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Abstract

We exploit a unique data set that features both un-intermediated mortgage requests and independent offers from multiple banks for each request. We show that households typically are not prudent risk managers but prioritize the minimization of current mortgage payments over the risk of possible hikes in future mortgage payments. We also provide evidence that banks do influence the contracted mortgage rate fixation periods, trading off their own exposure to interest rate risk against the borrowers' affordability and credit risk. Our results challenge the implicit assumption of the existing mortgage choice literature whereby fixation periods are determined entirely by households.

JEL-Codes: D120, E430, G210.

Keywords: Fixed-Rate Mortgage (FRM), Adjustable-Rate Mortgage (ARM), fixation period, maturity mismatch, interest rate risk, credit risk, duration.

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1 Introduction

In the wake of the Global Financial Crisis, central banks worldwide have exhibited a preference for historically low interest rate policies. In this paper, we ask how households and banks have been taking the risk of potentially rising interest rates into account when choosing mortgage rate fixation periods (*FP*)[1]. These choices are important: On the one hand, mortgages constitute by far the largest liability of households that do not rent. For adjustable rate mortgage borrowers, a positive interest rate shock can imply a significant decrease in households' income disposable for consumption, and can ultimately impair households' ability to meet their mortgage obligations. On the other hand, for the typical retail bank, mortgage lending constitutes the largest asset class.[2] In the presence of a positive maturity mismatch, rising interest rates would squeeze banks' net profits and decrease the value of their equity.

With a unique dataset that reveals the *FP* preferences of both households and banks, we contribute both to the household finance literature on mortgage choice, and to the literature on banks' interest rate risk management. The former literature so far[3] has analyzed determinants of households' *FP* choices, typically framed as a binary choice between Adjustable Rate Mortgages (ARM) and Fixed Rate Mortgages (FRM), but has only been able to analyze aggregated data or at best loan level contract data *after* interaction between households and banks. This has required the implicit assumption that banks simply provide the *FP* requested by households, so that the resulting contracts reflect the pure preferences of households. More recently, however, this implicit assumption has been questioned by *Foà et al (2015)* and *Fuster & Vickery (2015)* who show that contracted *FP* are correlated with bank characteristics and wholesale market conditions. Neither of these two papers, however, has been able to control for possible time-variant selection of different households to different banks. In this paper, we analyze pure, un-intermediated household requests for different *FP*. While we confirm that households care primarily about the relative price of longer vs. shorter fixation periods, we also

[1] The mortgage rate fixation period or repricing period designates the period until the rate may change again.

[2] As in most countries, in the Swiss setup studied here the largest category of mortgage borrowers are households and the largest category of lenders are banks, so we often speak of households and banks rather than more generically of mortgage borrowers and lenders.

[3] See, for example, *Campbell & Cocco (2003), Koijen et al (2009), Rubio (2011), Calza et al (2013), Malmendier & Nagel (2016), Rampini & Viswanathan (2016), Badarinza et al (2017), Ehrmann & Ziegelmeyer (2017).*

show that a household typically does not behave as a prudent risk manager. Precisely those households that would most need insurance against rate increases by taking long *FP* are less likely to request these. Instead, they prefer to minimize the present costs associated with their mortgage.

From banks' perspective, the relationship between pre-existing bank characteristics and bank interest rate risk management, or more specifically choices of mortgage rate fixation periods (FP), has been investigated by, amongst others, *Purnanandam (2007)*, *Foà et al (2015)*, *Fuster & Vickery (2015)*, and *Rampini et al (2017).* However, most existing work cannot isolate the link between banks' *FP* choices and borrower characteristics, as the demand and supply for different fixation periods are not observed separately. Besides, these studies are unable to control for the selection of different borrowers to different lenders. A notable exception is *Gomez et al (2016)*, who focus on lending to firms that entertain multiple relationships with different banks. However, this strategy can hardly be implemented when investigating mortgage lending, as households usually do not borrow mortgages from different banks at the same time in the way large firms do. The resulting lack of clean evidence on the supply of mortgage lending to households is regrettable in light of the importance of that type of lending for financial stability and the macro-economy.

Our dataset allows us to bridge this data gap. We use data from a website capturing households' mortgage requests between 2010 and 2013. Customers pay a fee to receive detailed, tailor-made quotes for their specific mortgage request from different banks. In a second step, we link this unique dataset with supervisory data on banks' pre-existing interest rate risk exposure and other key balance-sheet characteristics. First of all, we show that in many cases the assumptions of banks merely offering the requested *FP* is confirmed. Yet, there are remarkable deviations from this strategy and reality is much more complex. In fact, banks can and, on many occasions, do actively steer the contracted *FP* by (i) selectively rejecting requests, (ii) offering *FP* that differ from those requested, or (iii) charging higher mark-ups on *FP* not currently sought.[4]

We then analyze what shapes the way in which banks use these different channels. First, we find that, ceteris paribus, banks prefer shorter mortgage rate *FPs*, which typically mean lower exposure to the risk of losses from interest rate increases, when their pre-existing exposure is already high. Next, we exploit our link between bank and household characteristics and show

[4] In the setup analyzed by *Foà et al (2015)*, banks can additionally use the "advice" channel. By contrast, in our pure online setting this channel is not available to banks.

that the *Offered Fixation Periods (OFP*) do vary with household characteristics even after controlling for both the *Requested Fixation Period (RFP)* and bank characteristics. Specifically, we find that ceteris paribus banks prefer to offer *shorter FP* to households with particularly high *Loan-to-Value* (*LTV*) ratios.

The remainder of the paper is structured as follows. Section 2 presents the institutional setup, our data on mortgage demand, and supply as well as the supervisory data used. It also discusses the external validity of our dataset. Section 3 first derives our hypotheses on household behavior and the most suitable empirical strategy to test these hypotheses. Following that, it derives both hypotheses and empirical strategy also for our analysis of bank behavior. Section 4 presents our results on both sides of the market, and Section 5 concludes.

2 Institutional Background and Data

This section first explains the difference between *mortgage rate fixation periods*, *mortgage maturities* and *contract periods* in the Swiss context. It then provides descriptive statistics on our micro-level data of individual mortgage requests and offers from the website *Comparis*, as well as on the supervisory information we have for the banks studied.

2.1 Fixation Period vs. Maturity vs. Contract Period

The focus of this paper is on the *Fixation Period (FP)*, or *Repricing Period*, of the mortgage interest rate. We define this *Fixation Period (FP)* as the number of years for which the mortgage rate is fixed, while interest rates in the interbank market and hence banks' refinancing and opportunity costs may vary. Some banks' offers specify a single fixation period for the entire mortgage, while others propose to split the mortgage into several *tranches* with distinct fixation periods and distinct mortgage rates.[5,6] To make both single- and multiple-tranche offers comparable, we compute the tranche-weighted average fixation period, duration, mortgage rate, and mortgage spread. The weight of each tranche is given by its amount relative to that of the entire mortgage.[7]

[5] In some but by no means all cases, the tranching coincides with the 67% or 80% LTV thresholds.

[6] In principle, tranching is attractive to banks since it makes it more difficult for households to switch to a cheaper bank when one tranche matures but one or more other tranches have not matured yet. We do not explicitly investigate such motives for tranching here, as they would not appear correlated with fixation period choices.

[7] The tranche-specific duration, in turn, follows the standard definition from the bond asset pricing literature in that individual years until maturity are weighted by the present discounted value of individual payments. Instead of coupon payments, we

Conceptually, the *FP* is distinