, follow the results of the empirical testing of the hypotheses and discussion. The section concludes with the recommendations for financial institutions, based on the results of the theoretical and empirical research in the current market.

The generalization of the main findings of the theoretical and the empirical research finalize the dissertation.

Research limitations

- The research is mostly focused on the financially constrained households and the interest rate increase risk. Risk of interest rate decrease and choices of financially non-constrained households are analysed at a lesser extent.
- The methods of financial institution's influence on household decision are discussed but not tested empirically.

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- The empirical research does not disentangle the present influence of a financial institution as the available data shows only the final household's choice.

- The empirical research is based on the two sets of data – the Survey and time-series data of new mortgage lending volumes. Market conditions' specific influence upon the specified households is not tested.

- The empirical research reveals an influential additional factor not mentioned in the previous literature – currency of the loan. This research only associates currency choice with interest rate choice but does not assert causality.

Theoretical contribution and managerial implications

- This dissertation contributes to the existing literature on household finance and mortgage choice by incorporating behavioural lines to examine borrower attitudes towards interest-rate risk.

- This dissertation develops a conceptual model for household mortgage interest rate type choice management. The model is aimed to predict household behaviour deviations from the recommended optimal mortgage interest rate type choice. Thus, research contributes to the literature of behavioural theory application to the mortgage borrowing domain. So far, behavioural finance research is mostly related with investor behaviour and its influence on financial markets.

- The results of the empirical research of the factors influencing mortgage interest rate type choice contribute to the mortgage choice literature by the analysis of household behaviour in an under-researched context – emerging market.

- The conceptual model and empirical research results could be useful for financial institutions to predict household propensity to choose risky mortgage instruments and to prevent sub-optimal choice, to create mortgage innovations seeking efficient interest rate, credit, and reputation risks management; also for the regulatory institutions to create financial service consumer empowerment and protection strategies, policies, and procedures.

Publication and presentation of research findingas

Publications in international peer-reviewed periodical journals:

1. Varanauskienė, J. and Levišauskaitė, K. (2013). Macroeconomic factors influence on mortgage interest rate type demand. *Applied Economics: Systematic Research,* 7, 2, pp. 101-112.

2. Karmaziene, E. and Varanauskiene J. (2014). Selection of Short Term Fixed Rate Mortgages in an Emerging Market: a Case of Lithuania. Bank of Lithuania Working Paper Series, 16.

Presentations at international conferences

1. Varanauskienė, J. and Levišauskaitė, K. (2013). Macroeconomic factors influence on mortgage interest rate type demand. *Proceedings of the 12th International Scientific Conference "Management Horizons in Changing Economic Environment: Visions and Challenges".* European Management Association (EMA), Baltic Management Foundation and Vytautas Magnus University, September 26-28, 2013

2. Karmaziene, E., and Varanauskienė, J. (2014). Selection of Short-Term Fixed Interest Rate Mortgages in an Emerging Market: a Case of Lithuania. *Proceedings of the 14th Eurasian Business and Economics Society*, October 23-25, 2014.

1. HOUSEHOLD MORTGAGE INTEREST RATE TYPE CHOICE AND ITS MANAGEMENT: LITERATURE REVIEW

The goal of this part of the dissertation is to reveal the theoretical concept of the mortgage interest rate type choice management. Both parties of the mortgage contract, borrowers and lenders, are exposed to interest rate risk – the risk that the interest rate will change in the future. The interest rate change may cause undesirable consequences for both parties: increasing mortgage price and constrained consumption to borrowers and decreasing profits or asset value to lenders. Both parties of the contract play their role in mortgage interest rate risk management: borrower – by making choice of mortgage interest rate type, lender – by influencing the choice if the borrower is predicted to behave sub-optimally. This part of the dissertation also presents and discusses historical context of the mortgage market and mortgage product development which has led to current issues of household mortgage interest rate type choice research, normative theories of the optimal mortgage choice, and empirical evidence which does not necessarily support normative theories. There are still unanswered questions: why borrower's behaviour deviates from normative predictions; and which households and under what circumstances tend to commit the most harmful mistakes. These questions lead to the field of behavioural finance. Behavioural finance assumes that borrower's rationality is bounded, that a borrower tends to be overly optimistic and over-confident regarding their susceptibility to risks, myopic by focusing only on the current situation while making the decisions about long term mortgage contract terms and conditions. Once household characteristics and market conditions signalling about sub-optimal household behaviour are revealed, household behaviour can be influenced and corrected.

1.1. Mortgage market development: historical context

Mortgage interest rate risk and its management related literature follows the developments in the mortgage market. As R. K. Green and S. M. Wachter (2005) describe, over the two decades following World War II, the major funders of mortgages in the US – commercial banks and Savings and Loans associations – had an inexpensive source of funds for mortgages: deposits backed by the Deposit Insurance. These financial institutions could offer low interest rate on mortgage

loans. Fixed rate mortgage interest rate typically was between 5 and 6 percent in the market[1]. The ignition of inflation in the late 1960s and 1970s altered the ability to fund long term fixed rate mortgages. For a time in the early 1980s, when adjustable rate mortgages became available and when many pundits were projecting massive and variable inflation for years to come, it even appeared that the fixed rate mortgage might become an "historical anomaly".

Financial deregulation and liberalization in 1980s paved the way for mortgage innovations. Mortgage markets grew in many countries and the growth was related to the house price increase. Mortgage debt has been increasing and housing loan affordability has worsened. In this context, standard mortgages were supplanted by mortgages with non-standard features which aimed to reduce the borrower's monthly payment in the initial period of the loan. While these new mortgage types helped more households to acquire more expensive housing, such mortgages were also more risky (Scanlon et al, 2008). Mortgage interest rate risk over-exposure consequences were observed in Nordic banking crisis in 1990's. A shift in monetary policy with an increase in real interest rates and the currency crisis contributed to breaking the boom in real estate prices and triggering a downward price spiral resulting in bankruptcies and massive credit losses in Sweden (Englund, 1999).

The long period of house price growth in the markets across the world ended with the global financial crisis of 2007-2008. The crisis affected borrowers' capacity to meet mortgage payments and put pressure on both the mortgage industry and housing markets. New lending was down, mortgage characteristics again became tougher, and governments announced new policies to help to avert foreclosure on borrowers facing payment problems. In many countries, short term interest rates fell. Households whose incomes declined could often still make mortgage repayments However, current borrowers have to deal with serious interest rate risk since rates could not be expected to stay low indefinitely (Scanlon et al. 2011).

To generalize, economic environment affects mortgage market players – households, financial institutions and governments. On the other hand, behaviour of

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[1]Fixed rate mortgages are the mortgages with interest rate fixed for the whole duration of the contract. It is slightly different from LTFRM of this dissertation. LTFRM are characterized as the mortgages with interest rate term longer than one year and not for the whole life of the contract. However, as the main characteristic of different interest rate type mortgages is fixation period, fixed rate mortgages are associated to LTFRM, adjustable rate – to STFRM (see Key definitions).

the market players has impact both on the mortgage market development and on the wider economic situation.

1. 2. The concept of the mortgage interest rate risk and its management

Mortgage is probably the largest liability of the households, both in terms of size and duration. Household mortgage interest rate type choice is related with interest rate term choice. A LTRFM contract requires a constant stream of payments which are invariant to changes in the level of the current market interest rate. In this sense, the household is protected against interest rate shocks. However, in this case, another type of risk is created. It concerns the inflation rate over the term of the interest rate. If inflation accelerates and interest rate in the market increases, the real value of the fixed payments declines and the household does very well in real terms. If inflation decelerates, or the economy experiences deflation, interest rate in the market decreases, then the household real payments' value becomes higher (compared to income which probably has decreased due to deflation). On the other hand, a STFRM requires a household to pay a floating nominal interest rate. Payments have a relatively stable real value since most inflation upside and downside shocks are compensated by variation in the nominal interest rate. However, the nominal stream of payments is subject to significant uncertainty. If interest rate increases, then required nominal payments will also increase. If the household does not experience income increase, a significant consumption risk will arise. J. Y. Campbell and J. F. Cocco (2003) refer to this risk as "income risk" and contrast it with the "wealth risk" that decreasing inflation creates for a LTFMR borrower.

From the perspective of the financial institution, the consequences of long term interest rate and increasing market interest rate risks would be poor. As X. Freixas and J. C. Rochet (2008) state: "this is because the cost of funds – which depends on the level of short-term interest rates – may rise above the interest rate income determined by the contractual interest rates of the loans granted by the bank" (p.6). However, financial institutions have access to financial markets where they can hedge their interest rate risk.

In case when a household chooses a LTFRM and market interest rate decreases due to deflation, household's income probably would decrease. If house prices also decline far enough, and the household is not able to refinance to STFRM,

it may end in default. In case when a household has chosen a STFRM and interest rate trend coincides with household's income trend, both parties do well. But if market interest rate increases while household income does not, both sides of the contract would do poorly, as household's default risk increases. Thus, both contract parties – households and financial institutions – should be concerned with household interest rate risk management, though the decision regarding mortgage interest rate type choice is on the side of a household.

Literature on interest rate risk and its management brings a variety of theories. According to the *efficient market hypothesis*, the present value of STFRM and LTFRM would be equivalent since the expectations of future interest rates are already incorporated into current interest rates (Fama, 1984). However, there is ample empirical evidence that the expectation hypothesis does not hold (Campbell and Shiller, 1991). According to *casual logic*, as the term structure of interest rates is normally upward sloping, both the initial payments and the expected stream of future payments are normally lower for a STFRM as long term rate carries risk premium (Campbell, 1995). Thus, the casual logic suggests that STFRM is the more attractive choice. However, J. Y. Campbell and J. F. Cocco (2003) acknowledge that households with STFRM *ceteris paribus* are more likely to default during the life of the mortgage than households with LTFMR due to the cash flow risk of the STFRM. *Portfolio theory* stresses the covariance of asset returns (van Hemert, 2009).

Thus, interest rate is tough to predict, and interest rate risk is difficult to manage. Though the mortgage interest rate type choice is on the side of the household, an ordinary household is the less informed party of the contract and has limited access to hedging markets. Therefore, the responsibility of the choice should be shared with the mortgage providing financial institution.

1.3. Influencing factors of the household mortgage interest rate type choice

Significant spur of research on household mortgage choice factors arose during mortgage market liberalisation process in 1980's and later. The first optimal mortgage choice theories model mortgage demand under uncertainty where households are risk averse, household utility function includes wealth and its variance, interest rates and inflation are stochastically determined. The mortgage choice is examined in the context of the relevant covariances between income, interest rate and asset price without labour income risk and borrowing constraints

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(Baesel and Biger, 1980; Statman, 1982; Alm and Follain, 1987; Brueckner and Follain, 1988; Szerb, 1996; Stanton and Wallace, 1998).

Recently, J. Y. Campbell and J. F. Cocco (2003), and O. van Hemert (2009) proposed more realistic models that take into account household characteristics that are salient to mortgage type choice. R. Koijen, et al (2009) propose explanations under which pricing (interest rate) conditions a house should be financed using STFRM rather than LTFRM.

Based on the previous theoretical research, the main determinants influencing household mortgage interest rate type choice could be divided into two groups:

1) household characteristics

2) market conditions

Below, scientific discussion of both determinant groups is provided.

1.3.1. Household characteristics as factors influencing household mortgage interest rate type choice

Mortgage interest rate type choice involves elements of risk and uncertainty. Risk aversion is central in models of financial decisions under uncertainty. By definition, risk aversion is the attitude towards risk implying that people prefer lower but certain pay-offs to higher but uncertain (Mas-Colell and Whinston, 1995). In the borrowing field, the risk aversion definition should be restated taking into account that the pay-off for a household is the consumption after the mortgage payments. In this dissertation, I define risk aversion as the attitude towards risk implying that people prefer higher but certain (stable) mortgage payments to lower but uncertain (volatile).

Among the factors of risk aversion, the existing literature mentions wealth, income and other individual factors (household characteristics). There is a wide agreement that absolute risk aversion decreases with wealth (Arrow, 1971; Pratt, 1964). There are also other factors influencing risk aversion: background risk, access to credit, consumption commitments, demographics, past experiences, IQ and personality, genetics, etc. (Guiso and Sodini, 2012). Background risk is a type of risk that cannot be avoided as it is non-insurable and cannot be diversified away because of market incompleteness or illiquidity (Shiller, 2003). Labour Income volatility is the most illustrative source of the background risk. Risk aversion may increase due to the limited access to credit (Gollier, 2006). Risk aversion might be

affected by household size and composition as random liquidity needs of a larger family with children might discourage financial risk taking (Love, 2010). Consumption commitments, and expenditures related to durable goods, such as housing and cars, incentivize households to reduce financial risk exposure to make sure they can continue paying their bills when hit by temporary shocks (Grossman and Laroque, 1990; Chetty and Szeidl, 2007; Postlewaite et al, 2008). There could also be unmeasured effects of other risk aversion factors which are not directly linked to household financial characteristics, such as income, expenditure, assets, liabilities, and their volatility, therefore, not often used in normative finance theories. For instance, risk aversion may depend on gender: it is higher for women than for men (Dohmen et al, 2011). Risk aversion is positively correlated with age (Guiso and Paiella, 2008; Dohmen et al, 2010). Education and individual intelligence has a positive impact on risk taking (Vissing-Joergensen, 2002; Frederick, 2006; Calvet et al, 2007; Grinblatt et al, 2009; Dohmen et al, 2010). Risk preferences can reflect past experience: exposure to risky environments in the past (Malmeindier and Nagel, 2010; Fagereng et al, 2011). Risk aversion may also change over time as the wider economic environment changes (Guiso et al, 2011).

Theoretical predictions

J. Y. Campbell and J. F. Cocco (2003), solving a dynamic model of the optimal consumption and mortgage choice of a finitely lived investor who is endowed with non-tradable human capital that produces a risky stream of labour income, find that currently constrained households are better-off with STFRM, but those with large houses relative to their income, volatile labour income, and high risk aversion are particularly adversely affected by the income risk of a STFRM. O. van Hemert (2010), solving a life-cycle asset allocation model that includes mortgage and bond portfolio choice, finds that older, risk-averse investors should hold some long term rate mortgage debt.

Empirical evidence

Empirical research provides controversial evidence. M. Ehrmann and M. Ziegelmeyer (2013) find that large mortgage payments to income increase probability of the STFRM choice. S. Damen and E. Buyst (2013) find that for high income earning households, large mortgage payments to income increase probability of the LTFMR choice. Current constraints measured as large mortgages

to income, increase probability of STFRM choice (Coulibaly and Li, 2009; Bacon and Moffat, 2011). M. Hullgren and I. L. Soederberg (2013) find that households who state they would get into trouble handling interest rate increase more often have chosen STFRM. Limited access to credit, measured as high loan to value ratio increases probability of STFRM choice according to P. M. Bacon and P. G. Moffat (2011) and S. B. Coulibaly and G. Li (2009). S. Damen and E. Buyst (2013) find loan to value ratio influence also positive but significant only for low income earners. Evidence on the role of labour income volatility risk and differences in risk attitudes is scarce. U. S. Dhillon et al (1987) measure income volatility by household composition, assuming that married couples have lower income volatility. They find that those with volatile income are prone to choose STFRM. B. Coulibaly and G. Li (2009) construct income volatility measure based on age, income and race and find that those with more volatile income are more prone to choose LTFMR. On the other hand, M. Finke et al (2005) claim that single parent households have more volatile income but are more prone to choose STFRM. Evidence on the role of risk aversion is also limited. Risk aversion measured as self-certified risk aversion proves to be negatively related with the STFRM choice in B. Coulibaly and G. Li's (2009) findings. D. Bergstresser and J. Beshears (2010) elicit the qualitative risk aversion measure from the U.S. Survey of Consumer Finance and find that more risk averse households are more likely to choose LTFRM though effects are not strong. Risk aversion is also related to the demographic characteristics – household structure, borrower's age and education. M. Paiella and A. F. Pozzolo (2007) find that households with larger number of children are less likely to choose STFRM. J. Sa-Aadu and C. F. Sirmans (1995), J. Sa-Aadu and I. Megbolugbe (1995), M. Paiella and A. F. Pozollo (2007) find age negatively related with the probability of a STFRM choice. D. Leece (2000) finds the opposite. Mori et al (2010) measure risk aversion in an experimental setting by bond choice and suggest that risk averse people tend to become more risk seeking, leaning more toward STFRM, when choosing a mortgage type.

Summary of the empirical research is provided in the Table 1.

Table 1

Household characteristics' influence on the STFRM choice

Household characteristics	Influence on the STFRM choice	Authors
Current consumption constraints	Positive	Ehrmann and Ziegelmeyer, 2013; Hullgren and Soederberg, 2013 (for low income households)
	Negative	Damen and Buyst, 2013 (for high income households)
Limited access to credit	Positive	Coulibaly and Li, 2009; Bacon and Moffat, 2011; Damen and Buyst, 2013 (only for high income households)
Volatile income	Positive	Finke et al, 2005
	Negative	Dhillon et al, 1987, Coulibaly and Li, 2009;
Risk aversion	Positive	Leece, 2000; Mori et al (2010) Cox et al, 2011
	Negative	Sa-Aadu and Sirmans, 1995; Paiella and Pozzolo, 2007; Coulibaly and Li, 2009; Bergstresser and Beshears, 2010

Source: compound by the author

Empirical research provides controversial interpretation on the optimality of the choice, based household characteristics B. Coulibaly and G. Li (2009), D. Bergstresser and J. Beshears (2010), M. Finke et al (2005), S. Damen and E. Buyst (2013) find that high mortgages compared to income encourage STFRM choice. Part of the researchers (Coulibaly and Li, 2009; Begstresser and Beshears, 2010) relate large mortgages to income only with the temporary income constraints and find household behaviour consistent with normative recommendations. Others (Finke et al, 2006; Damen and Buyst, 2013) warn that high mortgage to income signals about the future constraints, and thus the choice of STFRM is sub-optimal in this case. The different interpretations arise due to the blurred boundary between the current constraints and the future constraints.

Besides, the existing empirical research finds that individual household characteristics explain little of the household choice (Dhillon et al, 1987; Brueckner and Follain; 1988; Sa-Aadu and Sirmans, 1995; Vickery, 2006; Paiella and Pozzolo, 2007). The weak explanatory power of household characteristics implies that household behaviour could be better explained by other omitted variables – unmeasured household characteristics, mortgage features or market conditions. Deviations from normative recommendations could simply be mistakes which arise

due to lack of financial literacy. Alternatively, they could be the result of behavioural biases and thus challenge the predictive role of normative models themselves.

Households take out mortgages relatively infrequently and often negotiate them at the same time that they are undergoing a major life transition. Under these circumstances, it is not surprising that households, particularly those with less financial sophistication, sometimes make decisions that appear to be suboptimal. A growing body of research indicates that households, in general, have very limited understanding of basic economic principles (Lee and Hogarth, 1999; van Rooij et al 2011), are unable to perform even simple interest rate calculations (Lusardi 2008). D. Miles (2004) finds that households have limited understanding of interest rate risk and potential savings arising from refinancing. B. Bucks and K. Pence (2006) show that low income and low educated households tend to underestimate how much interest rates can change. Gerardi et al (2010) find that less literate households seem to be less well informed about the terms and other aspects of their mortgages (e.g. interest rate type). D. Bergstresser and J.Beshears (2010) find that mortgage borrowers with STFRM exhibit a low comprehension of financial questions. M. Hullgren and I. L. Soederberg (2013) find that lower financial literacy increases propensity of households to choose STFRM.

To summarize the previous literature, the influential household characteristics are those which are related with household current constraints, limited access to credit, income volatility, and risk aversion. Based on the normative predictions, currently constrained households should choose STFRM, but those with limited access to credit, volatile income, and risk averse should choose LTFRM to insure against interest rate shocks. Empirical evidence suggests that household behaviour is not always consistent with normative models – some find that households with current constraints prefer LTFRM, and with future constraints – STFRM.

1.3.2. Market conditions as factors influencing household mortgage interest rate type choice

Not only household characteristics are important for the mortgage interest rate type choice but also the market conditions. Uncertain income and expenditure expectations are described by market conditions with some distribution of probabilities. When individuals face uncertain situations, they should employ probabilistic thinking to form the expectations. Market conditions include

macroeconomic situation, mortgage pricing variables, such as interest rates, and other mortgage terms and conditions differentiating LTFRMs and STFRMs.

Theoretical predictions

The early models of optimal mortgage choice use such market conditions as asset (housing) price, income, inflation, and interest rates. J. B. Baesel and N. Biger (1980) with extension of M. Statman (1982) offer that the key determinants of mortgage type choice are the size and the sign of the key covariances of inflation, income, and house prices. In their theoretical model, J. R. Alm and J. R. Follain (1987) argue that most important factor influencing mortgage instrument choice is the degree of correlation between house price and the real mortgage interest rate. Positive covariances encourage household STFRM demand as this choice minimizes the impact upon wealth (house price and residual income after mortgage payment). Modelling mortgage instrument choice includes some measure of interest rate expectations. In the previous literature, the benchmarks for interest rate expectations are interest rate variance (Arvan and Brueckner, 1986), term structure of interest rates (Brueckner and Follain, 1987), LTFRM-STFRM differential (Brueckner, 1989), spread between the yields on a nominal long-term and short-term bond (Campbell and Cocco, 2003), and level of the mortgage interest rate (Leece, 2001). Recently, R. Koijen et al (2009) proposed that inflation risk premium, real interest rate risk premium, volatility of expected inflation and expected real rate are the most important factors of mortgage choice. All the factors should have a positive influence to the attractiveness of the STFRM.

Empirical evidence

Empirical evidence shows that households are willing to assume the additional interest rate risk associated with STFRM in markets where house values are appreciating rapidly (Tucker, 1989; Furlong and Takhtamanova, 2012). It is also possible that some households with current borrowing constraints may be forced to either consider buying a house with a STFRM or not buying a house during periods when real house prices are increasing. Thus, in the environment of increasing prices and increasing income, STFRM becomes more desirable (J. Sa-Aadu and C. F. Sirmans, 1995). L. G. Goldberg and A. J. Heuson (1992) find that high unemployment has a strong negative impact upon STFRM choice and this relationship complies both borrowers' and lenders' interest. Interest rate arguments

have been more empirically successful predictors of mortgage choice. Some empirical research suggests that at a particularly high mortgage interest rate levels households might expect the rate to regress back to the mean (Jones et al, 1995, Leece 2001). Opposite evidence is presented by U.S. Dhillon et al, 1987 who find that the level of short term interest rate has a negative effect on STFRM demand. Interest rate expectations are also related to inflation levels. D. N. MacDonald and K. Winson-Geideman find that higher atnticipated inflation held with certainty increases the proportion of STFRM in new lending volumes, while greater inflation uncertainty decreases it. The most common empirical finding is the statistical significance of the spread between LTFMR and STFRM interest rate. Mortgage instruments are not efficiently priced to leave borrowers indifferent between them (Jones et al, 1995). J. Y. Campbell (2006) and J. Vickery (2006) use the spread between LTFRM and STFRM rate as a determinant of the STFRM demand. R. Koijen, O. van Hemert, and S. van Nieuwerburgh (2009) prove that the inflation risk (for the US) or real rate risk (for the UK) premium are strong predictors of household mortgage choice and can correctly classify almost 70 percent of household choices. J. Sa-Aadu and Sirmans (1989, 1995) find that the impact of price variables on household mortage interest rate type choice is different accros differentiated contracts.

The summary of the empirical evidence on market characteristics' influence on the STFRM choice is provided in the Table 2.

Table 2

Market characteristics influence on STFRM choice

Market condition	Influence on STFRM choice	Authors
Housing prices	Positive	Tucker, 1989; Furlong and Takhtamanova, 2012
Unemployment	Negative	Goldberg and Heuson, 1992
Short term interest rate level or inflation	Positive	Jones et al, 1995; Leece, 2001; Vickery, 2007
	Negative	Dhillon et al, 1987
	Positive and negative	MacDonald and Winson-Geideman, 2012
Interest rate differential	Positive	Brueckner and Follain, 1988; Coulibaly and Li, 2009; Koijen et al, 2009; Moench et al, 2010; Badarinza et al 2013

Source: compound by the author

The different findings on interest rate level impact may occur not only due to differentiated contracts, but they also may signal contrary expectations of the households (Goodman, 1992). However, household expectations, based on this form of behaviour, are not well developed theoretically (Leece, 2008). Also, borrower's behaviour might simply be myopic (Brueckner and Follain, 1989), or concerned only with immediate comparative costs (Earley, 2000; Damen and Buyst, 2013; Zocchi, 2013). The interest rate differential can be interpreted in versatile ways too. For example, large interest rate differential can be interpreted as an indicator of expected rate increase or volatility and have positive effect on LTFRM choice. On the other hand, interest rate gap can be viewed as a relative price of the two mortgage instruments or a signal of inefficient pricing and make positive impact on STFRM choice. This was found to be the case (Brueckner and Follain, 1988; Phillips and van der Hoff, 1991; Vickery, 2007; Moench et al, 2010; Badarinza et al, 2013).

Household decisions and their outcomes are often shaped by the institutional environment in which they are taken. Regulatory, historical, cultural reasons together with available product offerings and their features also influence mortgage interest rate type choice. Institutional factors include country specific, financial institution specific and product specific issues. Results from the US mortgage market research may not be generally applicable, as the US market is different than the other markets. Government sponsored institutions as *Fannie Mae* and *Freddie Mac*, widespread securitization, availability to choose very long term (up to 30 years) rate mortgage loan, relatively low refinancing fees – these characteristics that do not exist in other markets may be reflected in household decisions which will be different than of households in the other countries. M. Lea (2010) analyses mortgage product offerings in 12 developed countries with variation of the popularity of LTFRMs[2]. He argues that determinants of the popularity of the certain type mortgage are overall debt to income ratios, mortgage market funding (short term funding, such as deposits, or long term funding, such as capital markets or government sponsorship), prevailing other product features such as initial period discounts for STFRMs. The research of the IMF (2011) outlines mortgage systems differentiating factors by adding government support, bankruptcy laws, prepayment penalties, and historical events. A Bardhan et al (2012) find that mortgage systems are also differentiated by

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[2]The analysed countries are Australia, Canada, Denmark, Ireland, Japan, Germany, Netherlands, Spain, Switzerland, UK and US.

demographic and socio-cultural factors, economic conditions, level of development, local jurisdictions. M. Mori et al (2010) analyse US, German, and Japanese markets to find if any cultural differences may take place as some nations are more risk-averse than others (based on Hofstede's (2001) cited in Mori et al (2010) suggestion). However, they find no statistically significant relationship. J. Y. Campbell (2013) claims that in countries with historically volatile inflation, STFRM prevails. K. Scanlon et al (2009) argue that new mortgage features, such as interest only mortgages, negative amortization mortgages, option mortgages with low initial teaser rates, make STFRM type mortgages more demanded.

To summarize, in the environment of increasing housing prices and increasing income households should prefer STFRM. Interest rate expectations formation is related with interest rate level and volatility. Interpretation of the interest rate expectations' benchmarks depend on the assumption whether households form extrapolative or mean-reverting expectations, whether they consider interest rate differential as the benchmark of the expected interest rate volatility or just as the difference in the price of the two mortgage products. Market conditions are different from country to country so more different environments should be analysed to check whether households in different institutional and economic settings follow the same behavioural patterns.

1.4. Alternative explanation of household financial decision making under uncertainty

For a household, the decision of the optimal mortgage interest rate choice is extremely complex. "It would be a monumental task to incorporate all of the various aspects of mortgage instrument choice into a single theoretical model" states D. Leece (2008, p.145). Ordinary households may be not capable of doing complex calculations; they may have no solid appreciation of their risk, nor may know that they ought to reduce their risks. An important task becomes the identification of what households under what circumstances tend to make harmful mistakes. Standard economic theory models are dominated by a straight assumption that people behave rationally. However, it is obvious that most people are not. The normative theory of finance underwent a fundamental transformation with the development of behavioural finance which "corrects a major error in most mathematical finance: the

neglect of the human element" (Shiller, 2003, p. 13) by including the application of principles of psychology and insights from other social sciences to finance.

1.4.1. Behavioural explanation of decision making: Prospect theory

Normative theories model choice as the preference maximization and do not presuppose that the decision making model corresponds with any of mental activities, actually involved in making choices. There also is another approach more common in the psychology literature that seeks to model the process that leads to choice. A distinguishing feature of this approach is to assume that people draw on decision heuristics or rules of one kind or another when making choices. The most widely discussed theory representing this approach is the *Prospect Theory* (PT). PT was originally developed in D. Kahneman and A. Tversky (1979) paper and the extended in a later paper by the same authors in 1992, being renamed *cumulative PT*. The goal of the theory composers was "to assemble the minimal set of modifications of expected utility theory that would provide a descriptive account" (Kahneman and Tversky, 2000, p. 11).

PT departs form the conventional theories of finance and economics that assume the rationality of people. In PT, the bounded rationality is assumed. Bounded rationality implies that a decision maker has imperfect information, limited computational ability, imperfectly defined objectives (Simon, 1986). Because people lack the ability and resources to arrive at the optimal solution, they are forced to make decisions not by "maximization", but rather by "satisficing", i.e. setting an aspiration level which, if achieved, they will be happy enough with, and if not, they will try to change either their aspiration level or their decision.

PT includes two-phase decision making process. First phase is called editing phase. In the editing phase reference points are set and outcomes are interpreted as gains or losses relative to a reference point. Outcomes are evaluated via the utility function which D. Kahneman and A. Tversky call as value function (see Figure 1).

The properties of this function are the following:

- it is kinked at the reference point
- it is concave for gains and convex for losses
- it is steeper in the domain of losses
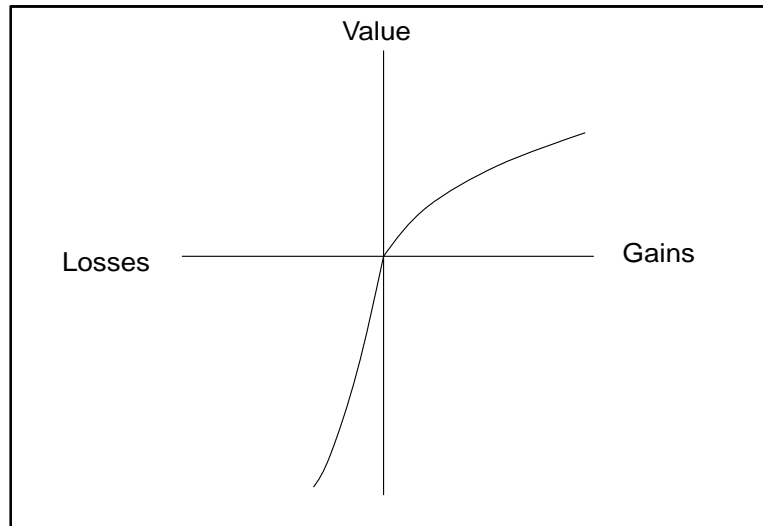
Figure 1. Prospect theory value line
Source: D. Kahneman and A. Tversky, 1979

The shape of the value function line represents diminishing sensitivity and loss aversion. Diminishing sensitivity holds that the psychological impact of marginal change will decrease when moving further away from the reference point. Loss aversion is the principle that "losses loom larger than corresponding gains" (Kahneman and Tversky, 1992 p. 303).

The second is evaluation phase. In this phase, the decision maker evaluates each of the edited prospects and chooses the prospect of the highest value. Decision maker estimates the probabilities of the events and puts some decision weights on certain events. Decision weights do not obey the probability axioms.

Still, PT application for explanation purposes brings difficulties. The central idea in PT is that people derive utility from gains and losses measured relative to a reference point. However, in any given context, it is often unclear how to define precisely what a gain or loss is. Many possible anchors and context factors can be used as reference points: for monetary outcomes the status quo generally serves as reference point (Samuelson and Zeckhauser, 1988), also past decisions (Kahneman and Tversky, 1979; Thaler and Johnson, 1990), aspirations (Lopes, 1987; Tversky and Kahneman, 1991), expectations, norms, social comparisons (Tversky and Kahneman, 1991), other available alternatives and outcomes (Mellers, 2000). Significant attempt to clarify how people think about gains and losses is the works of B. Koszegi and M. Rabin (2007, 2009). Their idea is that the reference point people

use to compute gains and losses is their expectations or beliefs held in the recent past about outcomes. They propose that people derive utility from the difference between actual consumption and previously expected consumption. According to N. C. Barberis (2010), the best way to solve the question of reference points and the main approach researchers are taking – is to derive the predictions of PT under a variety of plausible definitions of gains and losses, and then test these predictions.

Behavioural finance research is most often related with investors' behaviour and its influence on financial markets. Borrowing behaviour and decisions are less researched (Tufano, 2009; Zinman, 2014). Borrowing research from behavioural point of view is related with irrational or boundedly rational borrowing behaviour issues: over-indebtedness, over-excessive credit card borrowing, payday borrowing (Bertrand and Morse, 2011), simultaneous saving and borrowing puzzle (Basu, 2008), strategic default behaviour (Skiba and Tobacman, 2008; Gerardi and Li, 2010; Agarwal et al, 2013; Dobbie and Song, 2013). Research in household borrowing decisions suggests that households may have time-inconsistent preferences (Laibson et al, 2003; Heidhues and Koszegi, 2010; Meier and Sprenger, 2010); price perceptions may tilt toward making borrowing look deceptively cheap (Gabaix and Laibson, 2006; Stango and Zinman, 2009; Bertrand and Morse, 2011), expectations about various future parameters may tend toward optimism (M. Brunnermeier and Parker, 2005; Skiba and Tobacman, 2008; Iossa and Palumbo, 2010; Hyytinen and Putkuri, 2012; Mann, 2013). Also, many consumers tend to be "narrow thinking" and focus only on monthly payments which simplifies decision making (Elienhausen, 2010; Prelec and Loewenstein, 1998). The work by M. Mori et al (2010) relates PT and mortgage interest rate type choice. The authors suggest that households perceive mortgage payments as negative cash flows (loss). Thus, a choice between STFRM and LTFMR is framed as a choice between two types of negative prospects. By using experiments, the authors find that risk averse people tend to become more risk-seeking when choosing a mortgage type and leaning more toward STFRM. They also find evidence that households behave differently depending on their propensity for current consumption, i.e. consumption oriented vs. investment oriented, and the ways that they frame their mortgage choice decision.

1.4.2. Behavioural explanation of expectations' formation

Interest rate choice heavily relies on expectations. Cost minimisation in the short-run by liquidity constrained households and exploiting pricing inefficiencies in the long-run may be valid ways of examining actual household mortgage choices (Leece, 2008). However, another argument is that borrower's behaviour might simply be myopic (Brueckner and Follain, 1989), or concerned only with immediate comparative costs (Earley, 2000). For now, myopic behaviour has been mostly considered as an overall category for yet unexplained determinants of mortgage interest rate type choices.

The conventional expected utility theory assumes that consumers are on average correct about the distribution of the future states. Experiments suggest instead that consumers have systematically incorrect beliefs. One way of incorrect beliefs is the law of small numbers (Tversky and Kahneman, 1971; Rabin, 2002). The law of large numbers tells that people exaggerate how likely it is that a small sample resembles the parent population from which it is drawn. In his theoretical model, M. Rabin (2002) assumes that people, observing a sequence of signals drawn from an independent and individually distributed process, incorrectly believe that the signals are drawn from an urn of size N<∞ without replacement. If the distribution of the signals is (incorrectly) perceived to be known, this induces a "gambler's fallacy" belief: after a draw of a signal, subjects expect the next draw to be a different signal (since the draw is considered to be without replacement). The model also delivers the second prediction: in the case of uncertain distribution of signals, the subjects over-infer from a sequence of signals of one type that the next signal will be of the same type. N. Barberis et al (1998) apply an alternative model to financial markets. While the draws are independent and individually distributed, investors believe that the draws come from either a "mean reverting" regime or a "trending regime"; in addition, the investors believe that the first regime is more likely *ex ante*. If investors observe a sequence of identical signals in the short run, they expect a mean reverting regime (the "gambler's fallacy"); however, after a longer sequence, the individuals over-infer and expect a "trending" regime. Empirical evidence of over-inference (or extrapolation) or mean reversal is mostly related with investment. S. Benartzi (2001) provides field evidence of extrapolation from employees' investment in employer stock; B. M. Barber et al (2009) – from US stock

market. A. Fuster et al (2011) claim that people do not know that economy fundamentals are hump-shaped (exhibiting momentum in the short run and partial mean reversion in the long run), and base their beliefs on simplistic models that they fit to the available data. This assumption is confirmed by the empirically observed patterns in asset prices and macroeconomic dynamics: robust pick up of the short-term momentum in fundamentals, but failure to fully capture the long-run mean reversion. In the borrowing field, the evidence relates to the developments of mortgage and mortgage backed securities' price expectations (Chollete and Jaffee, 2009).

1.5. Financial institution's role in the household mortgage interest rate risk management

Mortgage contract evolves as a result of the interaction between a financial institution and a household. Thus, financial institution's motives and preferences are also being reflected in mortgage contract. The early theoretical models of household mortgage interest rate choice were based on the principle of interest rate risk sharing between a borrower (household) and a lender (financial institution). Though, as highlighted by J. K. Brueckner (1993), in most models, lenders are assumed to be risk-neutral, given that financial insitutions are able to diversify their portfolios, to hedge in derivatives (futures and options) markets and eliminate risk "allowing an exclusive focus on expected return" (p.334). This statement leads to an assumption that financial institutions may mitigate or eliminate interest rate risk. Yet, they still may be not indifferent to household mortgage type choice. Credit risk and reputation risk provide rationale for a financial institution to influence household's appropriate choice.

1.5.1. Interest rate risk inter-relation with other risks in a financial institution

Risk management is one of the key functions of a financial institution. Usually, bank management literature defines three types of risk affecting banks: credit risk, interest rate risk, and liquidity risk (Freixas, Rochet, 2008). I. Walter (2006) adds operational risk, sovereign risk and reputational risk. From the list, mortgage interest rate type choice management relates to interest rate risk, credit risk, and reputational risk.

Interest rate risk

Theoretical papers on loan contract design and bank risk management suggest that the share of interest rate risk taken should depend on the financial institution's interest rate risk profile. Models by L. Arvan and J. K. Brueckner (1986), G. Froot and J. Stein (1998), and R. Edelstein and B. Urosevic (2003) predict that financial institutions that are exposed *ex ante* to rising interest rate originate a smaller share of long term loans, as the present value of such loans declines. In the empirical paper, J. Vickery (2006) finds that high real interest rate and steep yield curve are correlated with a lower proportion of long term interest rate loans. That is consistent with M. Baker et al (2003) and M. Faulkender (2005).

Interest rate risk can be minimized or even eliminated. The first way to decrease interest rate risk exposure is to look for a better matching of maturities on the asset and liability sides of the balance sheet. But it could be impossible to reach a perfect matching of asset and liability maturities. The second way is to employ derivative instruments like futures, options, and interest rate swaps to minimize interest rate risk. Nevertheless, funding issues still do not always allow lenders to be indifferent to the preferred mortgage interest rate as it is related with the pricing and competition strategies. Short term funding sources, such as deposits, lower attractiveness of LTFMR in the eyes of the lender, while capital market funding (including securitization), government provided funding make LTFMR more attractive (Vickery, 2006; Krainer, 2010; Lea, 2010).

Credit risk

Interest rate risk is not isolated, but interacts with *credit risk*. The union of these risks reflects not only a fall in a financial institution's profitability due to a change in short term interest rate, but also the possibility of a household's failure to service debt if interest rate increases. R. A. Jarrow and S. M. Turnbull (2000) show in theory how to integrate interest rate risk and credit risk. Empirical evidence of interest rate risk impact on credit quality is presented by R. A. Jarrow and D. R. van Deventer (1998), T. M. Barnhill, Jr. and W. F. Maxwell (2002), and P. Grundke (2005).

From mortgage loan perspective, existing research proposes that STFRM must be considered riskier than LTFMR. The assumption underlying the proposition is household constraints. If income constraints are not binding, the household will choose an option that minimises not only costs, but also risk. However, if income

constraints matter, the household will minimise current costs and thus stay uninsured against real shocks. Long term rate is higher, so constrained households would opt for STFRM. L. Posey and A. Yavas (2001) present a theoretical model which shows that high risk households choose STFRM, while low-risk households prefer LTFMR. J. Y. Campbell and J. F. Cocco (2003) also link STFRM with higher default rate through an increasing payment burden and conclude that interest rate volatility can worsen default risk. Rich empirical research provides approving evidence. H. P. Hendershott and R. van Order (1987), D. F. Cunningham and C. A. Capone Jr. (1990), B. W. Ambrose et al (2005) find relatively high rates of default among STFRM households. However, most recent D. Harrison et al (2011) research findings reveal that when a household default costs are sufficiently small, high default risk households disproportionately self-select into LTFMR, while low default risk households tend to self-select into STFRM.

Recent market rends had an impact on financial institution's approach both to credit risk and interest rate risk. Dramatic increase in securitization activity has modified financial institution's abilities to grant credit and changed monitoring function performed by banks (Holmstroem and Tirole, 1997; Diamond, 1984). B. W. Keys et al (2008) present evidence of household screening moral hazard as a result of securitization arrangements. Thus, the importance of credit risk management has been minified. Other factors influencing financial institutions' approach to risk include increasing competition, increasing market share, and increasing appetite for profits. Competition encourages pursuing riskier policies in attempt to maintain profits (Keeley, 1990). Theoretical work of D. Besanko and A. Thakor (1993) states that increased competition enhances risk taking. T. F. Hellmann et al (2000) in a dynamic model of moral hazard show that competition can have a negative impact on prudent bank behaviour. R. Repullo's (2004) dynamic model of imperfect competition shows that more competition (lower bank margins) leads to more risk. Empirical investigation (Brewer and Saidenberg, 1996; Demsetz et al, 1996; Saunders and Willson, 1996; Salas and Saurina, 2003; Bofondi and Gobbi, 2004) suggests that bank risk is correlated with market power.

Reputation risk

Financial institutions can estimate their interest rate risk and credit risk. There is another type of risk that is less tractable but of high importance – reputation risk. As

stated in I. Walter (2006), "reputational losses may be reflected in reduced operating revenues as clients and trading counterparties shift to competitors, increased compliance and other costs required to deal with the reputational problem" (p. 4). The source of reputational risk is the intersection between the competitive environment of the firm and behavioural expectations within which the institutions operates (see Figure 2). Management must work to optimize against both sets of benchmarks. If it strays too far in the direction of the demands of social and regulatory controls, it runs the risk of poor performance in the market, punishment by shareholders, and possibly, a change in corporate control. If it strays toward unrestrained market performance, it may come too close to the questionable conduct and its behaviour may have disastrous results for the firm, its managers, and its shareholders.
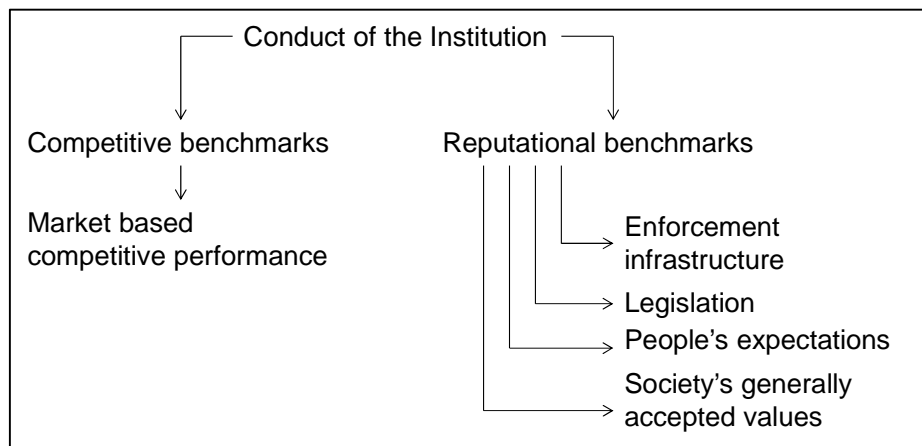
Figure 2. Sources of reputational risk.
Compound by the author based on I. Walter (2006)

As the Figure 2 shows, reputational risk may arise not only due to external compliance failures or illegal conduct, but also by irresponsible conduct in the light of people's expectations or immoral conduct by generally accepted values. Besides, laws and regulations are rooted in social expectations as to what is appropriate. These expectations sooner or later become regulations (Kroszner, Strahan, 2004). Recent examples from the 2007-2008 financial crisis show that there were cases when governments restricted financial institutions' actions even if according to the contractual terms. New regulations enabled households to re-mortgage or change the terms of their loan to reduce payments, even in cases when lenders would not

normally permit this. Another approach was simply to forbid banks from initiating foreclosure proceedings (Scanlon et al 2011).

Current social reactions such as *Occupy* movement shows that it is in people's expectations that being a better informed side of the contract financial institution must take responsibility for households' financial service contract choicoes.[3]

1.5.2. Inter-relationship between financial institution and households in the household mortgage interest rate type choice

At the centre of the events shaping the mortgage market and industry are the risk management practices. Financial institutiond form their business and risk taking decisions based on their risk aversion and business plans. These decisions become business intermediate outcomes – products, pricing strategies, distribution strategies. There is a cyclical relationship between business intermediate outcomes and market outcomes (household's behaviour) as financial institutions react to households' behaviour. In turn, households react to financial institutions' product solutions (Rossi, 2010). All the participants are influenced by economic environment. So the final outcomes of mortgage business – profitability, liquidity, and solvency depend on the institution business and risk taking decisions, household behaviour, institution's impact on that behaviour, and economic environment.

A simplified depiction of risk management practices in the mortgage Industry is presented in Figure 3.

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[3] The movement began in September, 2011 in New York, later protest movements and demostrations were staged around the world including Auckland (New Zealand), Sydney (Australia), Hong Kong, Taipei, Tokyo (Japan), São Paulo (Brasil), Paris (France), Madrid (Spain), Berlin, Hamburg, Leipzig, and Frankfurt (Germany), and Zurich (Switzerland). Protesters railed against corporate power, grinding poverty and government cuts. They were also criticizing financial institutions that have "gambled away our money." (http://edition.cnn.com/2011/10/15/world/occupy-goes-global). Retrieved 19 May, 2014.
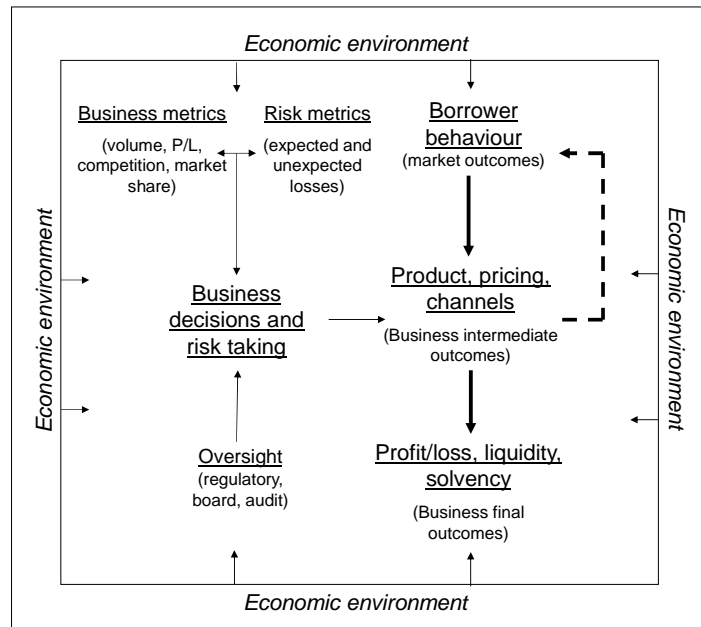
Figure 3. Anatomy of Risk Management Practices in the Mortgage Industry
Compound by the author, based on C. V. Rossi (2010)

Here, conflicts of interest between financial institutions and borrowers could arise. I. Walter (2006) outlines two kinds of conflicts of interest confronting financial institutions or other firms in the financial services industry:

- conflicts between the institution's own economic interests and the interests of its clients
- conflicts between the institution's customers (or between types of clients) which place the institution in a position of favouring one type at the expense of another

The examples of the first type conflict may include interest to enhance institution's profitability or market share, or to transfer risk to the less informed contract party. The example of the second type of the conflict may include subsidising new customers by discounts or teaser rates at a cost of old customers (Miles, 2004; Gabaix and Laibson, 2006).

The recent processes in the financial sector revealed agency problems and information asymmetries. Some of them are related with the channel strategy. There is a large volume of literature analysing principal – agent problems between financial institutions and mortgage brokers (middlemen between lenders and borrowers). M. LaCour-Little and G. H. Chun (1999) examine the prepayment behaviour of residential mortgages originated by mortgage brokers, as compared to loans

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originated directly through the lender's direct employees. They find that loans originated by mortgage brokers were significantly more likely to prepay. W. P. Alexander et al (2002) find empirical evidence that loans originated by mortgage brokers are more likely to default. S. Woodward (2003) notes that broker "fees are profoundly related to borrower education". A. El-Anshasy et al (2005) identify three potential agency problems: (1) brokers may attempt to originate loans to borrowers who do not qualify, i.e. misrepresent borrower qualifications; (2) brokers may actively solicit borrowers for refinancing after the original loan is made; (3) brokers may encourage borrowers to select products or lenders that maximize broker income, rather than acting in the borrower's best interest. Not all the blame should be attached to middlemen. There is rich literature which focuses on regulatory oversight and corresponding changes in incentives for various market participants. B. W. Keys et al (2009) show that incentives associated with the securitization process result in lax screening by mortgage originators. U. Rajan et al (2008) show that lenders are less likely to expend effort to collect and assess soft information on borrower credit-worthiness, as the ease of securitization increases. S. Agarwal, et al (2009) find that mandatory counselling legislation results in substantially lower *ex post* default rates and somewhat better loan choices among some of the counselled borrowers.

1.5.3. Tools of household mortgage interest rate choice management by a financial institution

For a financial institution to manage household interest rate risk and the related credit risk, the possible ways include credit rationing (reluctance to finance potentially interest rate risk sensitive households) or influencing vulnerable households to hedge against interest rate shocks by selecting a LTFMR. The latter is the object of the dissertation.

The goal of household interest rate choice management is to prevent household over-exposure to interest rate shocks. To reach the goal, financial institutions should take preventive actions to encourage the desirable behaviour. Among the tools of influence, existing literature outlines pricing, product innovations, and professional advice.

Mortgage product innovations resulted in many of new features aimed to reduce household's monthly debt service in the initial period of the loan and to increase potential market for mortgage loans. Among the variety of new mortgage products,

there are several new types that shift interest rate risk to households: interest only mortgages, negative amortization mortgages, and option adjustable mortgages (Scanlon et al 2008). While terminology varies from country to country, the common feature of these new mortgages is that required payments are low initially because the initial interest rate is low and often also because principal is not initially repaid and then payments increase discretely after a few years. Lower required initial payments make it possible to increase the amount borrowed. These types of mortgages were desirable for households who expect steep income increases, but currently can make only small down payments (Piskorski and Tchistyi, 2010; Cocco, 2010; Gerardi et al 2010; Corbae and Quintin, 2010). Yet, these mortgages may hide actual borrowing costs and fool unsophisticated households into inappropriate loans (Carlin and Manso, 2011).

If the goal is to protect households from the overexposure to interest rate risk, the product innovations should include terms that are less likely to cause later regret by buyers who are often present-oriented and have limited financial literacy. J. Y. Campbell (2006) has suggested alternative mortgage forms that may be superior to any of those observed in the marketplace. For example, a LTFMR with payments that are indexed to inflation, a STFRM with level nominal or real payments and a principal balance that adjusts to variation in short-term nominal interest rate. Or instead of focusing on helping households to choose a suitable mortgage, a complementary approach might focus on continuous mortgage modifications as an alternative to foreclosure when unexpected circumstances arise (Shiller, 2013). However, these products have not appeared yet in the market place. One of the reasons is based on S. Gabaix and D. Laibson's (2006) described cross subsidy from naive households to sophisticated. Financial innovators have only weak incentives to design and market new products that can only be evaluated by sophisticated households.

Product pricing may also increase one product attractiveness over the other. Pricing may be related to interest rate spread. S. Y. Ho and A. Saunders (1981) dealership model and extended version by L. Allen (1988) demonstrates that the interest spread may be manipulated by the benefits of product diversification. Following L. Allen's (1988) extension, it is assumed that relative price of alternative products may trigger demand of certain interest rate type mortgage. D. E. Page and

C. F. Sirmans (1984) present empirical evidence that the default risk premium imbedded in market yields on STFRM exceeds the default risk premium in LTFMR. Thus, STFRM is relatively less attractive. However, later the situation has changed (Phillips et al, 1991). STFRM has become more attractive than LTFMR in pricing terms. STFRMs are supplemented by especially low initial rate ("teaser rate"). This makes STFRM more attractive, especially if to consider intentions to refinance the mortgage after the end of the "teaser rate" to other "teaser rate" mortgage.

Empirical research of S. T. Jones et al (1995) on bank mortgage interest setting behaviour shows how financial institutions manipulate the premium on short and long term interest rate to trigger choice of interest rate type that is more favourable to financial institution. Also, there are other related pricing elements such as prepayment penalties or points for LTFMR which make this type of the mortgage more costly. Prepayment penalties are designed to compensate the lender for lost interest over the remaining term of the fixed rate (Sa-Aadu and Megbolugbe, 1995; Lea, 2010).

Information asymmetries, market participant incentives result in market failures. In addition to these, research in behavioural economics has highlighted consumer biases and cognitive limitations: households do not always behave as time-consistent, rational utility maximizers. They appear to have present-bias preferences, may lack the cognitive capacity to optimise their financial decisions even if presented with all the required information. These market failures proved to be devastating both to borrowers and lenders (Scanlon et al, 2011).

J. Y. Campbell et al (2011) advocate several ways of regulation that might improve situation: disclosure requirements that can facilitate not only cost comparison, but also risk comparison across mortgage types; fiduciary duty to advisors that they use their best judgment in acting in the best interest of households; promoting relatively small group of standard mortgages that are reasonable choice for most households (so called *default option*); mortgage modification as alternative to foreclosure when unexpected circumstances arise; qualification questionnaire to test financial experience and knowledge of the borrower; qualification based on financial strength of the household. However, these proposals raise many concerns from the industry: the cost of compliance with regulation requirements may be too high and cause credit prices to rise, filling out

financial sophistication questionnaires may be embarrassing for consumers, and profitability may be reduced so much that too many credit suppliers will exit the market.

A lot of models traditionally are based on a rather naïve understanding of what drives people's behaviour. More recent research of behavioural finance highlights consumers' cognitive limitations and psychological biases. Besides the incomplete information people have limited attention and cannot possibly focus on all of the information relevant for their decisions, they have limited computational capacity, their reasoning is biased, and their preferences are often context dependent: their choices are sensitive to how decisions are framed. Information provision could fill the gap of financial knowledge, but the effectiveness of information provision will be limited if consumers do not understand the information, believe that it is not relevant to their decision making or do not know how to access it (Madrian, 2014). J. Y. Campbell, et al (2010) highlight that it would be helpful to understand how financial decisions are made: what role advisors play in how consumers make financial decisions, at what stages what tools are most influential, what is the extent of consumers' understanding of the products, and can counselling de-bias people.

The literature review allows outlining the main aspects of the household interest rate choice management in the financial institution and the gaps in the literature:

- *Research on the factors influencing household optimal mortgage interest rate type choice follows mortgage market developments. Recent optimal mortgage choice models propose optimal mortgage interest rate type choice to be based on household characteristics and market conditions. Household characteristics related models show that LTFRM should be preferred by households with high risk aversion levels, with future consumption constraints (limited access to credit or volatile income). Market conditions related models propose that households should choose STFRM if inflation premium, real interest rate premium, expected volatility of inflation, and real interest rate is high. These optimal choice models are useful as to provide normative recommendations and as a benchmark to evaluate how efficient are households in choosing mortgage interest rate type.*

- *Empirical evidence shows that pricing variables have a powerful explanatory power of households' behaviour while household characteristics' heterogeneity plays a minor role. The empirical research brings controversial findings for both of the factor groups' influence. This is referred to the limited household's ability to choose optimally due to low financial literacy or cognitive biases and to different institutional backgrounds as evidence differs from country to country. Little evidence is available on the role of differences in risk attitudes or income risk which reflects binding constraints – an important predicate for LTFRM choice. It would be helpful to research household behaviour in the environment with binding constraints. Little evidence is available from other than the US mortgage markets. There is very limited research from emerging markets with immature mortgage markets, less predictable interest rate movements, more constrained households, and high default costs.*

- *Normative predictions are based on conventional rational utility maximization principles. However, many authors admit that in practice many households do not have a solid appreciation of their risk nor do they know that they ought to reduce the risks. It would be helpful to understand how households*

form their expectations and make their decisions regarding the mortgage interest rate type choice. Behavioural finance studies real life financial decisions and contrasts them with the prescriptions of normative models. Thus, for the analysis of how to manage or correct household behaviour deviations from the normative prescriptions, elements from behavioural finance theory should be applied.

- *Previous research shows that household's over-exposure to interest rate risk as income risk is closely related with financial institution's credit risk and reputational risk. Thus, financial institution has incentives to play its proper role in managing household's choice of the exposure to interest rate risk.*

- *To manage household interest rate choice decision, it is important to determine which households under which circumstances tend to over-expose to interest rate risk. Once the critical households are detected, financial institutions could take preventive actions to influence household mortgage interest rate type choice decision, to prevent households from the sub-optimal choice by using various tools, such as product innovations, pricing policies, and professional advice. This leads to the creation of the conceptual model of the mortgage interest rate type choice management in a financial institution.*

2. THE CONCEPTUAL MODEL OF HOUSEHOLD MORTGAGE INTEREST RATE TYPE CHOICE MANAGEMENT

The goal of this part of the dissertation is to develop and substantiate the conceptual model of household mortgage interest rate type choice management in a financial institution. This model is a descriptive model which considers real life household's behaviour. At the core of the model, there is a behavioural decision making under uncertainty based on PT. According to the normative theories, household optimal mortgage interest rate type choice is determined by external factors – household financial and socio-demographic characteristics and market conditions. In this part of the dissertation, I build the conceptual model of household mortgage interest rate type choice management in a financial institution by joining normative and behavioural theories. I discuss how household characteristics and market conditions influence household mortgage interest rate type choice, based on the behavioural theories, and present methodological assumptions for the proposed model testing.

2.1. Household decision making based on the behavioural theories

As previously reviewed literature shows, the core theory used in economics – expected utility theory – builds on a simplistic model of behaviour according to which individuals make choices so as to maximize a utility function using the information available and processing this information appropriately. Empirical household mortgage interest rate type choice evidence shows that household behaviour deviates from the normative predictions. Besides incomplete information, people have cognitive limitations, their reasoning is biased, and their preferences are context dependent. People are affected by the framing of a decision problem, they simplify a complex decision by being inattentive to less salient features of a problem, and they are also subject to social pressure and persuasion (DellaVigna, 2009).

At the core of the conceptual, there is a PT based decision making under uncertainty which suggests that individuals' behaiour deviates from the expected utility theory postulates. According to PT, decision making is divided into two phases: *editing* and *evaluation*. In the *editing phase* a reference point is set. Then, potential outcomes of the decision are formulated as gains or losses. Losses loom larger than gains. During the *evaluation phase* people assess the utility (value) of their decision

based on the potential probabilities of outcomes and the decision weights put on those probabilities. Therefore, the choice depends on the reference points and the perceived weighted probabilities of those outcomes.

Editing phase

The first question is of the reference points. As N. Barberis (2013) suggests, the best way to solve the question of reference points is to derive predictions under a plausible definition and then test the predictions. In this dissertation, I use consumption expectations as reference points. This is consistent with B. Koszegi and M. Rabin (2007, 2009).

Following M. Mori et al (2010), there are two alternative choice explanations. First, taking out a mortgage a household will have negative cash flows (compared to having no mortgage payments) and will experience losses of current consumption compared to pre-mortgage consumption. Second, mortgage interest rate type choice may be framed as a choice between whether or not to purchase insurance against interest rate volatility and future consumption decrease, compared to current consumption (after mortgage is taken). The differentiating factor between the alternatives is the different timing of the reference consumption. In the first case, reference consumption level is pre-mortgage consumption, in the second – consumption with mortgage already taken.

In the first case, the choice between mortgage interest rate types is framed as a choice between two types of negative prospects related with different size of the mortgage payments. Normally, higher LTFRM payments would decrease consumption more than the STFRM in the beginning. If reference point is pre-mortgage household consumption, then household would choose cheaper STFRM. In the alternative case, the concern about loss is related with potential consumption decrease in the future if the interest rate increases. If household is concerned about future consumption decrease compared to the consumption when the mortgage is already taken, higher current LTFRM payments compared to current STFRM payments are perceived as costs of insurance and not as losses, consistently with D. Kahneman and A. Tversky (1984) and E. Bowman, et al, (1997).

Due to the loss aversion phenomenon, households become risk-taking if there is a small chance to avoid losses. If the reference point is the pre-mortgage consumption, a household will seek to keep losses in the current period (just after

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taking out a mortgage) as small as possible and will neglect the risk of consumption decrease in the further future. The preferred option would be STFRM. When the reference point is consumption when the mortgage is already taken, a household will seek to keep future consumption stable – close to current consumption when mortgage is already taken – and will accept the risk to overpay. The preferred option would be LTFRM. Estimating the reasonable (perceived) price of the insurance, it is important to note, that expected gains (savings) that are less than double losses (risk of over-payment) will not outweigh losses (Levy, 2010).

The summary of the reference points, losses, and avoiding strategies is provided in the Table 3.

Table 3

Reference points, outcomes coding, and loss avoiding strategies

Reference point	Outcome coded as loss	Loss avoiding strategy
Pre-mortgage consumption	Current consumption decrease	Choose the lower mortgage payments currently (STFRM)
Consumption when the mortgage is already taken	Future consumption decrease	Choose the more stable payments (LTFRM) to insure against potential consumption decrease in the future

Source: compound by the author

Evaluation phase

Evaluation phase is for value assessment based on estimated probabilities and decision weights. For a household with the pre-mortgage consumption as the reference point, the choice outcomes are clear: LTFRM is a certain larger loss. Probability of the future consumption loss could be under-estimated based on over-confidence bias (DellaVigna, 2009). Future loss under-estimation is also consistent with irrational present-based bias (David Laibson, 1997; O'Donoghue and Rabin, 1999) or different decision weights to different periods, presuming that people, while making decision, value current consumption more than future consumption (Koszegi and Rabin, 2009). For a household with the reference point of the consumption after mortgage is already taken extra decision weight on probability of future consumption decrease should be added.

Graphical scheme of household mortgage interest rate type choice, based on the PT decision under uncertainty making, is provided in the Figure 4.

Reference point: →	Loss coding:		Probability weighting: → Valuation		Mortgage interest rate type **choice**
• Pre-mortgage consumption	• Current consumption decrease		• Expected income		
• Consumption when mortgage is already taken	• Future consumption decrease		• Expected interest rate		
			• Expected borrowing constraints		
Editing			**Evaluation**		
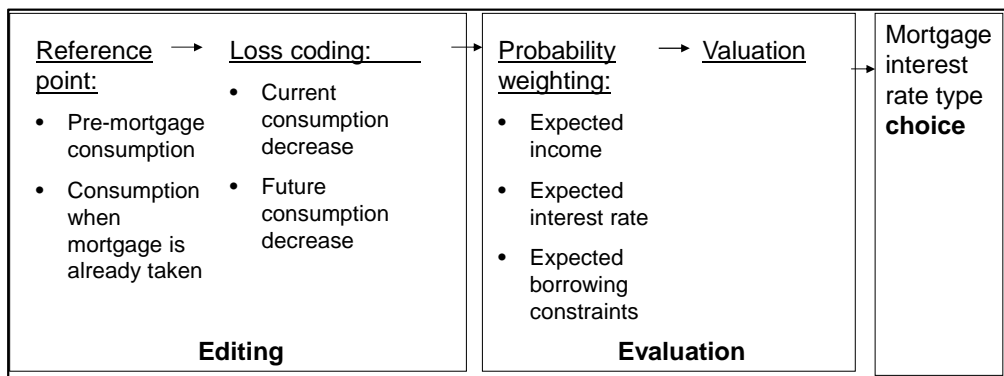
Figure 4. Household mortgage interest rate type choice decision scheme
Source: compound by the author

The behavioural approach to household decision making shows that a household who has pre-mortgage consumption level as the reference point would be seeking to keep the current consumption as high as possible. That is why the household would prefer taking on future consumption risks. Also the value estimation may be distorted by incorrect expectations and probability weighting. To manage household's choice, the first task is to differentiate households by their reference points; the second – to detect how households form expectations regarding the future consumption determinants: income, interest rate, and borrowing constraints.

2.2. Household characteristics' relationship with mortgage interest rate type choice

When deciding on a mortgage interest rate type, a household must assess its current situation and forecast future circumstances. In the normative model of the optimal mortgage choice, J. Y. Campbell and J. F. Cocco (2003) outline current constraints, future constraints, and risk aversion as the factors determining mortgage interest rate type choice. Current financial situation is relevant as it puts limits on the credit amount. The limits depend on the mortgage size and household's income. Future financial situation is relevant to assess household's ability to service the debt – to repay the loan and to pay the interest while keeping consumption at an affordable level. Here, access to credit and income volatility is relevant. Risk aversion determines the tolerance to the uncertainty.

According to the normative model, STFRM is generally attractive, also for those with current consumption constraints. In the early years, households may have high

mortgage to income ratio, however, later the ratio should decrease due to increasing income and asset value and decreasing mortgage nominal and real value. Still, J. Y. Campbell and J. F. Cocco (2003) warn that *"(h)ouseholds with large houses relative to their income, volatile labour income or high risk aversion are particularly adversely affected by the income risk of an ARM"* (p. 1489)[4] The normative model defines binding constraints as the states of the world when "high interest rates coincide with low income and house prices" (Campbell and Cocco, 2003, p. 1489). Following the definition, future borrowing constraints reflect whether the household is subject to income volatility and/ or limited access to credit. These conditions may be related both with household characteristics and market circumstances.

Based on the previous theoretical and empirical literature, I group household characteristics as factors influencing household mortgage interest rate type choice into three groups: current consumption constraints related factors, future consumption constraints related factors which can be divided into limited access to credit and volatile income factors, and risk aversion related factors.

Previous empirical research results show that current constraints are measured by various indicators, such as high mortgage balance to income (Coulibaly and Li, 2009, Bacon and Moffat, 2011), high payment to income ratios (Damen and Buyst, 2013; Ehrmann and Ziegelmeyer, 2013), current income and wealth levels (Finke et al, 2005; Bergstresser and Beshears, 2010; Ehrmann and Ziegelmeyer, 2013; Hullgren and Soederberg, 2013). Empirically tested measures of future constraints are as follows: liquidity constraints (Paiella and Pozzolo, 2007); self-reported credit constraints (Bergstresser and Beshears, 2010); income volatility measured as either a constructed variable of age, education and race (Coulibaly and Li, 2009), or as number of co-borrowers (Finke et al (2005); Ehrmann and M. Ziegelmeyer, 2013; Paiella and A. F. Pozzolo, 2007), or as amounts of savings and assets (Finke et al, 2005; Bergstresser and Beshears, 2010; Paiella and Pozzolo, 2007), or as self-certified ability to handle sudden increases in mortgage costs (Hullgren and Soederberg, 2013).

Table 4 provides the summary of the household financial, socio-demographic and behavioural characteristics used to measure current and future consumption constraints and risk aversion.

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[4]ARM meansadjustable rate mortgage and may be used as equivalent to STFRM

Table 4

Empirical research measurement indicators of household characteristics influencing household mortgage interest rate type choice

Characteristics		Measurement indicators	Authors
Current consumption constraints		Mortgage balance to household income ratio, level of income, mortgage payment to income, , earnings vs expenditure	Coulibaly and Li, 2009; Ehrmann and Ziegelmeyer, 2013; Bergstresser and Beshears, 2010; Bacon and Moffat, 2011; Hullgren and Soederberg, 2013; Finke et al, 2005; Johnson and Li 2011; Paiella and Pozzolo, 2007; Damen and Buyst, 2013
Future consumption constraints	Limited access to credit	Loan to value ratio, mortgage maturity, net worth, total household non-housing debt to income, rolling credit card balance, size of advance, being turned down for credit or past due on debt	Bacon and Moffat, 2011; Coulibaly and Li, 2009; Finke et al, 2005; Paiella and Pozzolo, 2007; Johnson and Li, 2011; Bergstresser and Beshears, 2010; Damen and Buyst, 2013
	Income volatility	Self reported; ability to handle sudden increases in mortgage costs, age, race, and education; working in the public sector; slope of income growth; whether a borrower is unemployed, self-employed, or subject to a temporary contract; size of the household, number of income earners	Coulibaly and Li, 2009; Damen and Buyst, 2013; Ehrmann and Ziegelmeyer, 2013; Paiella and Pozzolo, 2007; Bergstresser and Beshears, 2010; Hullgren and Soederberg, 2013; Finke et al, 2005; Johnson and Li, 2011
Risk aversion		Self-reported, whether households directly hold stocks; education; reported life expectancy (optimism); whether a household is a first time buyer; attitudes towards debt	Coulibaly and Li, 2009; Ehrmann and Ziegelmeyer, 2013; Bergstresser and Beshears, 2010; Hullgren and Soederberg, 2013, Bacon and Moffat, 2011; Johnson and Li, 2011).

Source: compound by the author

The Table 4 classifies current income and consumption related factors as current consumption constraints. Debt level related indicators which determine access to credit in the future and income volatility related indicators are classified as future constraints. Future constraints increases household's vulnerability to the risk of the future interest rate shocks. However, based on behavioural explanations, future constraints can be neglected if current constraints are relevant.

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2.3. Market conditions' relationship with household mortgage interest rate type choice

Following the household mortgage interest rate type choice decision making procedure presented in the Section 2.2, household should employ probabilistic thinking regarding the future circumstances. Not only household characteristics influence expectations of the future consumption (constraints), but also market conditions. The literature review presented in the Section 1.3 outlines housing price trends, general income trends, inflation level and volatility, and interest rate indicators as market conditions influencing household mortgage interest rate type choice (Baesel and Biger, 1980; Statman, 1982; Alm and Follain, 1987, Koijen et al, 2009).

According to the optimal mortgage interest rate type choice literature, a better macroeconomic environment encourages households to accept the payment risk inherent in STFRM (Goldberg and Heuson, 1995, Sa-Aadu and Sirmans, 1995). House price growth is also positively related with macroeconomic situation (Furlong and Takhtamanova, 2012). Increasing housing prices would decrease household debt levels (loan to value ratio) and loan service burden (payment to income ratio) even if the loan balance or nominal monthly instalment is not decreasing.

High inflation and high short term interest rate should decrease demand of LTFRM as households might expect decrease of inflation and interest rates in the future (Campbell, 2006). Mortgage pricing variables and especially interest rate differential are found to be of the strongest explanatory variables of the mortgage interest rate type choice (Dhillon et al, 1987; Brueckner and Follain, 1988). The differential might be perceived as a difference in costs of alternative mortgage types or a signal of future interest rate increase. Based on previous empirical research results, households prefer STFRM when the differential is high.

Table 5 provides a summary of market indicators used to test market conditions influence on household mortgage interest rate type choice.

Table 5

Empirical research measurement indicators of market conditions influencing household mortgage interest rate type choice

Conditions	Measurement indicators	Authors
General income	GDP, unemployment	Ehrmann and Ziegelmeyer, 2013, Goldberg and Heuson, 1995
Housing price	Current housing price developments, mortgage portfolio growth	Campbell and Cocco, 2011; Jones et al, 1995; Leece, 2000, Furlong and Takhtamanova (2012),
Inflation/ Interest rate indicators	Inflation level, inflation volatility	MacDonald and Winson-Geideman, 2012; Badarinza et al 2011; Campbell, 2013,
	Level of short term interest rates	Leece, 2000; Vickery, 2007;
	Gap between short term and long term interest rates, bond risk premium, inflation risk premium, real rate risk premium	Badarinza et al 2011; Campbell, 2013, Koijen et al, 2009; Ehrmann,. Ziegelmeyer, 2013; Moench et al 2010

Source: compound by the author

The Table 5 classifies market conditions indicators in the following way: income related conditions influence future income expectations; housing price related conditions – future housing price expectations; interest rate level indicators and inflation – future interest rate expectations. All these expectations are relevant for household future consumption constraints assessment.

A. Fuster et al (2011) argue that choosing the right model to forecast an economic time series is a trivial task. People tend to make forecasts based on statistical or mental models that are reasonable given the data available to them, but too simplistic to fully capture the long-term dynamics of many economic time-series. Based on the normative predictions, households should form rational expectations. Behavioural approach assumes that households have bounded rationality. A. Tversky and D. Kahneman (1974) describe overweighting of information that is available and representative. M. Rabin (2002) models the biased mean-reverting belief ("gambler's fallacy") and trending (over-inference) belief. R. Shiller (2005) points out the lure of "new era" stories. C. M. Reinhart and K. S. Rogoff (2009) document incorrect belief that "this time is different". Due to the reason that predicting future market conditions is very complicated, the conceptual model is aimed to indicate what market conditions encourage the choice of a more volatile STFRM rather than to assess when households do make incorrect expectations.

2.4. Developing the conceptual model for household mortgage interest rate type choice management by financial institution

As discussed in the previous sections, theoretical research on mortgage interest rate type choice describes optimal choice under certain conditions: household characteristics and market conditions. Empirical research presents evidence of the sub-optimal household behaviour. Behavioural approach admits that households may be prone to systematic and predictable biases in how they interpret relevant financial information and how they make mortgage interest rate type choices.

Based on the discussion presented in the previous sections, Figure 5 provides the graphic presentation of the household mortgage interest rate type choice management model.
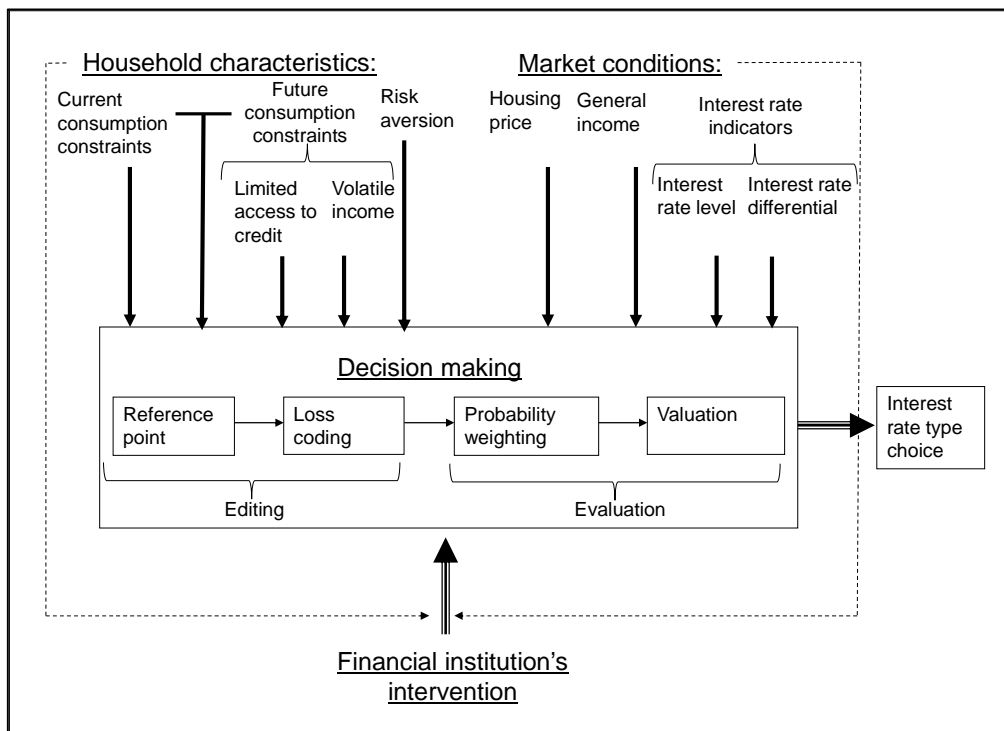
Figure 5. Household mortgage interest rate type choice and its management
Source: compound by the author

Factors influencing household decision are taken from the normative models of household optimal mortgage interest rate type choice. Based on the discussion presented in the Section 2.2, household characteristics define household's current consumption constraints, future consumption constraints, and risk aversion. Market

conditions such as housing price, general income, and interest rate indicators influence household expectations formation. There is ample empirical evidence that households' behaviour deviates from the normative predictions, thus, there should be a plausible alternative explanation of what is the effect of household characteristics and market conditions on household mortgage interest rate type choice.

Household characteristics

Based on the discussion presented in the Section 2.3, household characteristics are related with the three constraint groups: current consumption constraints, future consumption constraints, and risk aversion. The discussion of the impact of these influencing factors is provided below.

Current consumption constraints

Based on the normative predictions, currently constrained households are better off with lower mortgage payments of STFRM compared to LTFRM. According to the theories of life cycle, permanent income, and economic growth, increasing income and increasing asset prices during the mortgage contract period should eliminate consumption constraints in the future. However, in cases when constraints are binding or households are risk averse, they should choose LTFRM.

In this dissertation, I base predictions on the behavioural theories and assume that currently constrained household's reference point is pre-mortgage consumption level. The assumption is plausible given the empirical evidence of the positive relationship between current constraints and STFRM choice (Finke et al, 2005; Coulibaly and Li, 2009; Ehrmann and Ziegelmeyer, 2013, Hullgren and Soederberg, 2013). The assumption that constrained households are sensitive to current consumption decreases is also consistent with other research in the borrowing domain. For instance, D. B. Gross and N. S. Souleles (2001) find that increases in credit limits generate an immediate and significant rise in debt. The marginal propensity to consume out of liquidity is largest for people starting near their limit. Based on the latter, I assume that consumption constrained households would always prefer STFRM.

This raises Hypothesis 1:

H1. Households with current consumption constraints prefer STFRM

Although the normative predictions and behavioural predictions coincide, the rationale is different. Based on the normative predictions, consumption constrained households optimize their consumption choosing lower mortgage payments as they expect income and asset value growth in the future and no future consumption constraints. If they had future consumption constraints or high risk aversion, they should opt for LTFRM. Based on the behavioural predictions, the main assumption of this hypothesis is that currently constrained households neglect their future constraints and prefer lower initial payments. If households with current consumption constraints prefer LTFRM, behavioural theory would explain it by the different reference point of those households, i.e. current consumption and not the pre-mortgage consumption.

Future consumption constraints

It is very difficult or even impossible to forecast future events. Yet, certain current conditions signal about higher household's sensitivity to negative events such as interest rate shocks. As proposed in the normative model of the optimal mortgage interest rate type choice, these conditions include debt levels which *limit access to credit* and *volatile income*. High debt levels decrease access to credit. If faced with random liquidity needs due to interest rate shocks, these households would have fewer opportunities to borrow more and to smooth their consumption. Volatile income increases probability that increasing interest rate will coincide with decreasing income. Based on the normative model, households with future consumption constraints should choose LTFRM to hedge against interest rate increase.

Based on the behavioural theories, the decision to hedge or not to hedge against mortgage interest rate increase depends on household reference point (Bowman et al, 1999). If pre-mortgage consumption is set as reference point, households would be concerned only about current consumption. As explained and substantiated previously, I assume that households with current consumption constraints set pre-mortgage consumption as the reference point and try to keep the current consumption as high as possible, neglecting future risks.

Different explanations of the normative and behavioural theories raise competing hypotheses:

> *H2A. Households with future consumption constraints prefer LTFRM*
>
> and
>
> *H2B Households with current consumption constraints and future constraints prefer STFRM*

As future constraints are identified as two sets of constraints: (1) limited access to credit and (2) volatile income, I split the hypotheses *H2A* and *H2B* into two sets of sub-hypotheses:

> *H2A1 Households with limited access to credit prefer LTFRM*
>
> *H2B1. Households with current consumption constraints and limited access to credit prefer STFRM*
>
> and
>
> *H2A2 Households with volatile income prefer LTFRM*
>
> *H2B2 Households with current consumption constraints and volatile income prefer STFRM*

Hypotheses *H2A1* and *H2A2* test the normative model by J. Y. Campbell and J. F. Cocco (2003) predictions. Hypotheses *H2B1* and *H2B2* test the proposed behavioural model predictions. Adjusted by the joint effect of current and future consumption constraints, the behavioural predictions are opposite to the normative predictions. The predictions of future risk negligence are consistent with behavioural research on over-excessive and over-optimistic borrowing, and narrow focusing only on monthly payments in making credit decisions (Bertrand and Morse, 2011; Iossa and Palumbo, 2010; Elienhausen, 2010; Prelec and Loewenstein, 1998).

If future consumption constraints prove to be positively related with the probability of STFRM choice, the correction of households' behaviour is needed. Otherwise, if predictions of the normative model are confirmed, then it means that households behave optimally.

Risk aversion

As stated in the Section 1.3.1, unstable monthly mortgage payments are the source of financial risk. There are much more determinants of risk aversion than levels of income and wealth. Attitudes towards risk are formed by various other factors which incentivize households to reduce financial risk exposure. The

normative predictions admit that risk averse households should opt for LTFRM which stabilizes monthly mortgage payments.

This raises Hypothesis 3:

H3. Households with high risk aversion prefer LTFRM

According to the behavioural predictions, aversion to uncertainty implies that households set future consumption as their reference point and try to decrease probability of losses in the future by hedging against those losses even when it decreases current consumption (Bowman et al, 1999).

In general, according to the predictions of the normative model (Campbell and Cocco, 2003), households should opt for STFRM unless they have future consumption constraints; according to the proposed conceptual model based on behavioural predictions, households who have current consumption constraints would opt for STFRM despite future consumption constraints. Table 6 provides the measurement indicators of the household characteristics and their expected influence by the normative theory (Campbell and Cocco, 2003), the previous empirical evidence, and the influence of household characteristics proposed by the conceptual model developed in this dissertation.

Table 6

Household characteristics influence on STFRM choice
(STFRM = 1)

Household characteristic	Indicator	Campbell and Cocco (2003)	Empirical evidence	Proposed model*
Current consumption constraints	Mortgage to income ratio	+	+ Ehrmann and Ziegelmeyer, 2013; Hullgren and Soederberg, 2013)	+
			- Damen and Buyst, 2013	
Future consumption constraints	Limited access to credit	-	+ Coulibaly and LI, 2009; Bacon and Moffat, 2011; Damen and Buyst, 2013	+
	Volatile income	-	+ Finke et al, 2005	+
			- Coulibaly and LI, 2009, Dhillon et al, 1987	
Risk aversion	Attitudes towards risk	-	- Bergstresser and Beshears, 2010; Coulibaly and Li, 2009; Paiella and Pozzolo, 2007. +Leece, 2008; Mori et al, 2011	-

*Under current consumption constraints
Source: compound by the author

Empirical evidence from behavioural research supports the proposed behavioural hypotheses. Future borrowing constraints neglect is explained by behavioural biases: myopia (Damen and Buyst, 2013; Zocchi, 2011); lack of financial sophistication (Fornero, Monticone, Trucchi, 2011; Gerardi, Rosen, and Willen; 2010; Bucks and Pence, 2006), or over-optimism (Agarwall et al, 2009; Campbell et al, 2010).

Market conditions

Based on the discussion presented in the Section 2.3, market conditions are important for household expectations' formation. Household expectations influence assessment of the future consumption constraints. Among the market conditions that are important for the optimal mortgage interest rate type choice, the previous literature mentions house prices (Tucker, 1989; Furlong and Takhtamanova, 2012), unemployment (Goldberg and Heuson, 1992), inflation (MacDonald and Winson-Geideman, 2012), interest rate level (Jones et al, 1995; Leece, 2001; Vickery, 2007), and interest rate differentials (Coulibaly and LI, 2009; Koijen et al, 2009; Moench et al, 2010; Badarinza et al, 2014). These market conditions can be grouped into three groups according to the expectations they influence: conditions influencing housing price expectations; conditions influencing income expectations; conditions influencing interest rate expectations. The discussion of the impact of market conditions on the expectations and the household mortgage interest rate type choice is provided below.

House price expectations

Increasing housing prices would decrease household debt levels (loan to value ratio). According to the previous research, households form extrapolative expectations. House price growth decreases the perceived probability of future consumption constraints and increases the probability of STFRM choice (Furlong and Takhtamanova, 2012).

This raises Hypothesis 4.

H4. Increasing housing prices increase household demand of STFRM

On the other hand, expectations of growing housing prices increase willingness to borrow even financially constrained households that cannot afford a more stable

interest rate type (Sa-Aadu and Sirmans, 1995). If beliefs or expectations are incorrect, constrained households will become over-exposed to the risks.

Income expectations

Systemic income expectations are related with macroeconomic trends – general economic situation, unemployment, wages and salaries. When income is expected to grow, lower future ratio of mortgage payments relative to income can also be expected. The hypothesis is consistent with the findings of L. G. Goldberg and A. J. Heuson (1995) who find high unemployment to be negatively related with the STFRM demand and supply.

This raises Hypothesis 5.

H5. Increasing income increases household demand of STFRM

On the other hand, increasing income weakens beliefs of the future consumption constraints. Households have fewer incentives to save what increases the likelihood of volatile consumption in the future. If the expectations are not fulfilled, constrained households would become over-exposed to the interest rate risks.

Interest rate expectations

Concerning interest rates, normative theories propose that STFRMs should be preferred by the vast majority of households as LTFRMs are more expensive due to risk premium. Naturally, when households expect interest rate to increase they should consider hedging against that increase. On the other hand, if they do not expect interest rate to increase or if they expect interest rate to decrease, they would not choose to fix interest for longer term, especially at a high current level.

This leads to Hypothesis 6.

H6. High interest rates decrease household demand of LTFRM

The previous research is based on two indicators relevant for interest rate expectations – the level of the interest rates and the differential. Then, it is appropriate to split the Hypothesis 6 into two sub-hypotheses.

As high interest rate level is a consequence of high inflation, sometimes for the expectations of the interest rate levels, inflation levels are used (Campbell, 2006). The empirical evidence of high interest rate or inflation level is controversial. Some authors state that high interest rate (or inflation) level increases the demand of

STFRM as households form regressive expectations (Vickery, 2007; Leece, 2001; Jones, 1995). Others find that high interest rate level decreases the demand of STFRM as households form extrapolative expectations (Dhillon et al, 1987). From the behavioural point of view, households may have both mean-reverting and extrapolative expectations (Rabin, 2002, Barberis, Shleifer, Vishny, 1998). Testing the relationship will help to understand the principles of household expectations formation. Based on the evidence of J. Vickery (2007); D. Leece (2001) and S. T. Jones et al (1995), I assume that households form mean-reverting expectations for high inflation rate and opt for STFRM. This leads to Sub-hypothesis 6.1.

H61. High STFRM interest rate level increases household demand of STFRM

Household choice also depends on the price of the insurance against the interest rate shocks. Existing literature shows that interest rate differential has a positive influence on STFRM demand (Badarinza et al, 2013; Moench et al, 2010; Brueckner and Follain, 1998). But the interpretation is different: some authors claim that households are able to exploit price inefficiencies (Koijen et al, 2009). Others admit that households may short-sightedly consider the spread as the price differential between two options (Leece, 2008). Based on the previous empirical evidence, I assume that households make mean-reverting interest rate expectations for high interest rate differential levels or behave myopically and choose STFRM.

This leads to Sub-hypothesis 6.2.

H62. Large interest rate differentials increase household demand of STFRM

There are several options to evaluate the interest rate differential. One of them is straight-forward – to compare interest rates of LTFRM and STFRM. Other are more sophisticated and require households to be able to compare long term interest rate to some other measures – bond yields (Brueckner and Follain, 1998), inflation expectations, real interest rate expectations, or historical averages of interest rate (Koijen et al, 2009). There is a debate in the household finance literature on the degree of financial sophistication of households (Campbell, 2006). A more sophisticated interest rate differential analysis requires the ability of households to calculate bond risk premia, inflation risk premia, or real rate risk premia. However, R. Koijen et al (2009) show that a simple model (rule-of-thumb) approximates bond risk premia as the difference between the long-term nominal interest rate and a

backward-looking average of short-term nominal interest rate. This estimate is slightly different from the straight-forward LTFRM-STFRM differential and requires a more sophisticated solution. However it is still easy to compute – requires only calculation of an average short term interest rate over the recent past. The authors find that this indicator is strong predictor of STFRM demand.

Table 7 provides the market characteristics and their expected influence on STFRM choice.

Market characteristics and their influence on STFRM choice
(STFRM = 1)

Market characteristic	Indicators	Expected influence	Previous empirical evidence
Housing price	Housing price	+	+Tucker, 1989; Furlong and Takhtamanova, 2012
General income	Increasing labour income/ unemployment level (inverse)	+	+ Goldberg and Heuson, 1992
Interest rate indicators	Interest rate/inflation level	+	+Vickery, 2007; Leece, 2001; Jones et al, 1995
			- Dhillon et al, 1987
	Interest rate differentials	+	Badarinza et al, 2013; Moench et al, 2010; Koijen et al, 2009

Source: compound by the author

The behavioural approach to market conditions' influence implies that households may have non-rational expectations. According to over-inference bias, households may form extrapolative expectations. This principle is assumed for the hypotheses *H4* and *H5* formulation. Based on the behavioural research, households tend to make extrapolative expectations for the long sequence of observations (Barberis, Shleifer, and Vishny, 1998). From the individual household point of view, changes in housing prices, general situation related income, such as labour income, are slow compared to the fluctuations in stock markets or interest rate markets. Thus, extrapolative expectations should be more common for housing prices and general income.

Hypothesis of interest rate indicators H6 (*H61* and *H62*) is based on the mean-reverting expectations Formulation of the sub-hypothesis *H61* is consistent with the

"gambler's fallacy" (Rabin, 2002) and consistent with the over-optimism bias which also causes wishful thinking of the currently constrained households (Gross and Souleles, 2001; Bowman et al, 1995). Sub-hypothesis *H62* is consistent with the approach that households try to minimize their costs. Deeper analysis of the differentials' strength (whether it is a straight-forward LTFRM-STFRM differential or more sophisticated differentials) would help to explain if households attempt to exploit pricing inefficiencies.

Financial institution's intervention

Should a financial institution care about household's choice? The primary problem is one of incentives. As presented in the Section 1.5, for a financial institution, household's over-exposure to interest rate incurs credit risk. In turn, credit risk increases reputation risk for the institution. Based on the proposed model, by measuring household characteristics financial institution can predict household's reference points, decision weights, and the likelihood of the sub-optimal choice if not prevented.

The goal of the household mortgage interest rate choice management for a financial institution is to decrease household risk over-exposure and probability of default or arrears due to interest rate increase. Being able to identify households who are prone to choose a risky STFRM despite their sensitivity to interest rate volatility, a financial institution might influence or correct household's choice. Market conditions should also be considered, as the probability of risky choice depends on market conditions making STFRM more attractive.

2.5. Methods for the conceptual model testing

Mortgage interest rate type choice is a decision under uncertainty and reveals household's attitude towards risk. Researchers have followed two approaches to measure household risk attitudes. The first is based on a revealed preference strategy that infers risk aversion from the financial data or natural experiments. The second relies on the elicitation of risk preferences from respondent's answers to specific survey questionnaires or behaviours in lab (Guiso and Sodini, 2012).

Most of the empirical research of household mortgage interest rate type choice could be ascribed to the revealed preference strategy as it analyses actual financial behaviour of the mortgage takers. To the best of my knowledge, there was at least

one attempt to perform an experiment (Mori et al, 2010) and to validate loss aversion in mortgage interest rate type choice decision. The authors argue that controlled experiments are powerful tools for collecting evidence of causality because they offer an opportunity to isolate the impact of key explanatory variables and control for any influence of exogenous factors.

Regardless of such advantages of controlled experiments, the approach is often criticized as being unrealistic. P. M. Bacon and P. G. Moffat (2010) argue that analysing field data can be ascribed to the natural experiment that reveals behaviour of real mortgage takers in a natural environment. The authors outline that subjects are completely unaware that they are participating in an experiment; the subject pool consists entirely of ordinary individuals purchasing a mortgage; the commodity is real and purchased under normal economic conditions; information regarding choices is freely available; the choice itself is at the complete discretion of the subject who is normally unhindered by time constraints; the task requires no former experience and is salient of the incentives.

Based on the above arguments, I choose field data analysis to test the conceptual model. Although decision under uncertainty and loss aversion research have deep roots and require mental or psychological explanation, there are numerous empirical researches on confirmation of loss aversion from the market data (Mehra and Prescott, 1985; Benartzi and Thaler 1995, Hardie et al. 1993, Dunn 1996, Camerer et al. 1997, Pennings and Smidts 2003; Goette et al. 2004).

Other authors analysing household mortgage choice also use field data: time-series lending statistics (Jones et al 1995; Moench et al, 2010; Badarinza et al, 2013), lenders' financial data about households and their mortgages (Dhillon et al, 1987; Bacon and Moffat, 2010; Cox et al, 2011); Consumer Finance Surveys (or analogous surveys) with household financial data and specific questions about household risk aversion or expectations (Coulibaly and Li, 2009; Bergstresser and Beshears, 2010; Ehrmann and Ziegelmeyer, 2013; Zocchi, 2013). However, the main drawback of these specific or *what if* questions (self-certified risk aversion, self-certified borrowing constraints, or self-certified expectations about interest rate risk) is that the validity rests on the assumption that households report their truthful choices (Guiso and Sodini, 2012).

To test the conceptual model, it is necessary to identify the relationship between mortgage interest rate type choice and various influencing factors. Previous empirical research can be divided into whether the goal is to examine household characteristics' influence (Finke et al, 2005; Bergstresser and Beshears, 2010; Cox et al, 2011; Ehrmann and Ziegelmeyer, 2013; Hullgren and Soederberg, 2013), household characteristics' together with pricing influence (Dhillon et al, 1987; Brueckner and Follain, 1989; Vickery, 2006; Paiella and Pozzolo, 2007; Coulibaly and Li, 2009; Bacon and Moffat, 2010; Damen and Buyst, 2013; Zocchi, 2013); or market characteristics' influence (Badarinza et al, 2013; Damen and Buyst, 2013; Koijen et al, 2009, Moench et al, 2010). Based on the research object, different estimation methods are used. If the research object is the probability of STFRM (LTFRM) choice influenced by various factors, logit, probit or OLS methods are used. If the object is the share of STFRM in the new lending volumes influenced by various factors, OLS or non-linear least squares methods are used.

Based on the goals of the current research, I have chosen to examine separately household characteristics influence and market characteristics influence. Using only survey micro-level data to judge on the impact of market characteristics would be inaccurate, mostly due to the problem of inertia. For instance, it may take time for banks to shift their strategies towards mortgage forms that they think will have greater customer appeal under current market conditions. Households may also be slow to respond to movements in rates if they tend to copy other households who have taken out mortgages recently, or simply if their expectations adjust gradually over time (Ehrmann and Ziegelmeyer, 2013). However, using time-series data alone, there is a threat to overestimate the rich households who take large mortgages, though are not consumption constrained and do not expose themselves to significant consumption decrease risks.

Table 8 provides summary of the research methods of the previous research.

Table 8

Summary of the empirical research methods used to measure household characteristics and market conditions' influence on mortgage interest rate type choice

Method	Authors
Approach	
Revealed preferences	Brueckner and Follain, 1989; Coulibaly and Li, 2009; Bergstresser and Beshears, 2010; Damen and Buyst, 2013; Ehrmann and Ziegelmeyer, 2013; Hullgren and Soederberg, 2013; Cox et al, 2011; Bacon and Moffat, 2011; Damen and Buyst, 2013.
Elicitation of preferences	Mori et al, 2009.
Research object	
Household characteristics (cross-sectional)	Finke et al, 2005; Bergstresser and Beshears, 2010; Cox et al, 2011; Ehrmann and Ziegelmeyer, 2013; Hullgren and Soederberg, 2013.
Household characteristics and pricing (cross-sectional)	Dhillon et al, 1987; Brueckner and Follain, 1989; Vickery, 2006; Paiella and Pozzolo, 2007; Coulibaly and Li, 2009; Bacon and Moffat, 2010; Damen and Buyst, 2013; Zocchi, 2013.
Share of STFRM in the new lending volume (time- series)	Koijen et al, 2009, Moench et al, 2010; Badarinza et al, 2013; Damen and Buyst, 2013
Estimation model: for cross-sectional data	
OLS	Dhillon et al, 1987; Brueckner and Follain, 1989; Bergstresser and Beshears, 2010.
Probit	Bergstresser and Beshears, 2010; Ehrmann and Ziegelmeyer, 2013.
Logit	Coulibaly and Li, 2009; Cox et al, 2011; Damen and Buyst, 2013; Hullgren and Soederberg, 2013
Estimation model: for time-series data	
OLS, non-linear least squares	Jones et al, 1995; Koijen et al, 2009; Moench et al, 2010

Source: compound by the author

As shown in the table, empirical research on household characteristics influence mainly consists of binary choice models: logit (Hullgren and Soederberg, 2013; Coulibaly and Li, 2009; Damen and Buyst, 2013, Cox et al, 2011), or probit (Dhillon et al, 1987; Brueckner and Follain, 1989; Ehrmann and Ziegelmeyer, 2013). For dichotomous dependent variable using logit or probit models is usual. The logit function is similar to the probit, but has thinner tails than the normal distribution. Despite the similarity of logit and probit models, there are two practical advantages of the logit model: simplicity and interpretability.

Based on previous research, I have chosen to analyse field data as it reveals truthful household choices. For household characteristics' influence, cross-sectional household's financial data should be used, for market characteristics – time-series data of the variation of the STFRM share in the new lending. Two data sets are needed to measure market characteristics' influence more accurately as from the household level data alone, problem of inertia arises.

In the dissertation, the research of household characteristics impact influence is also based on a binary choice, the situation of a dichotomous dependent variable. Thus, for the *H1, H2A (H2A1, H2A2), H2B (H2B1, H2B2)*, and *H3* I have chosen to use logit function.

For market characteristics' influence analysis linear or non-linear least squares regression models are used (Jones et al 1995; Koijen et al, 2009; Moench et al, 2010) as the dependent variable – the share of STFRM in new the new lending volumes is of a metric measuring scale. By construction, the share of STFRM is bounded between zero and one, thus, robustness of the results is checked by Tobit (Moench et al, 2010). According to this rationale, for the *H4, H5, H61,* and *H62* hypotheses testing I have chosen Tobit function testing.

The proposed conceptual model and its testing methodology can be summarized in the following way:

- *The conceptual model is novel as it couples behavioural approach based household decision making and influencing factors outlined in the normative literature. The model provides alternative explanation of factors' influence on mortgage interest rate type choice, suggests different effects than normative models, and predicts household behaviour deviations from the normative recommendations.*

- *At the core of the model is decision making under uncertainty based PT, according to which household decision depends on household's reference points, based on which outcomes of the decision are coded as gains or losses.*

- *According to PT postulates, household seeks to avoid losses. If household reference point is pre-mortgage consumption, household would choose a STFRM which requires lower payments in the beginning of the contract. If household reference point is consumption when mortgage is already taken, household would choose LTFRM as it lowers the probability of the future consumption decrease.*

- *Based on the previously reviewed literature, the model assumes that household with current consumption constraints set pre-mortgage consumption as reference point and thus should prefer STFRM.*

- *Difference between normative predictions and behavioural explanation is that according to normative predictions, currently constrained households should opt for STFRM unless they have future consumption constraints. According to behavioural predictions, currently constrained households would choose STFRM and neglect future consumption constraints due to various biases.*

- *Market characteristics are important for expectations formation. Based on the previous research, under the certain market characteristics – increasing housing prices, increasing general income, high interest rate levels, and large interest rate differentials – STFRM becomes more attractive.*

- *Differently from normative predictions, behavioural approach assumes that households may form non-rational expectations. Due to the limited*

information or cognitive limitations, households are prone to incorrectly over-infer or revert to the mean.

- *Financial institutions should determine households with characteristics unreasonably encouraging STFRM choice and be especially cautious under market conditions which make STFRM more attractive to prevent household sub-optimal choice by influencing or correcting household's decision.*

- *To test the model, field data is appropriate data. Household characteristics influence should be measured by cross-sectional data on individual households, market characteristics influence – by time-series data on the variation of the share of STFRM in the new lending volumes.*

3. EMPIRICAL TESTING OF THE CONCEPTUAL MODEL OF MORTGAGE INTEREST RATE TYPE CHOICE MANAGEMENT IN THE LITHUANIAN MORTGAGE MARKET

Empirical testing of the conceptual model of household mortgage interest rate type choice management is based on the hypotheses outlined in the Section 2.4. I have chosen Lithuanian market for the model testing. Research in this market is important in two aspects. Lithuanian mortgage market, a representative of emerging market, is characterized by binding consumption constraints – pre-conditions helping to measure impact of future constraints on household mortgage interest rate type choice. This approach is consistent with the most recent mortgage interest rate type choice research trend which focuses on the analysis of the situation in different countries and seeks to measure the effect of different economic and institutional background. The second aspect is of the practical value – it is important to detect behaviour deviations from the optimal choice recommendations in an emerging market where households are more vulnerable to their financial mistakes. Mortgage markets in these countries are rapidly developing, thus, it is still possible to prevent major mistakes.

In this part of the dissertation I present the results of the empirical testing of the theoretical model. In the first section, I describe the institutional background of Lithuanian mortgage market. In the second section, I present the sample data and discuss its limitations. In the third, I present and describe measurement indicators (variables). The fourth section provides results of the empirical tests, the fifth – discusses the results. The part of the empirical testing of the theoretical model concludes with managerial implications for financial institutions in the current market.

3.1. Institutional and economic background of the empirical research

The research is conducted in the Lithuanian mortgage market. The decision to take a mortgage in this market exposes household to more significant risks than in a mature economy characterized by a more stable institutional setting. Lithuania is characterized as an emerging, small and open economy, characterized by volatile income and housing prices and diverging interest rate and income trends. Thus, the research contributes to the literature of household mortgage interest rate type choice in different countries.

Lithuanian mortgage market is affected by wide *macroeconomic fluctuations* which are characteristic to emerging economies. During 2004-2013, the country experienced full economy cycle: growth (2004-2006, boom in 2007, bust in 2009, and to gradual revival in 2010-2013 (see Figure 6).
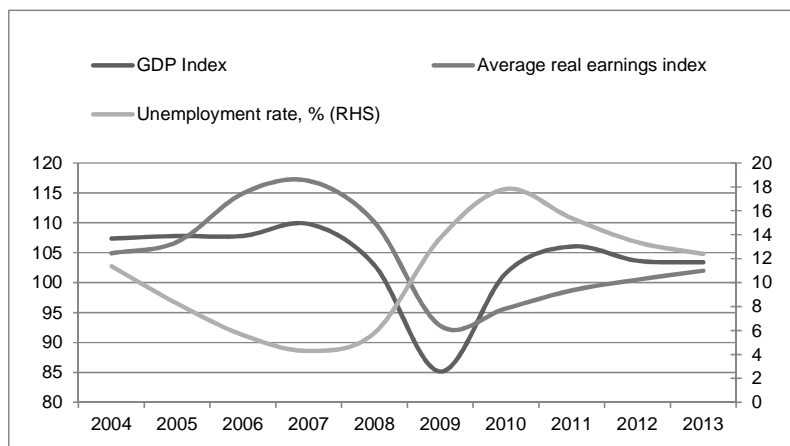
Figure 6. GDP, real earnings, and unemployment in Lithuania 2004-2013
Source: Statistics Lithuania

GDP development is directly related to households' income and wealth. Figure 6 shows that income decline (the length of the real earnings curve below the 100th partition) lasted longer than GDP decline.

In the Lithuanian mortgage market, both level and *volatility* of EURIBOR (for loans in Euro) and VILIBOR (for loans in Litas) *interest rates* are relevant. These measures make the base for the mortgage interest rates. Theoretically, due to fixed exchange rate, there should be no significant difference between the same maturity VILIBOR and EURIBOR. However, VILIBOR is more volatile than EURIBOR. There is a spread between VILIBOR and EURIBOR that varies (see Figure 7). The factors that have the strongest relationship with VILIBOR and EURIBOR spread fluctuation represent international, regional and domestic risk levels (Lapinskas, 2011).
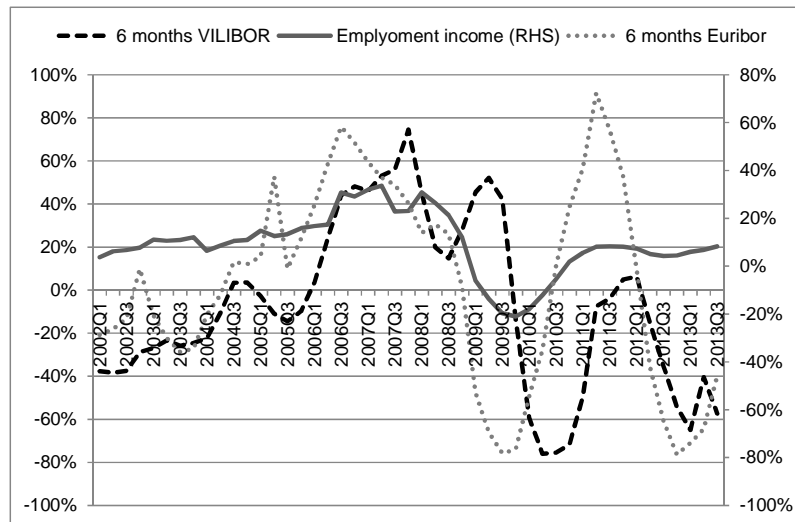
Figure 7 Annual change of interest rates and labour income in Lithuania 2002-2013
(in percent)
Source: Statistics Lithuania, Bank of Lithuania, European Banking Federation

Not only interest rates or their volatility is important, but also covariance with income. Figure 7 also shows that there are periods (e.g. throughout the year 2009) when income decrease coincides with the interest rate (VILIBOR) increase, or when the interest rate grow faster than earnings (e.g. in 2006–2008 and 2010–2012). Household with STFRM is sensitive to this type of divergence, especially if income is low income and mortgage payments are high compared to income.

Demand and supply in the *housing market* are influenced by economic conditions. Economic fluctuations pro-cyclically impact housing prices. Based on the data of *Ober-Haus Real estate*, housing prices experienced huge swing. From 2004 to 2008 prices, grew by 365 percent, then declined by 42 percent at the end of 2009, and fluctuates at that level for 4 consequent years. Housing price development patterns are closely related with labour income development, which means that decreasing income is followed by decreasing housing values.
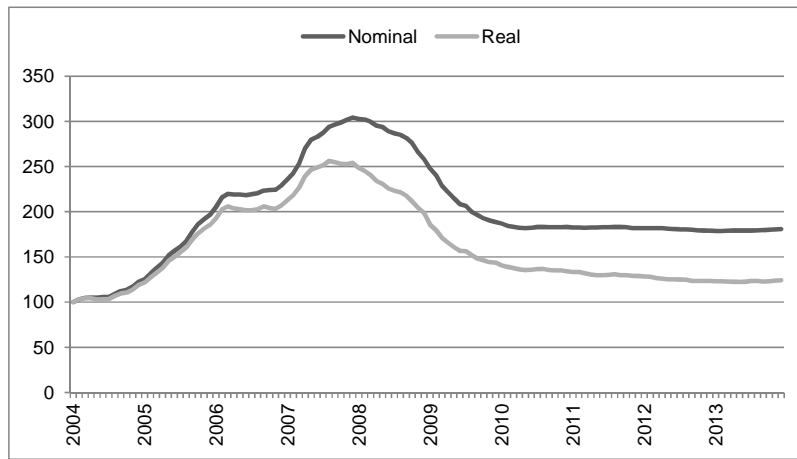
Figure 8. Lithuanian Housing Price Dynamics 2000-2013
Source *Ober-haus Real Estate Advisors,* January 2004 = 100

During the last ten years, Lithuanian *mortgage market* demonstrated tremendous growth. Starting from the level of 2 bn Litas at the beginning of 2004, the portfolio grew almost 8-fold to the level of 23 bn Litas at the end of 2008. Since then a gradual mortgage portfolio contraction continues (see Figure 9). Rapid growth of loan portfolio was determined by several inter-linked factors. Cheap funding enabled financial institutions to lower interest rates. Increasing household income resulted in increasing housing demand. Mortgage loans are considered less risky than other loans. This consideration allowed financial institutions to soften credit requirements. In such environment of optimistic expectations, real estate prices were also growing. That resulted in larger mortgage loans, increasing competition between mortgage providers, aggressive marketing and nurturing expectations of further housing price increase. All the same determinants but in opposite direction caused stopped mortgage loan portfolio growth in 2009-2012 (Kuodis and Ramanauskas, 2011). Increased risk appetite both of mortgage providers and of mortgage takers brought negative consequences – impaired mortgage loan portfolio quality. Based on the Bank of Lithuania statistics, the share of non-performing mortgage loans grew 15-fold from 0.6 percent in 2007 to the peak 8.8 percent in 2011. Up to the end of the year 2013, the share of non-performing mortgage loans has lowered to 7 percent.
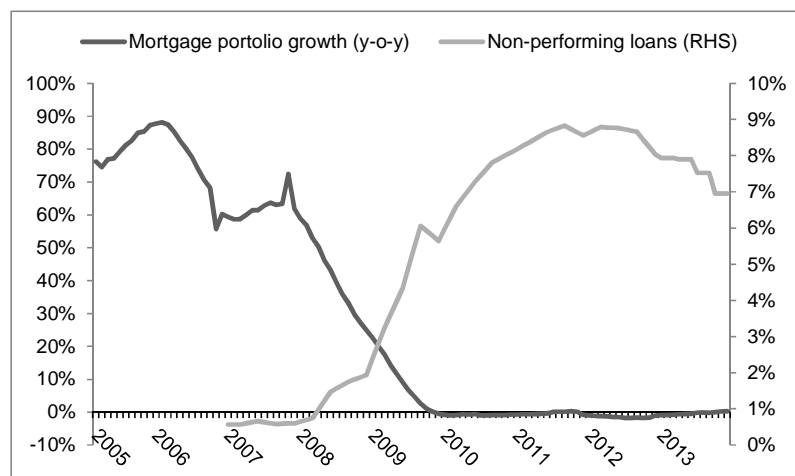
Figure 9. Lithuanian mortgage portfolio growth and non-performing loans dynamics 2005-2013
Source: Bank of Lithuania

Lithuanian *households'* decisions to take a mortgage expose them to significant risks. Social security system support is rather weak. Households are vulnerable to income fluctuations as they have insufficient buffer savings for the unexpected events. In case of unemployment, the unemployment benefit is assured only for 6 months, it is fixed at the level which is below the poverty threshold. In case of income decrease, households would face significant consumption constraints as lenders would not be willing to lend someone who cannot make ends meet.

In general, *a mortgage loan* application is approved, given that a household earns sufficient income to cover an average cost of living and service the debt, has no payment defaults, and the value of collateral is large enough to cover the obligations. After the loan approval, the household chooses the mortgage interest rate type – a STFRM (initial rate fixation is less than one year) or a LTFRM (initial rate fixation is more than one year, usually from 2 up to 15 years). In the end of interest rate fixation period, the interest rate for a new chosen period is set according to the market interest rate. The short term interest rate consists of interbank interest rate (EURIBOR or LIBOR EUR for 1, 3, 6 or 12 months optionally for loans in euros and VILIBOR for 1, 3, 6 or 12 months optionally for loans in national currency – Litas). Interest rate setting for LTFRM is less transparent but is still related to the price of Euro interest rate swaps. If a household is approved for a loan, there are no financial regulations on which mortgage interest rate type a lender should offer. It is

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up to the household to choose between STFRM and LTFRM and whether to have one loan or divide it in parts with different maturity. Dominating interest rate type in the mortgage market is STFRM (see Figure 10).
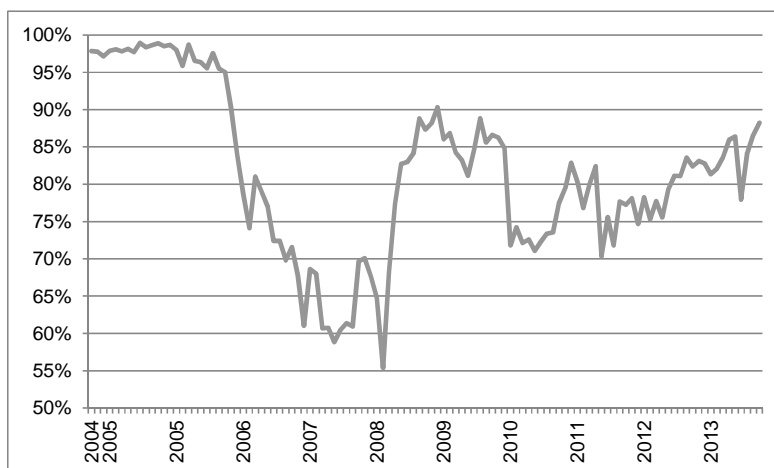
Figure 10. Share of STFRM loans in new lending volumes in Lithuanian mortgage market 2004-2013
Source: Bank of Lithuania

Since 2004 to 2012, the share of STFRMs fluctuates from the highest 99.9 percent in November 2005, to the lowest 50.6 percent in October 2008. There is a consecutive decrease in the share of new STFRMs for the period of two years (2006-2007). Also, there are several periods of consecutive increase of the share of STFRMs lasting for 6 months: in the end of 2008 – beginning of 2009 and in the beginning of 2011.

A household may choose whether to borrow in national currency (Litas) or in foreign currency (mostly Euro). In Lithuania, there was a fixed exchange rate 1 EUR = 3.4528 LTL since 1999. As the country was seeking to introduce Euro, it was politically committed to the requirement to keep stable national currency rate. Most of the mortgage credits to households are issued in Euro (at the end of 2013 – 76 percent). The share of new mortgage loans in national currency fluctuates around 28 percent (see Figure 11). In 2006 it peaked to almost 80 percent. This coincided with the expected (yet, failed) euro introduction in 2007 and decreased differential between VILIBOR and EURIBOR.
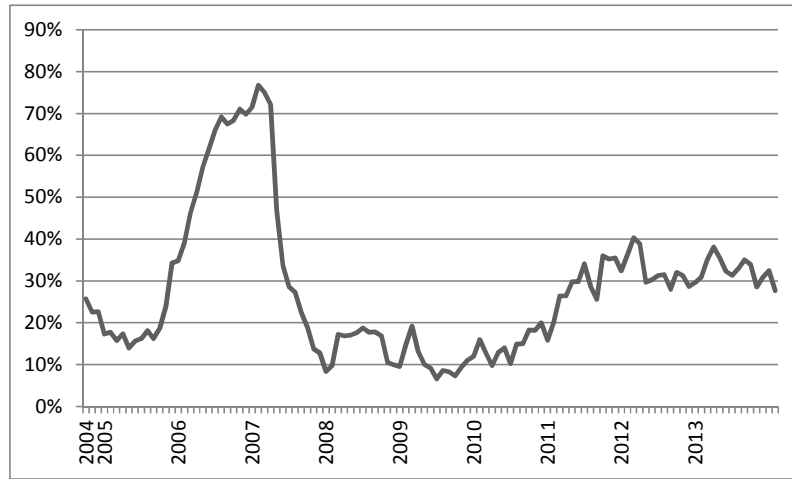
Figure 11. Share of loans in national currency in new lending 2004-2013
Source: Bank of Lithuania

The main mortgage providers do not offer teaser interest rates or deferred payments periods. Up to the year 2013, there was no legislation for household bankruptcy. Thus, no option for strategic default was available. In case of a financial trouble, the house or apartment had to be sold at a price not lower than the outstanding loan. Otherwise, any remaining loans continued to be household's liability.

In summary, Lithuanian mortgage market represents an emerging market characterized by low and volatile income, low savings, volatile asset prices and interest rates. Lithuania did not have a bankruptcy law, and loan refinancing was not widespread during the sample period. These conditions are different from the markets that were researched by other authors in several aspects: firstly, in emerging market borrowing constraints are binding as the risk of income volatility is high; secondly, interest rate volatility is also high, especially, for the loans in national currency (Litas); thirdly, probability of diverging trends of income and interest rate is high as most of the loans are taken in foreign currency; fourthly, as there was no bankruptcy legislation, households could not consider strategic default options and default was rather costly. These entire conditions signal about binding borrowing constraints which were outlined as the main pre-condition to choose LTFRM for households with large mortgages compared to their income in the optimal choice model. This condition allows to measure more correctly if households with both

current and future borrowing constraints prefer to insure against interest rate increase.

3.2. Empirical testing data sample and limitations

One of the goals of the research is to determine what factors and how influence household mortgage interest rate type choice. According to the methodological assumptions provided in the sections 2.4 and 2.5, data for the empirical research consists of the two samples. The first is for the household characteristics' influence testing, the second – for market characteristics' influence testing.

For the household characteristics' influence on mortgage interest rate type choice testing, I have chosen the data of the *Survey of Households with Housing Loans* (the Survey) performed by the Bank of Lithuania. The Bank performs the Survey with the purpose to obtain more information about the income of households with housing loans, their composition, main reasons for borrowing, loan amounts, monthly payments, the burden of debt service, etc. The Survey is conducted once per year. Between 2009 and 2012, the Bank surveyed more than 3,700 households. The Survey data covers loans originated from 1990 to 2012. To the best of my knowledge, the Survey data is the best available data in a chosen market. In Lithuania, there is no equivalent of *Consumer Finance Survey*, commercial banks are not willing to share their data due to identity protection requirements, collection of the primary data would have been too resource consuming as, based on the Bank of Lithuania estimates, only one out of eight households has a mortgage loan[5]. The research related Survey questions are provided in the Annex 1.

There are two limitations related with the data. The first is that it is only assumed that households report their truthful financial situation. However, when compared with the market data, the fluctuation in the share of STRFM (number of households) in the Survey is consistent with the fluctuation in the share of STFRM loans observed in the market data (new lending volumes) by year (see Figure 12). Statistical survey data on the number of respondents by year of loan origination is provided in Annex 2.

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[5] Estimate is based on the data of the Survey of the Households with Housing Loans (2012).
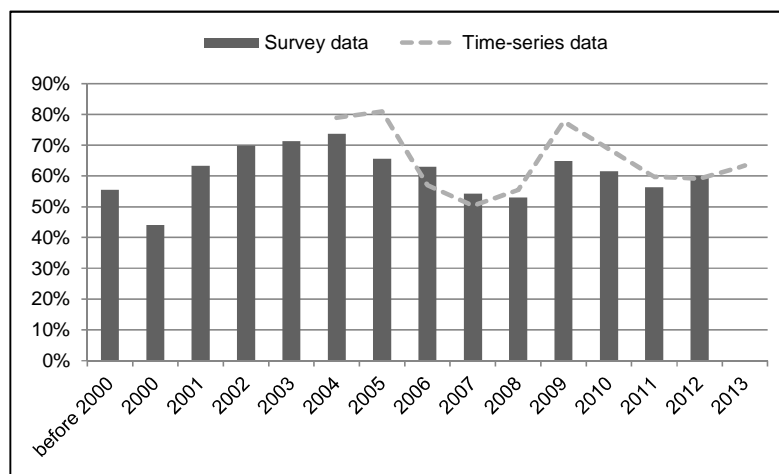
Figure 12. Share of STFRM loans in the Survey (number of households) and in the
market (new lending volumes) by year of loan origination
Source of market data: Bank of Lithuania, available since October 2004

Though the share of STFRM in the market time-series data is larger compared to the share of the Survey respondents with STFRM, the pattern of the share dynamics by year is the same. Since 2004 up to 2008 the share of STFRM is decreasing in both samples. From 2008 to 2009, there is a significant increase. After the 2009, the trend again changes in both samples. Due to the coincidence of the trends, I consider the Survey sample representative. I explain the higher average level of STFRM in the market data by the effect of rich households with larger (STFRM) mortgages.

The second limitation is the gap between the loan origination and the interview. For household financial constraints (income, other obligations, possession of savings) or demographics, the Survey captures the data in the year of the interview, not in the mortgage origination year. Considering this limitation, I exclude the observations where residual income is inadequate, i.e. the residual income per person after mortgage payments is lower than 500 Litas. Such households would not be granted any loans if applied. After the procedure, still 3,395 observations are left. Besides, to make allowances for this deficiency, I run robustness tests of the results, restricting the sample to households with mortgages that have been originated within three to five years prior the interview date.

To test the impact of market characteristics on mortgage interest rate type choice, I use another set of data – time-series statistics of new mortgage loans and

their interest rate from the Bank of Lithuania webpage. New contracts include all financial contracts terms and conditions that specify for the first time the interest rate of the loans and all new negotiations on existing loans. The available data covers period of 111 months from October 2004 to December 2013. Such duration is sufficient to evaluate macroeconomic factors' impact on mortgage interest rate type choice:

- it includes full economic cycle (economic boom and bust) in the country (see Figure 6)
- the rapid mortgage market growth started at approximately 2002–2004 (see Figure 9)
- the share of new STFRMs was fluctuating significantly during that period (see Figure 10)

Data for loans in Euros and loans in Litas is provided separately. Statistics of the time-series data is provided in the Annex 3.

3.3. Variables for the empirical testing of the conceptual model

As presented in the Table 4 and Table 5, other authors use various variables to measure household characteristics' and market conditions' influence on mortgage interest rate type choice. In the following sections, I present the variables that are used to measure household current and future constraints and risk aversion in this research.

3.3.1. Household characteristics testing variables

The proposed conceptual household mortgage interest rate type choice management model groups household characteristics into three categories: current consumption constraints, future consumption constraints, and risk aversion.

Current consumption constraints

Based on the previous research literature discussed in the Section 2.4 and mortgage lending practices described in the Section 3.1, I measure current consumption constraints by the following indicators: (1) mortgage payment to income ratio; (2) residual income indicator.

Mortgage payment to income ratio *(Payment to Income)* is estimated based on the answers to the questions about household's monthly income and monthly mortgage payment. In the existing research, authors use the same ratio (Damen and

Buyst, 2013; Ehrmann and Ziegelmeyer, 2011). Other authors also use mortgage balance to income ratio (Bacon and Moffat, 2010; Coulibaly and Li, 2009), or levels of income or assets (Bergstresser and Beshears, 2010). *Payment to Income* ratio measures current constraints better: firstly, it captures the duration of the loan effect which is absent in mortgage balance to income ratio (monthly payments of the loan of the same size might be different depending on the duration of the loan). Mortgage balance to income ratio can be also used as an indicator of future constraints (limited access to credit) as it shows general indebtedness level, not only current constraints. On the other hand, *Payment to Income* ratio is suspicious of the reverse causality issues as households with LTFRM, on average, should have higher mortgage payments given that the LTFRM interest rate is usually higher than STFRM. However, according to the logic of mortgage decision, households first decide to buy a house, then to take a mortgage, and after that they have to decide upon the acceptable mortgage payment to income level. Based on the proposed model assumptions, the lower the income in relation with mortgage payments, the stronger the incentives a household has to choose a cheaper mortgage, i.e. STFRM. The variable is estimated based on the answers to the questions about household income (B6) and mortgage monthly payment (D3) (see Annex 1).

Residual income indicator (*Residual Income*) indicates how much of household's income is left per person after paying the mortgage monthly instalment. I take this indicator based on the bank lending practices, presented in the section 3.1: a mortgage loan application is approved given that a household earns sufficient income to cover an average cost of living and service the debt. This indicator is important to prevent misclassification of the non-constrained households as the constrained ones. Households with very high income might have high mortgage payment to income ratios and be consumption non-constrained as the residual income might still be higher than needed to satisfy usual consumption needs. The variable is estimated based on the answers to the Survey questions B6, D3, and D1 (See Annex 1).

Future consumption constraints

According to the proposed model, *future consumption constraints* are defined as (1) limited access to credit and (2) volatile income.

Limited access to credit

In the previous literature*, limited access to credit* is measured as loan to value ratio, net worth, total housing debt to income, loan to value ratio, etc. (see Table 4). As discussed in the Section 2.4, limited access to credit limits opportunities to smooth household consumption if faced with random liquidity needs due to interest rate shocks. Based on the previous research and the available data, in this research I use (a) loan to value ratio and (b) other obligations indicator as variables measuring limited access to credit.

Loan to value ratio *(Loan to Value)* shows debt level. It indicates whether a household could borrow more against the housing. If the ratio is high, household has low or no ability to borrow more in case of unexpected income decrease or expenditure increase. This indicator is widely used in previous research (Paiella and Pozzolo, 2007; Coulibaly and Li, 2009; Bergstresser and Beshears, 2010; Bacon and Moffat, 2011; Damen and Buyst, 2013). The variable is estimated based on the responses to the question about loan to asset value ratio and measured in percent (B5, See Annex 1).

Other obligations' indicator *(Obligations)* is another variable of the access to credit. It shows whether a household has already exploited opportunities to borrow. Other authors use total non-housing debt to income (Coulibaly and Li, 2009) or rolling credit card balances (Bergstresser and Beshears, 2010; Johnson and Li, 2011). Based on the available data of the Survey, I measure other obligations by the answers to the question *Do you or your household members have other financial liabilities other than mortgage (i.e. consumer loan, study loan, payday credit, hire purchase, leasing or others)?* If the answer to the question "*Yes*", then variable is "1" and "0" otherwise (B15, See Annex 1).

Volatile income

As discussed in the Section 2.4, volatile income increases probability that increasing interest rate will coincide with decreasing income. That would lead to the consumption shock. According to the previous literature, income volatility is measured as self-stated ability to handle sudden increases in mortgage costs; as working in the public sector, as slope of income growth, as number of income earners in the household, as age, race, education, etc. (see Table 4). Based on the previous research and the available data, in this research I use (a) absence of

savings indicator; (b) number of adults in the household; (c) education of the respondent.

Absence of savings indicator (*No Savings*) signals about higher probability of consumption drops. It indicates whether a household could tap into savings in case of unexpected income decrease or expenditure increase. The indicator is measured by the responses to the question whether the household has savings (B22, see Annex 1). If the respondent indicates that he/she has no cash at home or bank deposit, the variable is "1" and "0" otherwise. This approach is consistent with M. Paiella and A. F. Pozzolo (2007) and M. Hullgren and I. Soederberg (2013) who measure influence of the presence of liquid assets or self-stated ability to handle sudden costs on household mortgage interest rate type choice.

Number of adults in the household indicator *(Single Adult)* is one more measure of income volatility. If there is only one breadwinner in the household, probability of consumption decrease due to income drops is higher compared to households with larger number of income earners. This approach is consistent with the previous research of U. S. Dhillon et al (1987); M. Finke et al (2005); B. Coulibaly and G. Li (2009); P. Zocchi (2011). If the respondent indicates that there is only one adult (a person not younger than 18 years) in the household, the variable is "1" and "0" otherwise (D1, Annex 1).

Education level indicator (*Education*) also indicates income volatility. Households with a higher education level have stronger position in the labour market. Their income volatility is lower. This approach is consistent with M. Finke et al. (2005) and B. Coulibaly and G. Li, (2009). Other authors use education for other household characteristics – financial literacy or risk aversion. In this research, education is an ordinal variable of 1 to 5, where "1" is for primary education, "5" – for university level education (D2, Annex 1).

Risk aversion

To measure risk aversion, I use an indicator of children in the household (*Children*). Using children indication as a proxy of risk aversion is based on the findings of D. Love (2010) who claims that random liquidity needs of a larger family with children might discourage financial risk taking. M. Paiella and A. F. Pozzolo (2007) also use children as a proxy of risk aversion. Other authors measure self-stated risk aversion (Coulibaly and Li, 2009, Bergstresser and Beshears, 2010),

attitudes towards debt (Bacon and Moffat, 2011; Johnson and Li, 2011), or age (Leece, 2000; Cox et al, 2011). Available data used for this research does not provide information which could be a stronger proxy of risk aversion. Risk aversion indicator is "1" if there is at least one child in the household and "0" otherwise (D1A, Annex 1).

Dependent variable is the probability that household's chosen mortgage is a STFRM.

Indicators for measuring current and future consumption constraints and risk aversion used in the conceptual model testing are presented in the Table 9.

Table 9

Current and future consumption constraints and risk aversion measurement indicators used to test the model of mortgage interest rate type choice management in Lithuania

Constraints		Indicator	Comment
Current consumption constraints		Payment to Income	Monthly mortgage payment to household income ratio.
		Residual income	Indicates how much of household's income is left per person after paying the monthly mortgage instalment.
Future consumption constraints	Limited access to credit	Loan to Value	Mortgage loan to housing value ratio at the time of the loan origination.
		Obligations	Indicates if the household has other obligations than mortgage
	Volatile income	No Savings	Indicates that the household has no cash at home or in a deposit account
		Single Adult	Indicates that a number of 18 years old or older people living in the household is one
		Education	Education level of the interviewed person (1 to 5)
Risk aversion		Children	Indicates if there is at least one child under 18 in the household

These measurement indicators also are of practical relevance. They are easily observable by the financial institutions before the mortgage origination and also can be followed during the mortgage contract duration without significant additional costs.

Table 10 provides descriptive statistics of the variables. Descriptive statistics shows that almost half of the sample (60 percent) has chosen STFRM. This is consistent with the optimal choice model which claims that STFRM is generally more

acceptable. Also, a large share of STFRM mortgages is appropriate for the goal of the research – to identify factors encouraging choice of STFRM, a riskier option. Mean payment to income ratio (0.24); loan to value ratio (0.71) and residual income per person (1,371 Litas with standard deviation of 880 Litas) are consistent with the casual bank lending requirements.

Table 10

Household characteristics' influence on mortgage interest rate type choice variables: descriptive statistics

Variable	Mean	St. dev.	Observations
STFRM	0.60	0.489	3,089
Payment to Income	0.237	0.127	3,036
Residual Income	1,371	879.746	3,034
Loan to Value	71.09	22.010	2,694
Obligations	0.26	0.441	3,350
No Savings	0.13	0.337	3,347
Single Adult	0.155	0.362	3,393
Education	4.45	2.973	3,395
Children	0.607	0.489	3,395

Note: Data is from the Survey of Households with Housing Loans

As a result of mean comparison between the two types of mortgages, we can see no clear differences between the two groups of the households (Annex 4). On average, the STFRM households have slightly higher monthly income than the LTFRM households, but the highest (maximum) income is also earned in the LTFRM group. The same holds for the loan amount mean and maximum values. The composition of the households is rather similar: on average, in both groups there are 60 percent of households with children; 16 percent of the STFRM households and 15 percent of the LTFRM households are single adult households. The STFMR households have slightly higher debt levels. Loan to value ratio is slightly higher in the STFRM household group, but the minimum value is also observed in the same group. There are more households with other obligations in the STFRM group. Payment to income ratios do not differ much. Mean of residual income is higher in the STFRM group, but the minimum values are the same. Thus, to detect differences between the groups, a deeper analysis is needed.

3.3.2. Market conditions testing variables

Based on the conceptual household mortgage interest rate type choice management model, market conditions influence household expectations' formation. These expectations are related to future consumption constraints – house price and income decrease and interest rate (expenditure) increase. According to the previously presented discussion in the Section 2.3, market conditions influencing household mortgage interest rate type choice are grouped into three groups by the expectations they are related to: (1) housing price expectations related conditions, (2) income expectations related conditions, and (3) interest rate expectations related conditions.

Based on the previous research, *housing price expectations* can be influenced by (a) housing prices (Furlong and Takhtamanova, 2012). They can also be reflected in loan demand (Sa-Aadu and Sirmans, 1995; Furlong and Takhtamanova, 2012) measured as a mortgage portfolio change (b).

Housing price

Housing price (*House price*) forms the base for the future housing price expectations assuming that households form extrapolative expectations as discussed in the Section 2.4. In this research, I measure house price change as an annual change in monthly index value of the *OHBI* real apartment price index adjusted by inflation[6].

Mortgage portfolio change (*Mortgage portfolio*) reflects housing loans demand and is also related to housing price expectations. Logically, households who expect housing prices to decline would rather wait than rush to borrow. The indicator of mortgage portfolio change is estimated as an annual change of monthly mortgage portfolio value based on the data by the Bank of Lithuania.

General income

Based on the existing research, *general income* conditions, such as income (measured as GDP) and labour market situation (measured as wage growth and/or unemployment) influence both the demand (households) and the supply (financial

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[6]The Lithuanian apartment price index (**OHBI**) applied by Ober-Haus Real Estate Advisors shows summarized changes in prices for apartments in the five largest Lithuanian cities. The **OHBI** is estimated every month. **Real apartment price index** shows the changes of real prices for apartments eliminating the effect made by inflation on the nominal values of the OHBI.

institutions) sides in the mortgage market. To measure general income, I pick up the following alternative measurement indicators: (a) real salary growth; (b) consumer sentiment index; and unemployment level (c).

Real salary growth (*Real salary*) is estimated based on the quarterly data about average salary yearly change adjusted by inflation.

Alternative indicator of income expectations is consumer sentiment index (*CSI*). I take the monthly values of CSI from the Consumer Survey Data, published by the *Statistics Lithuania*. Consumer Sentiment Index reflects households' opinions about future general economic conditions, household financial prospects, future situation in labour market, and future ability to save, i.e. expected future consumption constraints.

Unemployment (*Unemployment)* is one more indicator of income expectations. High levels of unemployment depress households' income and *vice versa*. The data is taken from the *Statistics Lithuania*.

Interest rate indicators

Based on the existing literature, reviewed in the Section 2.3, relevant factors for *interest rate expectations* include (a) inflation level or interest rate level; (b) interest rate differential.

Interest rate level

In this research, I use interest rate level (*STFRM rate*) as a benchmark for interest rate formation as households may borrow not only in national, but also in foreign currency. To forecast interest rate changes for loans in foreign currency, national inflation levels could be a poor proxy. To estimate the interest rate level indicator, I choose monthly weighted average of STFRM interest rate level. Data is taken from time-series statistics published by the Bank of Lithuania. Inflation data is taken from the *Statistics Lithuania* webpage.

Interest rate differentials

Interest rates differentials may be considered in three ways: as the signal about future interest rate changes; as the relative price of the two alternative mortgages; or as a measurement of inefficient pricing (Leece, 2008). Available diferentials' indicators are limited by country peculiarities and the available data. I choose three alternative indicators for interest rate expectations' influence measurement: LTFRM-

STFRM spread, Rule of Thumb (LTFRM-average of previous 12 month STFRM rate spread) and LTFRM-average inflation spread (the last two – as in R. Koijen et al, 2009).

LTFRM-STFRM spread (*LTFRM-STFRM*) is a straightforward differential between the long term and short term interest rate (Campbell and Cocco, 2003, Coulibaly and Li, 2009). The higher the spread, the higher is the attractiveness of the STFRM. On the other hand, if households form extrapolative expectations, larger spreads would lower the attractiveness of the STFRM.

Rule of Thumb (by Koijen et al, 2009) variable (*Rule of Thumb*) reflects differential between long term interest rates and average of short term interest rates for previous 12 months. The interpretation would be similar to the *LTFRM-STFRM* spread: the higher the gap, the more attractive is the STFRM given that households form mean-reverting expectations. As this is not so straight-forward indications and requires additional efforts, the relative power of these alternative variables may signal about household attempts to assess interest rate risk premia.

LTFRM interest rate – inflation gap (*LTFRM-Inflation*) is the differential between long term interest rate and average of inflation for previous 12 months as in (Koijen et al, 2009). The interpretation would be similar to the previous: the higher the gap, the higher is the attractiveness of the STFRM, assuming that households form mean-reverting expectations or assess pricing inefficiencies.

The dependent variable is the share of STFRM in new lending volumes.

Table 11 provides the indicators of market conditions which are used for expectations' measurement to test the conceptual model of household mortgage interest rate type choice management.

Table 11

**Market conditions expectations' measurement indicators used to test the
model of mortgage interest rate choice management in Lithuania**

Expectations	Indicator	Explanation	Data Source
House price	House price change	Annual change in monthly value of the *OHBI* real apartment price index adjusted by inflation	*Ober-Haus Real Estate Advisors*
	Mortgage portfolio	Monthly values of mortgage portfolio annual change	Bank of Lithuania
Income	Real salary growth	Monthly values of the inflation adjusted net salary change	Statistics Lithuania
	CSI	Monthly values (balance of opinions) of the Consumer Sentiment Index	Statistics Lithuania
	Unemployment	Monthly values of the level of unemployment	Statistics Lithuania
Interest rate	STFRM rate	monthly values of weighted average STFRM interest rate of new mortgage loans	Bank of Lithuania
	Inflation	monthly values of average annual inflation	Statistics Lithuania
	LTFRM-STFRM	The gap between the long term and short term interest rate (weighted average of the new loans, monthly values)	Bank of Lithuania
	Rule of Thumb	The differential between long term interest rate and average of short term interest rate for previous period of 12 months	Bank of Lithuania
	LTFRM-Inflation	differential between long term interest rate and average of inflation for previous period of 12 months	Bank of Lithuania and Statistics Lithuania

As shown in the Table 11, information on market conditions is easily accessible for the households to form their expectations.

Table 12 provides descriptive statistics for market characteristics variables.

Table 12

Market conditions' influence on mortgage interest rate type choice variables: descriptive statistics

Variable	Mean	St.Dev.	Min	Max	Observations
STFRM	0.822	0.114	0.506	0.999	222
House price	0.047	0.238	-0.319	0.593	222
Mortgage portfolio	0.318	0.357	-0.018	1.004	222
Real salary growth	0.039	0.084	-0.089	0.229	222
Consumer sentiment index	-16.5	16.763	-56	9	222
Unemployment	0.107	0.046	0.037	0.187	222
Inflation	0.041	3.038	-0.47	12.47	222
STFRM rate	4.40	1.86	2.07	10.32	222
LTFRM-STFRM	0.800	1.071	-4,37	4,48	222
Rule of thumb	0.775	0.935	-2.89	4.59	200
LTFRM-inflation	4.5372	1.7970	2.17	9.52	222

Note: Data is from the new lending volumes and interest rates statistics

The mean share of STFRM is 82 percent with standard deviation of 0.11 percentage points ad fluctuates from 51 percent to 99.percent. During the observation period, housing price, real salary, consumer sentiment, mortgage portfolio changes were both positive and negative. The mean inflation level was 4 percent with standard deviation of 5 percentage points. The sample includes both inflationary and deflationary periods. Interest rate differentials – LTFRM-STFRM spread, Rule of Thumb also include negative values which, according to the economic logic, should be signals of inefficient mortgage pricing. The number of the observations is double the number of months of observation (from October 2004 to December 2013). This is because loans in Litas and loans in Euro were registered separately.

3.4. Testing the hypothesized influence of household characteristics and market conditions on mortgage interest rate type choice

To test the hypotheses of the conceptual model and to find whether current and future consumption constraints and risk aversion explain household mortgage interest rate type choice, I relate household characteristics with the probability of STFRM choice based on the household level data (the Survey). Next, I relate market

conditions with the share of STFRM in the new lending volumes (monthly) to find under what market conditions the demand (share) of STFRM increases.

3.4.1. Testing household characteristics relationship with mortgage interest rate type choice

One of the research questions is to identify what household characteristics and how influence household mortgage interest rate type choice. Household characteristics, which might explain household behaviour, are outlined based on the previous literature and grouped as (1) current consumption constraints related characteristics (mortgage payment to income ratio); (2) future consumption constraints related characteristics indicating limited access to credit (loan to value ratio and existence of other obligations) and volatile income (having no liquid savings, low number of adults in the household, and the lower education level of the respondent); and (3) risk aversion (measured as having dependent children in the household).

To test hypotheses *H1*, *H2* (*H2A1*, *H2A2),* and *H3*, I construct a multivariate linear probability model (logit regression) by adding all the related factors to explain the choice of STFRM. The regression equation is as follows:

STFRM = *Payment to Income + Loan to Value + Obligations + No Savings + Single Adult + Education + Children + Year of the Loan origination + Currency of the loan + ε*   (1)

I exclude *Residual Income* from the equation due to the multicollinearity issues. A rule of thumb suggests that a higher than 0.4 correlation between explanatory variables indicates a potential problem. An indicator of *Residual Income* and *Children* are the tightest related variables with the correlation 0.445 (See Annex 5). It is expected that the existence of dependents in the household is related to lower income per capita. *Residual income* has also significant correlation with *Payment to Income* (-0.272), and both of the variables measure current constraints. The correlations among the other explanatory variables are lower.

I include currency of the loan and the year of the loan as control variables. Currency of the loan is related with mortgage characteristics: interest rates for loans in Euro are lower and less volatile, albeit borrowing in foreign currency brings up currency risk. Year of the loan is related with macroeconomic and mortgage market

conditions prevailing at the moment of the loan origination. These controls help to deal with potential heteroskedasticity issues. Based on previous research, both of the controls might influence mortgage interest rate type choice.

The regression results are provided in the Table 13.

Table 13

Household characteristics' relationship with STFRM choice based on logit regression results

Indicator	β	SE	Sig.	Odd ratio
Payment to Income	-1.820***	(0.372)	0.000	0.162
Loan to Value	0.005**	(0.002)	0.020	1.005
Obligations	0.248**	(0.107)	0.020	1.282
No Savings	-0.178	(0.138)	0.196	0.837
Single Adult	0.324***	(0.124)	0.009	1.383
Education	0.106**	(0.051)	0.039	1.112
Children	-0.026	(0.091)	0.785	0.975

Notes: statistically significant at: *0.10, **0.05, ***0.01 levels (two-tailed); the dependent variable is STFRM; controlled variables are *Currency of the loan* and *Year of the loan origination*; the number of observations is 2,155; the Cox and Snell R^2 is 0.033; the Nagelkerke R^2 is 0.045.

The model is statistically significant, χ^2 (9, n=2,155) = 72.573, p<0.001 indicating that the model is able to distinguish between those who choose STFRM and those who choose LTFRM. Hosmer and Lemeshow test is non-significant (0.987). The model, as a whole, explains between 3.3 per cent (Cox and Snell R^2) and 4.5 per cent (Nagelkerke R^2) of the variance in mortgage rate choice.

As results presented in the Table 13 show, firstly, the likelihood of picking STFRM decreases in increasing *Payment to Income* ratio. The odds ratio suggests that households with a payment to income ratio that is one standard deviation above the mean are 83 percent less likely to choose a STFRM. This is the highest coefficient value. Therefore, the result suggests that households with current consumption constraints are more likely to prefer LTFRM.

Secondly, estimates of the limited access to credit related variables coefficients show that indebted households more often choose STFRM. The higher loan to value ratio slightly increases the probability of STFRM choice. All else being equal, a loan to value ratio higher by one standard deviation above the mean increases the odds of STFRM choice by 0.5 percent. A household that has other obligations is more likely to choose STFRM. The odds for a household with other obligations to have

STFRM are higher by 28 percent compared to a household with no other obligations, all else being equal.

Thirdly, estimates of income volatility related variables' coefficients bring mixed results. Odds of STFRM choice by a household where there is only one adult person are higher by 38 percent compared to a household with more income sources, all other things to be equal. *Absence of Savings* coefficient is low has no statistically significant relationship with mortgage interest rate type choice. Still, the sign of the coefficient is negative. Respondent's education has a positive effect on the probability of STFRM choice. All told, I find some evidence that households with future consumption constraints are more likely to choose STFRM

Fourthly, the relationship between having children in the household and STFRM choice stays statistically non-significant. The result from this model suggests that households do not consider children as a risk factor when making a mortgage interest rate type choice.

To test the hypothesis *H2B* (split into the sub-hypotheses *H2B1* and *H2B2*), I perform another test of the joint effects of current consumption constraints and future consumption constraints. The goal is to check whether households with current consumption constraints (who have residual income per person less than 900 Litas) neglect future consumption constraints, as assumed by behavioural model predictions[7]. I substitute *Payment to Income* with *Low Residual Income* as the latter indicates absolute current consumption constraints and helps to avoid mis-classifying non-constrained households as the constrained ones if judged only by the payment to income ratio. For this goal, I run the following regression:

STFRM = *Low Residual Income x High Loan To Value* + *Low Residual Income x Obligations* + *Low Residual Income x No Savings* + *Low residual income x No Savings* + *Low residual income x* Low *Education* + *Low Residual Income* + *Loan To Value* + *Obligations* + *No Savings* + *Single Adult* + *Education* + *Children* + *Year of the Loan origination* + *Currency of the loan* + ε   (2)

where

Low Residual Income is a dummy variable which indicates that residual income per household member is lower than 900 Litas.

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[7] According to Household Budget survey data, 900 Litas was an average cost of living in Lithuania in 2012

High Loan to Value is estimated based on the *Loan to Value* ratio. If the *Loan to Value* ratio is higher than 70 percent, the *High Loan to Value* variable is "1" or "0" otherwise.

Low education is estimated based on the *Education* variable. If the education is lower than 4 (higher education level), *Low education* variable is "1" or "0" otherwise.

The regression results are presented in the Table 14.

Table 14

Joint current and future consumption constraints' relationship with STFRM choice based on logit regression results

Indicator	β	SE	Sig.	Odd ratio
Low Residual Income x High Loan to Value	-0.249	0.181	0.171	0.780
Low Residual Income x Obligations	-0.378*	0.226	0.096	0.686
Low Residual Income x No Savings	-0.257	0.279	0.358	0.774
Low Residual Income x Single Adult	-0.395	0.283	0.162	0.674
Low Residual Income x Low Education	-0.049	0.219	0.821	0.952

Notes: Statistically significant at: *0.10, **0.05, ***0.01 levels (two-tailed); the dependent variable is STFRM; controlled variables are *Low Residual Income*, *Loan to Value*, *Obligations*, *No Savings*, *Single Adult*, *Education*, *Children*, *Currency of the loan*, and *Year of the loan origination*; the number of observations is 2,155; the Cox and Snell R^2 is 0.027; the Nagelkerke R^2 is 0.037,

The model is statistically significant, χ^2 (14, n=2,155) = 59.892, p<0.001, indicating that the model is able to distinguish between the respondents who chose STFRM those who choose LTFRM. Hosmer and Lemeshow test is non-significant (0.707). The model explains between 2.7 per cent (Cox and Snell R^2) and 3.7 per cent (Nagelkerke R^2) of the variance in mortgage rate choice.

The results in the Table 14 show that the estimated coefficients of interactions of current borrowing constraints (*Low Residual Income*) and future borrowing constraints (*High Loan to Value*, *Absence of Savings, and Single Adult*) variables are negative and sizable but statistically insignificant. The interaction of *Low Residual Income* and *Obligations* coefficient is significant and brings a negative sign. The result indicates that households with low residual income and other obligations are by 31 percent less likely to have STFRM compared to those who have no joint

constraints. Therefore, I find some evidence that households with both current and future consumption constraints are less likely to choose STFRM.

Low explanatory power is characteristic to the research of household characteristics' influence on mortgage interest rate type choice (Paiella and Pozzolo, 2007; Bergstresser and Beshears, 2010; Hullgren and I. Soederberg, 2013), especially those with large samples. The regression model (1) constructed of the chosen predictor variables is able to predict 62.7 percent of the household correctly: 92.2 percent of cases when STFRM is chosen but only 15.7 percent of LTFRM cases. The model with the joint constraints (2) correctly predicts correspondingly 62.2, 94.9, and 11.9 percent of observations. As the purpose of the mortgage interest rate choice management is to determine what household characteristics increase the probability that a more volatile STFRM is chosen, the predicting power of STFRM choice is appropriate.

Robustness tests

To test the robustness of the models, I consider the following factors which could influence household mortgage interest rate type choice:

1) market environment

2) mortgage characteristics

3) the time gap between the loan origination and the survey

4) household income level

5) double checking risk aversion influence

Market environment influence

The Survey captures loans originated in different years from 1990-2012. During the 22 years, many conditions – both economic and institutional – have changed. Economic cycle stage, labour market situation, interest rate dynamics, and real estate market – all influence household expectations about future consumption constraints. Thus, households may become more or less risk averse (Malmeinder and Nagel, 2010). Macroeconomic environment also influences mortgage providers' behaviour. The available sample does not allow testing causality between various market conditions and households' choices as the Survey does not include information about market conditions, just the year of loan origination, but provides the opportunity to control some of the effects.

In the original regression, I use year of the loan as the control variable. To check market conditions effects, I split sample by the economic cycle stages into four groups by year: loans originated pre-2005; 2005-2007 (economic growth); 2008 (the breakpoint year), and post-2008 (economic bust and later). Estimates of the regression are provided in the Annexes 6A and 6B.

Payment to Income ratio seizes to keep negative value and statistical significance in economic downturn. *Loan to Value* ratio coefficient estimate increases in statistical significance and value. *No Savings* estimate switches the sign from negative and significant in 2005-2007 to positive and significant post-2008. *Obligations* carry the positive sign through all the periods. Relevant statistical significance is observed in 2005-2007 – the years of the easy access to credit, loosening lending requirements, and rapid appreciation of the real estate (See Figures 8 and 9). *Single Adult* estimate keeps its positive sign persistently. *Education* estimate keeps the positive sign and shows up with relevant statistical significance in post-2008. *Children* estimate is mixed and non-significant.

Sample split shows that changing market environment changes the effect of household characteristics upon the probability of STFRM choice. The most visible are the changes in *Payment to Income* ratio (from strong negative to non-significant) and *No savings* (from significant negative in economic growth times to positive and significant in economic downturn times). This implies that larger current consumption constraints measured by payment to income ratio and higher income volatility measured by absence of savings are les related to STFRM choice in economic downturn. However, this is a very preliminary assumption as year control is a rough proxy for the market conditions.

Joint effects of current constraints and future constraints also slightly change. Limited access to credit variable *High Loan to Value* jointly with *Low Residual Income* becomes statistically significant (negative) in early years. Post-2008, joint effects of *Low Residual Income* and *Obligations*, *Low Residual Income* and *High Loan to Value*, *Low Residual Income* and *Single Adult*, and *Low Residual Income* and *Low Education* seize to be negative, though become statistically non-significant with large standard deviations. Limited access to credit variable *High Loan to Value* jointly with *Low Residual Income* becomes significant (negative) in early years.

Mortgage characteristics

The sample provides very little for mortgage characteristics' impact testing. One of the mortgage characteristics is the currency of the loan. Interest rate for loans in Euro is most usually lower than for loans in Litas, both for STFRM and LTFRM. Also, volatility of Litas loan interest rate is higher than of Euro (see Figure 10). The odds for loans in Litas to be STFRM are lower by 33 percent compared to loans in Euro.

To check the robustness of the original regression estimates, I split the sample by currency. Estimates are provided in the Annexes 7A and 7B. For loans in Litas the explanatory power of the constructed regression is higher. Although the samples are of the similar size, Nagelkerke R^2 is higher for loans in Litas.

Payment to Income ratio is consistent for both samples, the sign is the same, statistical significance and value is similar. Borrowing in foreign currency does not change the effect of current constraints on mortgage interest rate type choice. Statistical significance of all other variables disappears when sample is split. *No Savings* and *Other obligations* variables have different signs for different currency loans but lack statistical significance. For loans in Euro the latter variables have opposite signs compared to the full sample, but the coefficient value is low.

There could be different motives for STFRM in Euro choice: (1) some of the households could perceive borrowing in a less volatile currency (in terms of interest rate) as an insurance against interest rate volatility; (2) others might follow cost-minimization principle at their existing level of interest rate risk aversion.

Joint effects of current constraints and future constraints hold for loans in Litas. For loans in Euro, statistical significance disappears, though the signs remain robust except the *Low Residual Income* and *Low Education* interaction variable. However, the value is rather low and standard deviation is large.

Time gap between loan origination and survey year

Despite of being representative, the Survey has a drawback. The findings lie on the assumption that household characteristics did not significantly change since loan origination to the Survey year. However, it is a quite strong assumption given that there are observations in the sample with a loan and a survey more than ten years apart. To reduce the measurement errors, I focus only the households that took the mortgage not more than five and three years prior to the Survey. Excluding the cases with more than five years between a decision and observation apart decreases the sample by 30 percent but keeps the previously significant estimates

still significant and not statistically different from the whole sample estimates (See Annex 8A and 8B). Reducing the time to three years deletes 71 percent of observations eliminates the *Loan to value* and *Obligations* effect and changes *No Savings* effect. Introducing the time gap between the loan origination and the Survey (Column 4) increases the coefficient value of *Payment to Income* and does not significantly change other effects.

Joint effects of current constraints and future constraints statistical significance also diminishes, but the signs remain robust (see Annex 8B).

Income level influence

Households in different income groups may demonstrate different behaviour (Damen and Buyst, 2014; Hullgren and Soederberg, 2013). To check the robustness of the original regression estimates, I split the sample into 5 groups based on the level of the household monthly income. I form the quintiles based on the sample data. The cut point for the first group is 3,000 Litas, for the second – 3,800 Litas, for the third – 4,500 Litas, for the fourth – 5,680 Litas, the fifth group consists of households with monthly income higher than 5,680 Litas. The estimates are provided in the Annexes 9A and 9B.

The estimates show that *Payment to Income* and *Loan to Value* coefficients are robust in all the income groups. *No Savings* variable has an inconsistent positive sign in the 4th quintile. However, the 4th quintile households are not characterized as constrained. *Obligations* variable is consistently positive, and statistically significant in the 3rd quintile. *Single Adult* variable is positive in the 1st to the 4th quintile. In the 5th quintile the effect diminishes, but this can be explained by assumption that single adult households rarely belong to the 5th quintile as groups are formed by household income and not by income per household member. *Education* variable has a consistent positive sign, except the 2nd quintile where the coefficient has a small negative and statistically non-significant estimate value. *Children* variable is non-significant in all the five quintiles.

Statistical significance of joint effects of current constraints and future constraints diminishes. The 4th and 5th quintile coefficients are extreme and non-significant. Low residual income should be rare in the 4th and 5th quintile. Joint effects between *Low Residual Income* and *No Savings* coefficient changes the sign in the 2nd quintile, however is statistically non-significant.

Risk aversion

To double-test the effect of risk aversion, I split the sample into two groups: households with children and households without children to observe if there are any differences (this approach is consistent to B. Coulibaly and G. Li (2007)). Estimates of the regression are provided in the Annexes 10A and 10B. The signs of the coefficients in optimal model choice model are robust. In households with no children, future consumption constraints variables' coefficients are statistically significant and appear to have somewhat larger values for the *Loan to Value* ratio (positive), *Obligations* (positive), and *Single adult* (positive). Thus, positive impact of future constraints on STFRM choice is clearer in households with no children. *Payment to Income* ratio coefficient's negative value is also higher of households with no children. The premise could be that households without children need smaller (and cheaper) houses which result in smaller mortgages and lower payment to income ratios.

Joint effects of current constraints and future constraints statistical significance diminishes. Joint effect of current consumption constraints and limited access to credit (*High Loan to Value*) is negative and significant for households with no children. This result supports the previous assumption that households with no children need smaller (and cheaper) houses.

3.4.2. Testing market characteristics' relationship with mortgage interest rate type choice

Under one the main research questions, what factors and how influence mortgage interest rate type choice, market conditions are also assumed. The premise is that variation in the share of STFRM is driven by the variation in market conditions which may have effect on household expectations' formation regarding future consumption constraints. To test the conceptual model, market conditions' variation should be related to the variation in the share of the STFRM in the new lending. Market conditions are grouped according to the expectations they impact: (1) house price expectations; (2) general income expectations; and (3) interest rate expectations.

As the first step, I perform correlation analysis for numerous potential explanatory variables. The goal of this analysis is double: firstly, to measure the association between a dependent variable – a share of STFRM – and one of

previously defined explanatory variables; secondly, to pick up the strongest explanatory variables for the multivariate regression as the number of observations is rather limited. To control the potentially different effects for loans in Litas and loans in Euro, I split the sample into two groups by currency. Figure 13 provides the graphical results the correlation analysis. Annex 11 presents all bivariate correlations' coefficients.
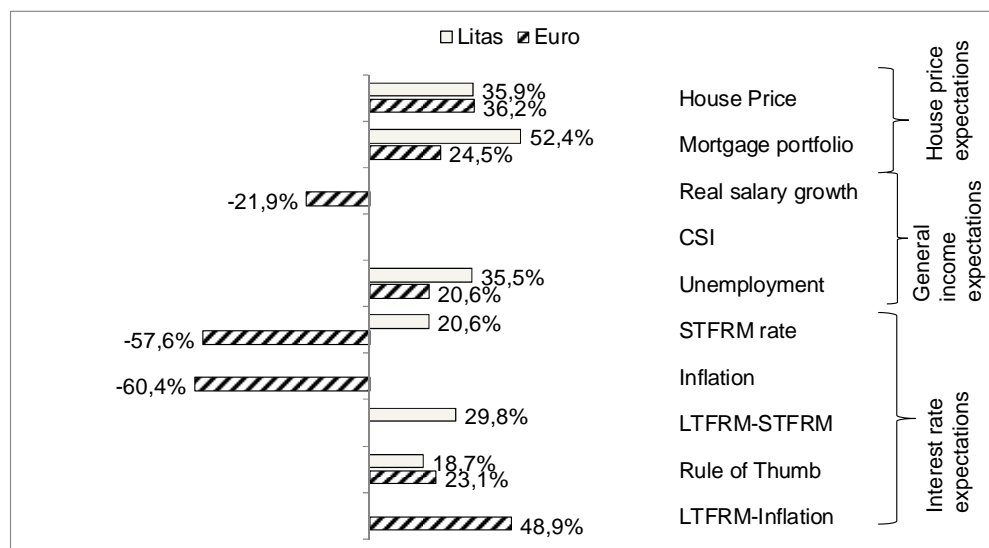
Figure 13. Correlation between market conditions and STFRM share in new lending for loans in Litas and Euro

Note: Correlations are measured by the correlation coefficient, which is bounded between -100% (perfect negative correlation) and +100% (perfect positive correlation). "0" indicates no significant correlation.

To solve multicollinearity issues, the number of variables should be reduced. From housing prices expectations related variables, I exclude *mortgage portfolio,* as this variable has three drawbacks. Firstly, the inflation effect is not controlled; secondly, its explanatory power diminishes for loans in Euro; thirdly, it is highly correlated with the income indicators – *Real Salary Growth* (0.705) and *Unemployment* (-0.781). A casual test for multicollinearity suggests that a share close to 0.8-0.9 warns about a potential multicollinearity. Due to these reasons, I choose *House Price* variable as a measure of housing price expectations.

Analysis of income expectations related market conditions variables shows that *Unemployment* is correlated with the share of STFRM for loans in both currencies. While *Real salary growth* is correlated with STFRM share only for loans in Euro. CSI is not correlated with the share of STFRM in both currencies. The negative

correlation between *Unemployment* and *Real Salary Growth* or *CSI* is consistent with economic logic. Due to these reasons, I pick *Unemployment* for general income expectations.

Consistently with the previous empirical research, pricing factors (interest rate level and spreads) should have the most significant influence. I have drawn two hypotheses: one is related with interest rate level (H61), the other – with interest rate spread (H62). Interest rate level can be measured as inflation level or STFRM interest rate level. Inflation, as a benchmark for future interest rates, should be more relevant for those who prefer borrowing in Litas. National inflation levels are less related to Euro interest rate. Yet, for loans in Litas, *Inflation* variable has no significant correlation with the share of STFRM. *STFRM rate* variable has significant correlation with both Litas and Euro loans. Also, the variable has lower correlations with interest rate differential variables. Due to these reasons, I choose *STFRM rate* variable for Hypothesis *H61* testing. Other interest rate related variables – differentials between LTFRM interest rate and various short term interest rate benchmarks – are of different significance. *LTFRM-STFRM* gap is significant for Litas loans, *LTFRM-inflation* gap – for Euro loans, *Rule of thumb* – for both. As one of the goals of the research is to analyse whether households base their decisions on straightforward benchmarks (*LTFRM-STFRM*), or more sophisticated, the variables should be tested by alternating them.

Inconsistent effects of the explanatory variables for different currencies imply that there could be other factors that influence STFRM demand. Actually, households choose not out of the two options (LTFRM or STFRM), but out of the four options: LTFRM in Litas, LTFRM in Euro, STFRM in Litas and STFRM in Euro. Due to the sovereign risk, interest rate for loans in Litas is usually higher than for loans in Euro – both for LTFRM and for STFRM. It follows, that those who prefer borrowing in Litas should have a motive to pay higher interest rates. That motive could be currency risk, although Lithuanian national currency Litas has a peg to Euro and the exchange rate has never been adjusted. The share of loans in national currency fluctuates (see Figure 11). It is not clear whether households first decide on the currency risk or on the interest rate risk. To control for the currency risk effects, I introduce currency risk control variable into the main regression. I construct the variable as a difference between VILIBOR 6 months and EURIBOR 6 months.

Following V. Lapinskas (2011), the differential reflects country default risk and may have impact on its currency exchange rate. Correlation between the constructed currency risk variable and the share of loans in Euro is significant and negative (-0.348) which means that when the currency risk is increasing, the share of new loans in Euro decreases. Bivariate correlation between currency risk and STFRM share is non-significant for the whole sample, but becomes significant for the Euro loans STFRM share (0.243).

To test hypotheses *H4, H5, H6 (H61 and H62)*, I augment multivariate regression equations:

STFRM = *House Price + Unemployment + STFRM rate + LTFRM-STFRM + Currency risk* + ε $\qquad$ (3)

STFRM = *House Price + Unemployment + STFRM rate + Rule of Thumb + Currency risk* + ε $\qquad$ (4)

STFRM = *House Price + Unemployment + STFRM rate + LTFRM-inflation + Currency risk* + ε $\qquad$ (5)

By construction, the share of STFRM is bounded between zero and one. This censored support of the dependent requires a Tobit approach to be used. The regressions are run separately for loans in Litas and loans in Euro. The regressions results are presented in the Table 15.

Table 15

Market conditions' relationship with STFRM choice based on Tobit regression results

Indicator	(1)	(2)	(3)	(4)	(5)	(6)
House Price	0.167***	0.155***	0.152***	0.366***	0.307***	0.395***
	(0.043)	(0.051)	(0.046)	(0.051)	(0.053)	(0.053)
Unemployment	-1.539***	-1.300***	-1.456***	0.822**	-0.052	0.466
	(0.275)	(0.308)	(0.286)	(0.348)	(0.356)	(0.331)
STFRM rate	-3.245***	-3.784***	-3.688***	-7.308***	-7.050***	-6.371***
	(0.959)	(1.109)	(0.000)	(1.104)	(1.015)	(1.168)
LTFRM-STFRM	2.058**			-4.361**		
	(0.663)			(1.066)		
Rule of Thumb		1.050			2.546	
		(0.708)			(1.673)	
LTFRM– inflation			0.450			0.031
			(0.312)			(0.431)

Note: Statistically significant at: *0.10, **0.05, ***0.01 levels (two-tailed); the dependent variable is STFRM share in new lending volumes; control variable is currency risk. Columns 1, 2, 3 are for loans in Litas, 4, 5, 6 – for loans in Euro. Number of observations and Wald-Statistics: (1) 111 and 146.802; (2) 100 and 111.790; (3) 111 and 130.630; (4) 111 and 201.131; (5) 100 and 158.184; (6) 111 and 187.901. Standard errors in parentheses.

House price expectations effect is positive, significant and consistent for both currencies. Increase in housing price index by 1 percentage point increases the share of STFRM by 0.15 - 0.4 percentage points depending on currency.

Unemployment coefficient has a negative value for loans in Litas. The result indicates that households form extrapolative expectations regarding the unemployment. However, the relationship for loans in Euro is positive (Column 4) and indicates that those who prefer borrowing in Euro form mean-reverting optimistic expectations regarding the unemployment or general income expectations.

STFRM rate variable has a negative sign and large value for loans in Litas and Euro. This result indicates that households, form extrapolative expectations. STFRM interest rate level variable is the strongest variable, indicating that 1 percentage point increase in STFRM interest rate level decreases the share of STFRM by 3.2-7.3 percentage points depending on the currency of the loan.

Out of interest rate differentials, the strongest statistically and economically is the straightforward *LTFRM-STFRM* differential. However, the sign is different for different currency loans indicating that those who borrow in Litas form mean-reverting expectations or judge only based on the cost of two alternative mortgages. One percentage point increase in the LTFRM-STFRM differential increases the share of STFRM loans in Litas by 2 percentage points. On the other hand, those who prefer borrowing in Euro, form extrapolative expectations. One percentage point increase in the LTFRM-STFRM differential decreases the share of STFRMs by 4.4 percentage points.

3.5. Discussion of the results of the conceptual model of household mortgage interest rate type hypotheses empirical testing

The major intents of this research were to (1) determine what factors and how influence household mortgage interest rate type choice; (2) to detect when a financial institution should intervene and influence household choice to prevent the over-exposure to interest rate risk. Also the hypotheses are formulated to compare which of the models – the normative optimal choice model of the proposed model based on the behavioural approach – better explains household behaviour.

3.5.1. Household characteristics' influence on mortgage interest rate type choice

Empirical results of the research of household characteristics' relation with the mortgage interest rate type choice show that household characteristics' explanatory power is weak. This finding is consistent with the existing research literature. M. Hullgren and I. Soederberg (2013) report $R^2 = 0.115$ with the sample of 505 observations, D. Bergstresser and J. Beshears (2010) report $R^2 = 0.0503$ for the OLS regression in the sample of 5,385, M. Paiella and A. F. Pozzolo (2007), P. Zocchi (2011) report higher R^2 – correspondingly 0.13 (sample 420) and 0.35 (sample 908), but they have also included mortgage characteristics into the regression. Other authors (Coulibaly and Li, 2009, Damen and Buyst, 2013; Ehrmann and Ziegelmeyer, 2011) do not report R^2, of their regression models. Still, the results allow concluding about the relationship between household characteristics and mortgage interest rate type choice.

Current consumption constraints

In the Lithuanian mortgage market, the strongest effect is observed by the mortgage payment to income ratio (*Payment to Income*). The estimate of the logistic regression analysis shows that the higher the ratio, the lower the probability that a household will have a STFRM. Yet, the direction of the effect is opposite to the direction proposed by the hypothesis *H1*.

The negative impact of *Payments to Income* is inconsistent with M. Ehrmann and M. Ziegelmeyer (2014) who analyse Eurozone countries mortgage markets, P. Zocchi (2011) who analyse Italian mortgage market. P. M. Bacon and P. G. Moffat (2011) analyse the UK market and measure current borrowing constraints by loan to income ratio. They also find that the higher the mortgage compared to income, the higher probability of STFRM. B. Coulibaly and G. Li (2009) present analogous findings from the US market.

In this research, the negative impact of current consumption constraints upon STFRM choice is robust for the households in different income groups: both richer and poorer households prefer LTFRM when their payment to income ratio is increasing. This finding is inconsistent with S. Damen and E. Buyst (2013) findings that rich households opt for a more expensive but safer LTFRM. Also, the finding is

inconsistent with J. K. Brueckner and J. R. Follain (1988) who find the opposite – higher income makes STFRM more probable.

The additional tests when sample is split by the year of the loan origination show that result is not robust. The coefficient is negative and significant before the year 2009, but later the statistical significance diminishes and the coefficient brings a positive sign. What are these time specific features that change the way how household characteristics influence the mortgage choice? This is not in the scope of current research, so I just provide several possible explanations. Firstly, economic environment is different. The interest rate levels post-2008 in Euro and post-2009 in Litas are at the record low. Secondly, the borrower profile is assumingly less risk averse. The 2009-2012 borrowers were those lucky to keep their jobs and income while unemployment increased to double digits and aggregate income shrank (see Figure 6). Post-2008 borrowers' behaviour was counter-cyclical: they acquired housing when housing prices were still falling down (see Figure 8). Thirdly, emerging market gradually transforms to mature market, mortgage borrowing and lending experience is growing with every year, and households' behaviour patterns become less divergent compared to the mature markets. Based on the above, I conclude that current constraints' influence upon household mortgage interest rate type choice is dependent on the economic and institutional environment.

So far, the hypothesis *H1* should be rejected. The result of the empirical research suggests that currently constrained households opt for LTFRM. This finding contradicts the main assumption of the proposed behavioural model that households with current consumption constraints set their pre-mortgage consumption as the reference point and suffer from temporal bias. Yet, to reject the behavioural assumption, one should be sure that these households were not influenced (de-biased) by financial institutions prior the making their final contract choice. Unfortunately, based on the available data, I cannot control that. The current rejection of hypothesis *H1* is also not sufficient to reject assumption of the normative optimal choice model. The Lithuanian mortgage market is characterized by binding constraints (as discussed in 3.1). When currently constrained households choose LTFRM in the environment of binding constraints, they demonstrate rational behaviour.

Future consumption constraints

In the Lithuanian mortgage market, future consumption constraints' effects are smaller than that of the current consumption constraints. Normative predictions related hypotheses *H2A1* and *H2A2* tests provide mixed results. Relationship between limited access to credit indicators and the probability of STFRM choice is positive while relationship between volatile income indicators and the probability of STFRM choice shows versatile effects depending on the measurement indicators.

Coefficients of the both indicators of limited access to credit are positive. *Loan to value* ratio coefficient has a low value. The positive, though small, effect of *Loan to value* ratio is robust in different years and in different income groups. *Obligations* coefficient value is higher – the odds that a household with other obligations will have a STFRM are higher by 28 percent compared to a household with no other obligations. The sign of the coefficient is consistent through different years, though statistical significance appears only during the economic growth 2005-2007.

There are few comparisons with the existing literature available. D. Bergstresser and J. Beshears (2010) measure self-certified borrowing constraints and rolling credit card balance and find the relationship positive and significant. K. W. Johnson and G. Li (2011) measure card usage and find it positively related with STFRM choice, B. Coulibaly and G. Li (2009) measure non-housing debt to income ratio and find relationship non-significant. S. Damen and E. Buyst (2013) measure *Loan to Value* ratio and find the effect positive, but only for low income earners.

The finding in Lithuanian market is inconsistent with the normative optimal choice predictions. The Hypothesis *H2A1* is rejected. However, one could argue that having obligations does not necessarily imply borrowing constraints. Households with other obligations may be either constrained or non-constrained. The mortgage takers may be certain about their future income and take another loan to enjoy a more luxurious lifestyle. Poorer households' residual income may be insufficient to be approved for any additional loan. Therefore, other obligations may be a better signal of borrower's attitude towards credit than of borrowing constraints. K. W. Johnson and G. Li (2011) measure this attitude and find that STFRM borrowers are more positively disposed to using credit. Nevertheless, the household characteristic of having other obligations is positively related with the probability of STFRM choice

and should be taken with appropriate cautiousness, despite the arguments that other obligations may be a poor indicator of future borrowing constraints.

The relationship between volatile income and probability of STFRM choice is not clear. The indicator of having no savings has a negative sign, but lacks statistical significance. *Single adult* proxy of volatile income measured as one income earner in the family is related with the higher probability of STFRM choice. The odds of STFRM choice for a household with one single adult are higher by 38 percent compared to a household with larger number of adults. This is the second strongest coefficient value after *Payment to Income* ratio. Lower income volatility measured as *Education* level slightly increases the probability of STFRM choice.

In the original regression model, *No savings* coefficient is not significant. However, the deeper analysis shows that the coefficient is significant and negative for loans originated in 2005 – 2007, but the sign changes for loans originated in 2009 and later. The odds that a household with no savings has chosen the STFRM are almost twice higher compared to a household with savings in 2009-2012. There are three explanations of the sign switch. Firstly, in 2009-2012 households could suffer from the economic downturn in the country, thus, current consumption constraints could cause the choice of the cheaper STFRM. Secondly, households' risk aversion could be lower (as discussed in the previous paragraphs). This assumption is approved by income quintile tests. The test of *No Savings* in different income groups shows that those with lower income (1st quintile) have negative relationship between having no savings and STFRM choice likelihood, though those with higher income (4th quintile) – positive (Annex 9A). Thirdly, at the beginning of the mortgage contract households could have low savings due to the reason that they had just paid the downpayment. Later they have more spare funds to accumulate as savings. This assumption is approved when the duration between loan origination and the Survey is controlled (Annex 8A): for loans originated not longer than 3 years prior the Survey, *No Savings* has a positive sign, for households where the time gap from the loan origination year to the Survey year is longer, *No Savings* indicator has a negative impact on STFRM choice. This explanation leads to the assumption that STFRM borrowers are more likely to have savings, but it takes time to accumulate them. The *No Savings* effect is not clear. However, the assumption that households lack savings in the early years of the mortgage loan should increase cautiousness.

Based on previous research, most defaults occur between two and eight years into the life of the loan (Campbell, 2011).

Single adult ratio has a consistent positive value during different economic cycle stages and in different income groups. The positive effect is inconsistent with the normative theory which states that households with volatile income should opt for STFRM. In the existing literature, P. Zocchi (2011) also finds that the lower number of income earners, the higher the probability of STFRM choice. Others find that the number of income earners (Ehrmann and Ziegelmeyer, 2013) or family size (Coulibaly and Li, 2009) or married couple households (Paiella and Pozzolo, 2007) effect on mortgage interest rate type choice is non-significant.

Education coefficient is positive and statistically significant though of low economic significance. The additional degree in education increases the odds of STFRM choice by 11 percent. The effect is persistent by year of the loan origination and by household income group. The highest value, though, is observed in the lowest income quintile. The positive effect of education is consistent with normative predictions and with the empirical findings by B. Coulibaly and G. Li (2009) and inconsistent with P. Zocchi (2011) findings. The more significant positive education effect for the lower income earners is consistent with M. Hullgren and I. Soederberg and inconsistent with S. Damen and E. Buyst (2013).

All told, *Single Adult* is a strong predictor of STFRM choice. Significance of having no savings is lower both economically and statistically. Also, the indicator is suspicious for having change since the loan origination. *Education* may capture other effects than income volatility. Other authors use education as financial literacy or risk aversion indicator. Based on these reasons, despite the mixed results of the income volatility indicators, I conclude that in the Lithuanian market, volatile income is positively related with the STFRM choice, though the measurement of volatile income by indicator of single adult in the household is not with no criticism. *Single Adult* may also capture risk aversion as according to D. A. Love (2010) larger households due to the random liquidity needs may be less averse. In the research sample, the positive effect of single adults is of stronger significance for households with no children (See Annex 10A).

To generalize the discussion, contrary to the normative predictions, future consumption constraints increase the probability of STFRM choice. Hypotheses *H2A1* and *H2A2* are rejected.

Joint effect of future consumption constraints and current consumption constraints

According to the behavioural predictions, households with current consumption constraints should neglect future consumption constraints. However, test results do not confirm hypothesis H2B (*H2B1* and *H2B2*). Low residual income (which is identified as less than average costs of living and indicates absolute current consumption constraints) in interaction with future consumption constraints variables is persistently negatively related with STFRM choice. Households with low residual income and either limited access to credit or volatile income do not show higher probability of STFRM choice. Those with low residual income and other obligations more probably will choose LTFRM (the odds are higher by 38 percent compared to those with no joint constraints). The result is inconsistent with S. Damen and E. Buyst (2013) who find that lower income households with higher loan-to-value ratios prefer STFRM mortgages. The proposed behavioural model's prediction that currently constrained households who also have future constraints' indications opt for a cheaper but more volatile STFRM is rejected and contradicts the assumption that currently constrained households neglect future constraints and suffer from the temporal bias (contrary to P. Zocchi, 2011). The findings raise counter-assumption: household expectations of their future constraints depend on their current constraints.

Risk aversion

Based on the research results, risk aversion measured by having children in the households has no significant effect on mortgage interest rate type choice. The hypothesis *H3* is not accepted. Yet, the sample split into households with children and those without shows that future constraints indicators' coefficients become statistically significant (positive) in households with no children.

There is no much evidence in previous research. B. Coulibaly and G. Li (2009) find that risk aversion measured as self-certified risk aversion changes how household characteristics affect mortgage interest rate type choice. J. Bergstresser and D. Beshears (2010) find negative impact of self-certified risk aversion on the

STFRM choice. While P. G. Bacon and P. M. Moffat (2011) argue that high mortgage to income ratio is a signal of low risk aversion itself.

The result of this research leads to the conclusion that children in the house is a weak indicator of risk aversion. Based on the assumption that low risk aversion should increase probability of STFRM choice, out of the list of the variables and based on other authors' risk aversion measurement indicators, *Single Adult* and *Obligations* could be these indicators. *Single Adult* might choose riskier options as he or she would not care about other household members' random liquidity needs, especially if young (Dohmen et al, 2011; Guiso and Paiella, 2008). *Obligations* may signal about attitude towards borrowing and risk taking (Johnson and Li, 2011; Bacon and Moffat, 2011).

3.5.2. Market conditions' influence on mortgage interest rate type choice

Market conditions' effect on household mortgage interest rate type choice is measured as market conditions' relationship with the share of STFRM in new lending. This way does not capture the number of borrowers just the lending volumes. Thus, influence of the rich households with large mortgages can be over-weighted. Also, the share of STFRM in new lending volumes reflects not only the demand side (household) effects, but also the supply side (financial institutions') effects. On the other hand, these limitations still allow answering the research question: under which market conditions STFRM demand increases.

Housing price

Research on market characteristics influence on the share of STFRM show that hypothesis *H4* can be accepted under the assumption that households form extrapolative housing price expectations based on the recent housing price developments. The positive coefficient of the right hand variable *House Price* is statistically significant and robust, though relatively weak. The positive coefficient is consistent with the findings of Furlong and Takhtamanova (2012) who claim that house price appreciation during the housing boom significantly influences homebuyer selection of STFRM over LTFRM. The result is also consistent with the findings of K. Scanlon et al (2009) who claim that house price increase is inter-related with mortgage demand increase. Increasing housing prices and increasing mortgage demand is also related to the increasing competition in the mortgage

market. As a result of this competition, interest rate risk is shifted to households to make mortgage initial monthly payments lower. Due to this reason, more households are provided with more opportunities to take larger mortgages. However, behavioural theories and the recent housing bubble experience warn that under "natural" (DellaVigna, 2009) or "simplistic" (Fuster et al, 2011) expectations, market beliefs are often characterized by endogenous extrapolation bias. Beliefs may be too optimistic in good times relative to the rational expectations benchmark (Fuster et al, 2011).

General income

Hypothesis *H5* assumes that in a good economic environment, when there is high confidence in the future income, households are encouraged to accept the payment risk inherent in STFRM. Income expectations are inverse reflections of the unemployment level which is measured in this research.

The hypothesis test results are versatile: those who borrow in Litas behave according to the predictions; those who borrow in the Euro behave contrary to the predictions. There could at least three plausible explanations of the different behaviour. Firstly, the time-series data may be contaminated by loans which are not new but refinanced. Refinancing activities – when household decides just to change the loan terms – can be high in high unemployment periods as some of the households may attempt to decrease monthly payments of their loans as they suffer from income decrease. STFRM in Euro requires the lowest monthly payments. Thus, switching from LTFRM to STFRM in either currency or from the Litas loan to STFRM in Euro helps households to smooth their consumption. Secondly, mortgage foreign currency choice may reflect higher household's risk aversion as found by S. Ongena et al (2010). Thirdly, it might be related with lower volatility of Euro interest rate. In this sense, borrowing in Euro can already be perceived as insurance against interest rate volatility. Thus, the assumption that in periods when aggregate income declines, households choose a less volatile interest rate cannot be rejected although it is confirmed only for Litas loans.

Interest rate level

Hypothesis *H61* assumes that households form mean-reverting expectations when the interest rate (or inflation) level is high. The test results show that this hypothesis is not confirmed. The impact of interest rate on STFRM choice is negative. Statistical significance is slightly lower for loans in Litas. D. N. MacDonald

and K. Winson-Geideman (2012) find that higher anticipated inflation held with certainty increases the proportion of STFRM originations, while greater inflation uncertainty decreases it. In Lithuania, a country with volatile inflation and interest rates, increasing levels of interest rate and inflation increase uncertainty. The effect is stronger for loans in Euros. This can also be explained by a higher uncertainty: when loan currency is not the national currency. Foreign country (in this case Eurozone) inflation can be perceived as less familiar. Also, "national" inflation or interest rate level may serve as a benchmark for future expectations of foreign currency loan interest rate. This is consistent with anchoring bias presented in the behavioural literature (Tversky and Kahneman, 1974; Kahneman, 1992; Kahneman and Thaler, 2006). When interest rate for loans in national currency is high, households may expect relatively low long term interest rate for loans in foreign currency to rise.

The *STFRM rate* variable is the strongest variable. The correlation coefficient between inflation and STFRM interest rate for Litas loans is 0.48 and increases when inflation is lagged: 10 month lagged inflation and STFRM interest rate in Litas correlation coefficient reaches the value of 0.81. However, the interest rate differential variable *LTFRM – inflation* which captures lagged inflation, is non-significant statistically. This result suggests that households tend not to capture lagged effects and make their decisions based on current situation only. This is consistent with the findings of Fuster et al (2011) who suggest that people do not consider sufficient number of past periods while making their decisions. The opposite than expected result suggests that households may form extrapolative expectations regarding interest rate changes. However, it could be dangerous in the environment of the low interest rates.

Interest rate differentials

Analysis of various differentials influence on the share of STFRM in new lending shows that higher differentials make positive influence on STFRM choice for Litas loans and negative for Euro loans. The discussion of different behaviour of households borrowing in different currencies is presented in the earlier paragraphs. The potential reasoning for different differentials' effect is the same – greater uncertainty for foreign currency loan interest rate (MacDonald and Geideman, 2012) or anchoring on the national inflation levels to predict future interest rate for foreign

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currency loans (Kahneman and Tversky, 1974; Kahneman, 1992; Kahneman and Thaler, 2006). The strongest variable for both loans is the straightforward differential *LTFRM-STFRM.* This result supports the finding that households base their decisions mostly on current conditions.

The summary of the empirical research results of household characteristics and market conditions' effect on STFRM choice are provided in the Figure 14.
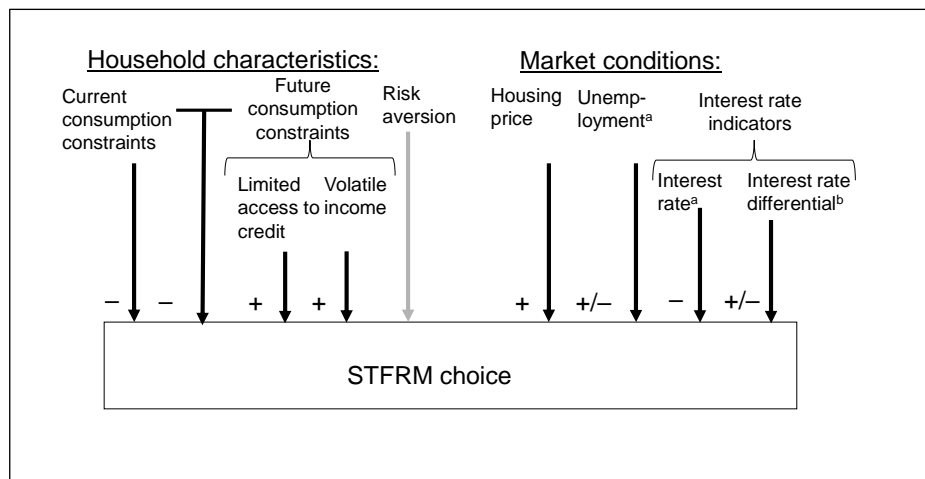
Figure 14. Empirical test results for hypothesized relationship between household characteristic and market conditions and STFRM choice

Notes. "+" indicates positive influence, "–" indicates negative influence. Influence estimates are based on statistically significant test results. [a]Influence of unemployment is negative for loans in Litas and positive for loans in Euro. [b]Interest rate differential's influence is positive for loans in Litas and negative loans in Euro.

The results allow comparison of the two mortgage interest rate type choice models presented in this research: the normative model by J. Y. Campbell and J. F. Cocco (2003) and in this dissertation proposed model. The normative model states that current consumption constrained households should opt for STFRM unless they have future consumption constraints. The research results does not support the predictions of the normative model as, based on the results of the empirical research, households with current consumption constraints prefer LTFRM while future borrowing constraints influence is positive. However, assuming that Lithuanian mortgage market is characterized by binding constraints, households with current constraints choice of LTFRM is optimal. Future consumption constraints have a positive effect on STFRM choice. This result is inconsistent with the normative

predictions. However, one may argue if other obligations or being single adult in the household are true future borrowing constraints.

On the other hand, research results do not confirm the proposed model's assumptions that currently consumption constrained households prefer STFRM and neglect future consumption constraints. It is not clear, whether financial institution has not de-biased the present-biased borrowers. A further investigation is needed to understand how households set their reference points. Despite of the fact that the results of the empirical research do not fully support the initial position, the model was tested under specific conditions of one country (Lithuania) and the data on household characteristics had relevant limitations.

The following limitations of the research should be noted:

- The assumption regarding households' reference point was based on the empirical research in other countries. A different institutional setting with binding constraints may have changed the expected effects of current constraints. A deeper investigation of how households make their decisions, how they set their reference points, what is the influence of the negotiating financial institution is needed.

- Limited access to credit, income volatility, and risk aversion were measured as household characteristics at the time of the Survey and not the loan origination Future constraints should be measured by more accurate indicators.

- Household expectations regarding house prices, income, and interest rate are assumed based on the indirect evidence – the variation of the STFRM share in the new lending. It would be useful to measure household expectations directly.

- The episodes of deflationary environment were rather short in the observed period. Household interest rate expectations should be researched in the setting of low interest rates.

- Market conditions' effects are different for foreign currency loans. The effect of foreing currency borrowing on mortgage interest rate type choice stll needs to be researched.

3.6. Managerial implications

Mortgage interest rate type preferences by a financial institution may be at odds with mortgage interest rate type preferences of a household. Initially cheaper STFRMs may increase lending and borrowing volumes as larger mortgages are available to a larger share of the population. However, household's over-exposure to interest rate risk is closely related with financial institution's credit risk and reputational risk, which may affect the financial institution's profitability at a much wider scope. Thus, a financial institution should play a proper role in managing household's exposure to mortgage interest rate risk via influencing household's interest rate type choice.

Based on normative recommendations of the optimal mortgage interest rate type choice, households with future consumption constraints would be adversely affected by payment shocks caused by interest rate volatility. Under future constraints, high mortgage to value ratios, large obligations to assets ratios and volatile income are assumed. Households with such characteristics should choose LTFRM. The market conditions are also relevant. Mortgage markets in emerging countries are characterized by high volatility of income, asset price, and interest rate. These are also the features of the above mentioned future constraints. Households in these markets are sensitive to interest rate increases, especially those with binding household level constraints. Thus, households, especially constrained ones, should prefer LTFRM. However, the evidence shows that demand is higher for the STFRM. In the case of Lithuania, on average, 80 percent of new mortgage borrowing volume was STFRM during 2004-2013.

Behavioural research demonstrates that households may behave in a sub-optimal way which leads to over-exposure to various risks. Households may be unable to manage their financial affairs in their own long-term interest. Households take out mortgages relatively infrequently, often negotiate them at the same time that they are undergoing a major life transition, are affected by various surrounding pressures. Under these circumstances, it is not surprising, that household decisions, particularly by those with less financial sophistication, appear to be sub-optimal.

Empirical research in the Lithuanian mortgage market shows that currently constrained households, i.e. those with high mortgage payment to income ratios, are more likely to choose LTFRM. However, the result does not disclose whether this

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choice was a household decision initially or it occurred after the talks with the financial institution. According to the varying situation in other markets, much should depend on the institutional background, including financial institutions' behaviour. In more mature markets, there is evidence of household interest rate risk over-exposure (including, but not limited to the Italian, Flanders region (Belgium), the UK, Swedish and the US markets). In these markets borrowers seem to be less interest rate risk averse and/or demonstrate more myopic behaviour. In Lithuania, in the most recent years the strong positive effect of high payment to income ratio on LTFRM choice has diminished.

In Lithuania, the higher likelihood of STFRM choice is observed in case of higher loan to value ratios, existence of other obligations, single adult households, and higher level of finished education. Assumedly, households with higher degree of education have better financial literacy so they should better understand the STFRM related risks. Also their income volatility seems to be lower and they should be more successful at managing temporary income decreases or expenditure increases, including mortgage interest expenditure. Yet, other obligations and higher loan to value ratios signal about higher debt levels. Being single adult in the family increases the probability of income shocks. Having no savings is positively related with the likelihood of STFRM choice especially in early years of the mortgage contract. Based on previous research, most defaults occur between two and eight years into the life of the loan, thus, financial institutions should encourage households with STFRMs to acquire some savings.

Research of market characteristics' influence on mortgage interest rate type choice shows that increasing housing prices result in increasing household demand for STFRM. One may assume that expected housing price growth decreases perceived probability of future consumption constraints as the value of equity against which households may borrow increases. On the other hand, growing house prices increase the willingness to borrow even financially constrained households who cannot afford long term interest rates. Thus, when housing prices are increasing, financial institutions should pay adequate attention to borrower's characteristics.

Market characteristics' influence on STFRM choice is different by currency. Borrowing in Litas behaviour follows the predictions of the previous research: low unemployment, increasing interest rate differentials, is related with increasing

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demand of STFRM. However, borrowing in Euro behaviour is inconsistent with the predictions. High unemployment results in the increasing share of STFRM. That leads to the assumption that in period of higher unemployment, households may follow cost-minimization principle – choose STFRM in Euro as the cheapest option and neglect income risks.

The negative effect of high STFRM rate level on STFRM choice prompts that households form extrapolative interest rate expectations. Ih this principle holds in the environment of low interest rates, households may expect low interest rates for too long. Thus, households should be informed about historical interest rate fluctuations.

Summarizing the results of market characteristics' influence research, financial institutions should be more cautious when an economy is growing. When an economy is declining, higher attention is needed for households who choose to borrow in a foreign currency. Euro introduction in Lithuania would eliminate the latter concern.

After the euro introduction, the relative attractiveness of the cost of insurance (in Euro) would diminish. Thus, introduction of Euro may decrease overall demand of LTFRM and increase household over-exposure to interest rate risks.

For households with previously listed characteristics that increase the likelihood of STFRM choice, especially under the aforementioned market circumstances, financial institutions should manage household choices, preventing risk over-exposure. The methods of influence discussed in the previous literature include product features, pricing, and advice.

If the goal is to protect households from the over-exposure to interest rate shocks, product innovations should include terms that are less likely to cause later regret by buyers who are often present-oriented and have limited financial literacy. The mortgage product innovations related literature (Campbell, et al, 2013, Shiller, 2013) proposes inflation indexed mortgages; STFRM mortgages with level nominal or real payments and a principal balance that adjusts to variations in short-term nominal interest rates; prepayment/switch option in a deflationary environment; mortgage modification as an alternative to foreclosure when unexpected circumstances arise.

There is ample evidence, that the relative price of alternative products may trigger the demand for certain interest rate type mortgages.

Financial institutions or regulatory bodies might develop and introduce other benchmarks, such as an inflation expectations index or requirement to publish both LTFRM and STFRM rates to provide potential borrowers with the relevant information.

The complexity of the mortgage interest rate type decision process can be overwhelming to ordinary consumers. And thus professional advice may assist. There are three routes through which to improve borrowers' understanding and help them to make better-informed decisions: (1) improving the standard of verbal advice given to borrowers during the sales process; (2) improving the standard of documentation that lenders are required to provide during the sales process; (3) improving the decision-making capability of the borrowers themselves.

Significant steps are already done in the field of the provisions of advice. The Bank of Lithuania has approved the Responsible Lending Regulation effective since 2012 which "obliges credit institutions to assess in every possible way the borrower's ability to repay the credit in the long term". The Bank also regulates the information required to provide prior to granting credit with a variable interest rate: "Institutions shall calculate the amounts of repayment of the principal and payment of interest applying the interest rate base existing at the moment of granting a credit increased by 4 and 8 percentage points".

Based on the time frame of current borrowing constraints and future borrowing constraints, I would add the recommendation to monitor mortgage takers after the mortgage is provided – to follow their saving levels and other obligations. This right and mechanisms enabling the collection of such information about existing borrowers should be ensured for financial institutions.

CONCLUSIONS

In order to achieve the main aim of the doctoral dissertation and carrying out formulated tasks, the main results of the theoretical and empirical research are summarized in the following conclusions.

1. The analysis of the literature reviewed in the first part of the dissertation, seeking to outline factors influencing household mortgage interest rate type choices and their predicted influence leads to the following conclusions:

    *   Recent optimal mortgage choice models propose optimal mortgage choices to be based on household characteristics and market conditions.

    *   Optimal mortgage choice models show that LTFRM should be preferred by high risk averse households, by those who plan to use large mortgages relatively to their labour income, by borrowers with a highly volatile labour income and low probability of moving.

    *   Based on optimal mortgage choice models, households should choose STFRM if the inflation premium or real rate risk premium is high.

    *   Empirical evidence shows that pricing variables (market characteristics) have a powerful explanatory power of household's behaviour while household characteristics heterogeneity plays a minor role.

    *   Empirical research provides controversial evidence and shows that household behaviour deviates from normative predictions. Large mortgages to income are proved to increase the probability of STFRM choice. High loan to value ratios are proved to increase probability of STFRM choice. Evidence on the role of labour income risk and differences in risk attitudes is scarce.

2. Analysis of the behavioural literature seeking to provide alternative explanation of household mortgage interest rate type choice decision making that would be consistent to the empirical evidence leads to the following conclusions:

    *   Most of the normative recommendations are based on conventional rational utility maximization models, however in practice many borrowers do not have a solid appreciation of their risk nor do they know that they ought to reduce risks.

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- Research in household borrowing decisions show that households tend to be overly optimistic and over-confident regarding their own susceptibility to risk or too "narrow thinking" and focusing only on monthly payments in making long term credit.

- Normative recommendations are useful and important as to provide benchmarks to evaluate how efficient households are in choosing mortgage types.

3. Analysis of the managerial literature seeking to disclose inter-relation between a financial institution and a household in the household mortgage interest rate type choice leads to the following conclusions:

- Interest rate risk management in a financial institution is at odds of interest rate risk management by a household. Interest rate shift towards households increases the market share.

- Household exposure to interest rate risk is closely related with financial institution's credit risk and reputational risk, which may affect profitability at a much wider scope. Thus, financial institution should play its proper role in managing household's exposure to mortgage interest rate risk.

- To manage household interest rate risk and financial institution's credit risk and reputation risk, the institution may employ pricing strategies, product innovations, and direct advice to households in order to prevent sub-optimal household mortgage interest rate type choice.

4. The proposed conceptual model for household interest rate risk management by managing households' choices was designed considering the gaps between theoretical predictions and empirical evidence. The model includes essential methodological aspects, drawn on literature research:

- At the core of the model is decision making under uncertainty based on PT, according to which the household behaviour depends on its reference points, based on which outcomes of the decision are coded as gains or losses. Households seek to avoid losses.

- Based on the previous empirical research, the model assumes that reference points of different households can be differentiated by household characteristics. Households with current household consumption constraints would set the pre-mortgage consumption level

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as the reference point and compare the consumption when the mortgage is already taken to the consumption level before the mortgage takeout. The perceived loss is larger initial payments. Trying to minimize the loss, currently constrained households would choose riskier STFRM.

- Household characteristics signalling sensitivity to interest rate increases in the future are large mortgages to their income and/or assets, volatile income, high indebtedness, and low risk aversion. Contrary to normative predictions, currently constrained households would neglect future consumption constraints and would prefer STFRM.

- Market conditions are important for the expectations' formation. Based on previous research, the model assumes that under certain market characteristics – increasing income, increasing housing prices, high inflation, and large interest rate differentials – STFRM becomes more attractive.

- Financial institutions, seeking to manage not only their interest rate risk and credit risk but also reputational risk, should identify households with characteristics unreasonably positively related with the probability of the STFRM choice. Furthermore, they should be especially cautious under market conditions in which STFRM becomes even more attractive.

5. For the empirical testing of the designed conceptual model and theoretical hypotheses, the author chose the Lithuanian mortgage market. Theoretical model testing was performed in the Lithuanian mortgage market, covering the period of 2004-2014 based on Household with Housing Loans Survey data and time-series data of new lending volumes and interest rate. The empirical results are as follows:

- Consumption constrained households are more likely to choose LTFRM.

- Households with limited access to credit are more likely to choose STFRM.

- Households with volatile income are more likely to choose STFRM.

- Households with current constraints and limited access to credit or volatile income were not confirmed to be more likely to choose STFRM.

- Increasing housing prices slightly increase the demand of STFRM.

- Higher unemployment increase the demand of LTFRM for those who borrow in Litas and increase the demand of STFRM for those who borrow in Euro.

- High interest rate level increases the demand of LTFRM.

- Larger interest rate spreads increase the demand of STFRM for those who borrow in Litas and increase the demand of LTFRM for those who borrow in Euro.

6. Following on from the theoretical and empirical research, managerial implications for household mortgage interest rate type choice management are as follows:

- The results of the empirical test suggest that currently constrained households in Lithuanian market behave rationally and, in the presence of future constraints incurred by institutional and economic setting, choose LTFRM. However, recent developments show that this relationship between current constraints and LTFRM choice is weakening. Thus, financial institutions should keep cautiousness about currently constrained households.

- Other obligations, single adult in the household, and having no savings in the beginning of the contract are household characteristics related with higher probability of STFRM choice. Household financial and demographic situation should be monitored after the mortgage takeout.

- Households, who choose to borrow in Euro in economic downturn times, tend to expose themselves to the interest rate risk. This behaviour may signal about myopic cost-minimization principle based choice.

- Euro introduction may decrease demand of LTFRM as Euro loans of this type will lose their relative attractiveness.

- To manage a household's choice, financial institutions might enhance product innovation, pricing, and advice. Product innovation might include terms that are less likely to cause later regret by buyers who are often present-oriented and have limited financial literacy.

- The financial institutions or regulatory bodies might develop and introduce benchmarks, such as LTFRM rate, expected STFRM or

expected inflation to provide households with a better base for interest rate expectations.

Regarding the limitations of empirical study, presented in the doctoral dissertation, the following research directions for the future are as follows:

- The research of the behaviour of non-constrained households and their optimal mortgage choice.
- Household mortgage choices in deflationary and low interest rate environment.
- The research of household financial decision making based on the direct evidence of household reference point setting and expectations
- Household mortgage choices and the relationship between interest rate risk and currency risk.
- The methods of financial institutions influence on the households mortgage interest rate type choice.

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ANNEXES

Annex 1. Household with Housing Loans Survey questions used for the research.

B2a. In what year did your household obtain the mortgage loan?
_____ year   0. (N/A)

B3. What was the size of the loan at the time of origination? Please identify the currency and the amount.
a) Loan amount _____ LTL   0. N/A
b) Currency _____   0. N/A
1. LTL
2. EUR
3. USD
4. Other

B5. What was the loan to housing value ratio in percent ?
_____ percent   0. N/A

B6. What is your average monthly mortgage loan instalment in Litas? If loan is of other currency, identify amount and currency .
Average monthly _____LTL   0. N/A

B9. How often does the interest rate of the loan change?
1. More than once a year (variable)
2. Less than once a year (fixed)
0. N/A

B15. Do you or your family have other financial liabilities than the mortgage loan (consumer loan, study loan, payday credits, hire purchase, leasing or others)?
1. Yes
2. No
0. N/A

B22. What of the listed savings or investments do you or other household members have?
1. Savings at home (in Litas or other currency)
2. Deposit in a bank
3. Life insurance
4. Pension funds
5. Mutual funds
6. Securities and shares
7. Real estate investments
8. Other _____ (identify)
9. None of these
10. N/A

D1. How many members (including you) are in your household?
_____ people   0. N/A

D1a. How many children younger than 18 do live in your household?
_____ people   0. N/A

D2. Data of the household member/interviewee education (level reached):
1. Primary.
2. Secondary
3. Vocational

4. Higher (college)
5. Higher (universiity
6. N/A

D3. What is the average monthly income of your household (including salaries, social benefits, scholarships, pensions?
_____ LTL   0. N/A

Annex 2. Survey data: number of respondents and loan volumes in Litas by year of loan origination

Year	LTL						EUR						Grand Total	
	SITRFM		LTIRFM		Total		SITRFM		LTIRFM		Total			
	Number	Volume	Number	Volume	Number	Volume	Number	Volume	Number	Volume	Number	Volume	Number	Volume
1990			2	240000	2	240000							2	240000
1994	1	80000	2	47000	3	127000							3	127000
1995			1	30000	1	30000							1	30000
1996			2	25200	2	25200							2	25200
1997	2	160000	2	96000	4	256000							4	256000
1998	1	34000	5	515000	6	549000							6	549000
1999	2	25000	4	565000	6	590000	2	420000			2	420000	8	1010000
2000	14	1302000	15	1916300	29	3218300	4	598610	6	925750	10	1524360	39	4742660
2001	27	2668500	15	1002000	42	3670500	12	2063117	4	562650	16	2625767	58	6296267
2002	45	5125500	20	2064000	65	7189500	17	2411651	10	1614857	27	4026508	92	11216008
2003	53	5770950	25	2998500	78	8769450	43	6205975	12	2024567	55	8230542	133	16999992
2004	80	9347600	42	5636800	122	14984400	93	13379313	23	4944316	116	18323629	238	33308029
2005	105	13240850	79	9586000	184	22826850	139	23625099	45	7042592	184	30667691	368	53494541
2006	234	32878000	151	19443361	385	52321361	198	38098424	98	17685582	296	55784006	681	108105367
2007	237	34391303	202	26956700	439	61348003	202	42744122	167	30044639	369	72788761	808	134136764
2008	115	18819400	124	21249300	239	40068700	184	41064721	138	26091003	322	67155724	561	107224424
2009	36	5339000	26	3323000	62	8662000	58	12574102	36	6200188	94	18774290	156	27436290
2010	26	3662000	21	1319500	47	4981500	24	4726324	16	2402927	40	7129251	87	12110751
2011	16	2696100	14	891400	30	3587500	17	5844890	11	1642431	28	7487321	58	11074821
2012	3	176500	4	343000	7	519500	3	645554			3	645554	10	1165054

Note: data taken from the Survey of Households with Housing Loans (Bank of Lithuania)

Annex 3. Time-series data: volumes of new lending in mLTL by year

Year	LTL			EUR			Total
	STIRFM	LTIRFM	Total	STIRFM	LTIRFM	Total	
2004	144,4	11,4	155,8	501,3	5	506,3	662,1
2005	969,1	67,6	1036,7	3792,2	16,5	3808,7	4845,4
2006	4082,8	469,4	4552,2	2881,8	216,4	3098,2	7650,4
2007	3552,1	749,4	4301,5	4057,5	2458,2	6515,7	10817,2
2008	1029,7	239,6	1269,3	4340,7	2810,3	7151	8420,3
2009	357,5	30,2	387,7	2758,5	479,5	3238	3625,7
2010	264,7	90,9	355,6	1656,5	426,8	2083,3	2438,9
2011	612,3	271,3	883,6	1723,1	416,4	2139,5	3023,1
2012	735,2	227,6	962,8	1580,3	411,2	1991,5	2954,3
2013	910,9	184,3	1095,2	1910,9	350,6	2261,5	3356,7

Note: data taken form new lending and interest rates time-series (Bank of Lithuania)

Annex 4. Comparison of the descriptive statistics of the household characteristics' variables

	STFRM (N=2,037)				LTFRM (N=1,358)			
	Mean	Min	Max	SDev	Mean	Min	Max	SDev
Payment to Income	0.25	0.03	0.83	0.125	0.2296	0.01	0.83	0.136
Residual income	1,448	500	10,100	949	1,297	500	9,315	797
Loan To Value	0.719	0.06	1	0.214	0.704	0.10	1	0.224
No Savings	0.11	0	1	0.318	0.14	0	1	0.348
Obliga-tions	0.29	0	1	0.454	0.23	0	1	0.423
Single Adult	0.162	0	1	0.368	0.147	0	1	0.354
Educa-tion	4.42	1	5	0.904	4.33	1	5	0.934
Children	0.608	0	1	0.488	0.596	0	1	0.491
Loan amount	163,217	4,000	1,173,952	127,613	153,076	5,000	1,500,000	122,364
Monthly income	4,695	800	24,000	2,357	4,399	1,000	29,000	2,177

Note: data taken from the Survey of Households with Housing Loans (Bank of Lithuania)

Annex 5. Correlation between household characteristics and STFRM choice

	STFRM	Payment To income	Residual Income	Loan To value	Obligations	No Savings	Single Adult	Education
STFRM	1							
Payment To Income	-0.064** (0.001)	1						
Residual Income	0.082** (0.000)	-0.272** (0.000)	1					
Loan To Value	0.028 (0.163)	0.266** (0.000)	-0.012 (0.544)	1				
Obligations	0.063** (0.001)	-0.068** (0.000)	0.056** (0.002)	0.019 (0.318)	1			
No Savings	-0.040* (0.028)	0.048** (0.008)	-0.086** (0.000)	0.000 (0.984)	-0.043* (0.013)	1		
Single Adult	0.020 (0.260)	0.139** (0.000)	0.172** (0.000)	-0.001 (0.941)	-0.036* (0.039)	0.044* (0.011)	1	
Education	0.053** (0.003)	0.052** (0.004)	0.160** (0.000)	0.038* (0.046)	0.004 (0.833)	-0.116** (0.000)	-0.012 (0.474)	1
Children	0.013 (0.470)	-0.131** (0.000)	-0.445** (0.000)	0.067** (0.001)	0.020 (0.250)	-0.001 (0.963)	-0.170** (0.000)	-0.050** (0.004)

. * correlation significant at $p<0.05$, **$p<0.01$ (two-tailed)

Annex 6A. Household characteristics' relationship with mortgage interest rate type choice logistic regression estimates by economic cycle stage

Indicator	Full Sample	Pre-2005	2005-2007	2008	Post-2008
Payment To Income	-1.820***	-1,912*	-2.267***	-1.019	0.979
	(0.372)	(0.984)	(0.504)	(0.878)	(0.134)
Loan to Value	0.005**	0.008	0.006**	-0.005	0.022***
	(0.002)	(0.005)	(0.003)	(0.005)	(0.007)
No Savings	-0.178	-0.045	-0.437**	0.266	1.095**
	(0.137)	(0.420)	(0.176)	(0.365)	(0.484)
Obligations	0.248**	0.052	0.414***	-0.144	0.327
	(0.107)	(0.283)	(0.146)	(0.257)	(0.326)
Single Adult	0.324***	0.524	0.130	0.746**	0.645*
	(0.124)	(0.332)	(0.166)	(0.326)	(0.371)
Education	0.106*	0.140	0.044	0.122	0.483***
	(0.051)	(0.140)	(0.069)	(0.124)	(0.164)
Children	-0.026	0.007	-0.061	-0.090	0.358
	(0.091)	(0.245)	(0.130)	(0.225)	(0.287)
Nagelkerke R^2	0.045	0.281	0.057	0.059	0.135
Observations	2,155	348	1,197	370	240

Notes: statistically significant at: *0.10, **0.05, ***0.01 levels (two-tailed); the dependent variable is STFRM; controlled variables are *Currency of the loan* and *Year of the loan origination.* Standard errors in parentheses.

Annex 6B. Household characteristics' relationship with mortgage interest rate type choice logistic regression estimates by economic cycle stage (joint effects)

Indicator	Full Sample	Pre-2005	2005-2007	2008	Post-2008
Low Residual income x High Loan to Value	-0.249	-1.424***	-0.082	**0.065**	**0.037**
	(0.181)	(0.509)	(0.243)	**(0.418)**	**(0.700)**
Low Residual income x Obligations	-0.376**	-0.336	-0.298	-0.696	0.204
	(0.226)	(0.615)	(0.312)	(0.540)	(0.717)
Low Residual income x No Savings	-0.257	-0.383	-0.208	-0.328	-0.861
	(0.279)	(0.869)	(0.355)	(0.760)	(0.978)
Low Residual income x Single Adult	-0.395	0.447	-0.635*	-0.529	0.365
	(0.283)	(0.810)	(0.377)	(0.723)	(0.947)
Low Residual income x Low Education	-0.049	-0.195	-0.126	-0.146	0.693
	(0.219)	(0.617)	(0.284)	(0.545)	(0.844)
Nagelkerke R^2	0.037	0.083	0.04	0.076	0.147
Observations	2,155	348	1,197	370	240

Notes: Statistically significant at: *0.10, **0.05, ***0.01 levels (two-tailed); the dependent variable is STFRM; controlled variables are *Low Residual Income*, *Loan to Value*, *Obligations*, *No Savings*, *Single Adult*, *Education*, *Children*, *Currency of the loan*, and *Year of the loan origination*. Standard errors in parentheses.

Annex 7A. Household characteristics' relationship with mortgage interest rate type choice logistic regression estimates by loan currency

Indicator	Full Sample	Litas	Euro
Payment to Income	-1.820***	-1.576***	-2.025***
	(0.372)	(0.514)	(0.546)
Loan to Value	0.005**	0.006**	0.004
	(0.002)	(0.003)	(0.003)
No Savings	-0.178	-0.349*	0.047
	(0.137)	(0.188)	(0.211)
Obligations	0.248**	0.590***	-0.052
	(0.107)	(0.157)	(0.147)
Single Adult	0.324***	0.432**	0.197
	(0.124)	(0.171)	(0.183)
Education	0.106*	0.109	0.182
	(0.051)	(0.071)	(0.076)
ChildrenInHouse	-0.026	0.061	-0.096
	(0.091)	(0.133)	(0.137)
Nagelkerke R^2	0.045	0.052	0.032
Observations	2,155	1,072	1,083

Notes: statistically significant at: *0.10, **0.05, ***0.01 levels (two-tailed); the dependent variable is STFRM; controlled variable is *Year of the loan origination*.

Annex 7B. Household characteristics relationship with mortgage interest rate type choice logistic regression estimates by loan currency (joint effects)

Indicator	Full Sample	LItas	Euro
Low Residual income x High Loan to Value	-0.249	-0.265	-0.214
	(0.181)	(0.252)	(0.267)
Low Residual income x Obligations	-0.376**	-0.309	-0.500
	(0.226)	(0.327)	(0.321)
Low Residual income x No Savings	-0.257	-0.156	-0.354
	(0.279)	(0.375)	(0.435)
Low Residual income x Single Adult	-0.395	-0.550	-0.302
	(0.283)	(0.411)	(0.399)
Low Residual income x Low Education	-0.049	-0.266	0.062
	(0.219)	(0.291)	(0.348)
Nagelkerke R^2	0.037	0.047	0.027
Observations	2,155	1,072	1,083

Notes: Statistically significant at: *0.10, **0.05, ***0.01 levels (two-tailed); the dependent variable is STFRM; controlled variables are *Low Residual Income*, *Loan to Value*, *Obligations*, *No Savings*, *Single Adult*, *Education*, *Children*, and *Year of the loan origination*. Standard errors in parentheses.

Annex 8A. Household characteristics' relationship with mortgage interest rate type choice logistic regression estimates time gap between loan origination and survey year

Indicator	Full Sample	3 years	5 years	Time between survey and loan origination control
PaymentToIncome	-1.820***	-1.543**	-1.772***	-2.082***
	(0.372)	(0.728)	(0.445)	(0.379)
LoanToValue	0.005**	0.007	0.005*	0.005**
	(0.002)	(0.004)	(0.003)	(0.002)
NoSavings	-0.178	0.530*	-0.267*	-0.178
	(0.137)	(0.285)	(0.159)	(0.199)
Obligations	0.248**	0.155	0.300**	0.255**
	(0.107)	(0.206)	(0.126)	(0.108)
SingleAdult	0.324***	0.254	0.243*	0.345***
	(0.124)	(0.231)	(0.147)	(0.125)
Education	0.106*	0.270***	0.169***	0.130**
	(0.051)	(0.095)	(0.061)	(0.052)
ChildrenInHouse	-0.026	-0.051	0.029	-0.028
	(0.091)	(0.178)	(0.112)	(0.095)
Nagelkerke R^2	0.045	0.058	0.064	0.057
Observations	2,155	619	1,528	2,155

Notes: statistically significant at: *0.10, **0.05, ***0.01 levels (two-tailed); the dependent variable is STFRM; controlled variables are *Currency of the loan* and *Year of the loan origination.* Standard errors in parentheses.

Annex 8B. Household characteristics' relationship with mortgage interest rate type choice logistic regression estimates time gap between loan origination and survey year (joint effects)

Indicator	Full Sample	3 years	5 years	Time between survey and loan origination control
Low Residual income x High Loan to Value	-0.249	-0.092	-0.126	-0.218
	(0.181)	(0.369)	(0.214)	(0.182)
Low Residual income x Obligations	-0.376**	-0.337	-0.375	-0.324
	(0.226)	(0.443)	(0.267)	(0.227)
Low Residual income x No Savings	-0.257	-0.759	-0.310	-0.271
	(0.279)	(0.588)	(0.321)	(0.280)
Low Residual income x Single Adult	-0.395	-0.318	-0.309	-0.397
	(0.283)	(0.550)	(0.334)	(0.283)
Low Residual income x Low Education	-0.049	-0.171	-0.150	-0.020
	(0.219)	(0.429)	(0.261)	(0.219)
Nagelkerke R^2	0.037	0.051	0.032	0.045
Observations	2,155	619	1,528	2,155

Notes: Statistically significant at: *0.10, **0.05, ***0.01 levels (two-tailed); the dependent variable is STFRM; controlled variables are *Low Residual Income*, *Loan to Value*, *Obligations*, *No Savings*, *Single Adult*, *Education*, *Children*, *Currency of the loan*, and *Year of the loan origination.* Standard errors in parentheses.

Annex 9A. Household characteristics' relationship with mortgage interest rate type choice logistic regression estimates by household income quintile

Indicator	Full Sample	1 quintile	2 quintile	3 quintile	4 quintile	5 quintile
PaymentToIncome	-1.820***	-2,714***	-1.145	-1.505*	-1.316	-2,962***
	(0.372)	(0.807)	(0.897)	(0.790)	(0.881)	(1.004)
LoanToValue	0.005**	0.000	0.003	0.012**	0.004	0.006
	(0.002)	(0.004)	(0.006)	(0.005)	(0.006)	(0.005)
NoSavings	-0.178	-0.507**	-0.209	-0.386	0.986	-0.130
	(0.137)	(0.254)	(0.380)	(0.282)	(0.435)	(0.358)
Obligations	0.248**	0.211	0.052	0.381*	0.156	0.279
	(0.107)	(0.233)	(0.284)	(0.282)	(0.261)	(0.230)
SingleAdult	0.324***	0.392*	0.339	0.354	0.823	-0.092
	(0.124)	(0.201)	(0.330)	(0.311)	(0.450)	(0.379)
Education	0.106*	0.299***	-0.015	0.005	0.053	0.073
	(0.051)	(0.095)	(0.132)	(0.116)	(0.137)	(0.142)
ChildrenInHouse	-0.026	-0.025	0.099	-0.133	-0.209	-0.192
	(0.091)	(0.194)	(0.238)	(0.198)	(0.243)	(0.223)
Nagelkerke R^2	0.045	0.09	0.045	0.070	0.068	0.052
Observations	2,155	546	332	489	365	423

Notes: statistically significant at: *0.10, **0.05, ***0.01 levels (two-tailed); the dependent variable is STFRM; controlled variables are *Currency of the loan* and *Year of the loan origination.* Standard errors in parentheses.

Annex 9B. Household characteristics' relationship with mortgage interest rate type choice logistic regression estimates by household income quintile

Indicator	Full Sample	1 quintile	2 quintile	3 quintile	4 quintile	5 quintile
Low Residual income x High Loan to Value	-0.249 (0.181)	-0.331 (0.312)	0.218 (0.401)	-0.258 (0.403)	0.213 (0.639)	-39.952 (25946)
Low Residual income x Obligations	-0.376** (0.226)	-0.468 (0.510)	-0.855 (0.604)	-0.440 (0.513)	-0.422 (0.741)	19.739 (16091)
Low Residual income x No Savings	-0.257 (0.279)	-0.608 (0.535)	1.196 (0.795)	-0.211 (0.586)	0.070 (1.065)	-1.452 (33987)
Low Residual income x Single Adult	-0.395 (0.283)	0.080 (0.438)	-0.299 (0.884)	-0.223 (0.834)	23.545 (23091)	-20.906 (40193)
Low Residual income x Low Education	-0.049 (0.219)	0.142 (0.356)	-0.462 (0.512)	0.295 (0.569)	0.979 (1.219)	
Nagelkerke R^2	0.037	0.081	0.073	0.068	0.104	0.069
Observations	2,155	546	332	489	365	423

Notes: Statistically significant at: *0.10, **0.05, ***0.01 levels (two-tailed); the dependent variable is STFRM; controlled variables are *Low Residual Income*, *Loan to Value*, *Obligations*, *No Savings*, *Single Adult*, *Education*, *Children*, *Currency of the loan*, and *Year of the loan origination*. Standard errors in parentheses.

Annex 10A. Household characteristics' relationship with mortgage interest rate type choice logistic regression estimates by existence of children in the household

Indicator	Full Sample	Children	No children
Payment to Income	-1.820***	-1.641***	-2.189***
	(0.372)	(0.502)	(0.555)
Loan to Value	0.005**	0.003	0.007**
	(0.002)	(0.003)	(0.004)
No Savings	-0.178	-0.121	-0.276
	(0.137)	(0.175)	(0.225)
Obligations	0.248**	0.216	0.310*
	(0.107)	(0.135)	(0.175)
Single Adult	0.324***	0.290	0.384**
	(0.124)	(0.179)	(0.174)
Education	0.106*	0.116*	0.082
	(0.051)	(0.067)	(0.081)
ChildrenInHouse	-0.026		
	(0.091)		
Nagelkerke R^2	0.045	0.031	0.060
Observations	2,155	1,306	849

Notes: statistically significant at: *0.10, **0.05, ***0.01 levels (two-tailed); the dependent variable is STFRM; controlled variables are *Currency of the loan* and *Year of the loan origination.* Standard errors in parentheses.

Annex 10B. Household characteristics' relationship with mortgage interest rate type choice logistic regression estimates by existence of children in the household

Indicator	Full Sample	Children	No children
Low Residual Income x High Loan to Value	-0.249	-0.102	-0.983**
	(0.181)	(0.207)	(0.477)
Low Residual Income x Obligations	-0.376**	-0.343	-0.474
	(0.226)	(0.272)	(0.522)
Low Residual Income x No Savings	-0.257	-0.284	-0.710
	(0.279)	(0.360)	(0.691)
Low Residual Income x Single Adult	-0.395	-0.597	-0.066
	(0.283)	(0.368)	(0.557)
Low Residual Income x Low Education	-0.049	-0.055	-0.113
	(0.219)	(0.261)	(0.549)
Nagelkerke R^2	0.037	0.034	0.064
Observations	2,155	1,306	849

Notes: Statistically significant at: *0.10, **0.05, ***0.01 levels (two-tailed); the dependent variable is STFRM; controlled variables are *Low Residual Income*, *Loan to Value*, *Obligations*, *No Savings*, *Single Adult*, *Education*, *Children*, *Currency of the loan*, and *Year of the loan origination.* Standard errors in parentheses.

Annex 11. Correlation between market conditions and the share of STFRM in new lending volumes

	STFRM	House Price	Mortgage Portfolio growth	Real Salary growth	Unemploy-ment	CSI	Inflation level	STFRM rate	LTFRM-STFRM	Rule of thumb
STFRM	1									
House Price	0.356** (0.000)	1								
Mortgage portfolio	0.364** (0.000)	0.819** (0.000)	1							
Real Salary Growth	-0.049 (0.470)	0.594** (0.000)	0.705** (0.000)	1						
Unemploy-ment	-0.040 (0.550)	-0.610** (0.000)	-0.781** (0.000)	-0.879** (0.000)	1					
CSI	0.096 (0.155)	0.806** (0.000)	0.643** (0.000)	0.786** (0.000)	-0.657** (0.000)	1				
Inflation level	-0.360** (0.000)	-0.075 (0.267)	0.249** (0.000)	0.363** (0.000)	-0.529** (0.000)	-0.035 (0.600)	1			
STFRM rate	-0.058 (0.389)	-0.249** (0.000)	0.163* (0.015)	0.093 (0.169)	-0.246** (0.000)	-0.314** (0.000)	0.541** (0.000)	1		
LTFRM-STFRM	0.061 (0.364)	-0.304** (0.000)	-0.537** (0.000)	-0.538** (0.000)	0.658** (0.000)	-0.298** (0.000)	-0.617** (0.000)	-0.400** (0.000)	1	
Rule of Thumb	0.228** (0.001)	-0.106 (0.134)	-0.234** (0.001)	-0.185** (0.009)	0.253** (0.000)	-0.014 (0.841)	-0.425** (0.000)	-0.167* (0.018)	0.682*** (0.000)	1
LTFRM-Inflation	0.330** (0.000)	-0.176** (0.009)	-0.322** (0.000)	-0.473** (0.000)	-0.529** (0.000)	-0.249** (0.000)	-0.846** (0.000)	-0.066 (0.325)	0.691** (0.000)	0.530*** (0.000)

* correlation significant at p<0.05, **p<0.01 (two-tailed). Standard errors in parentheses.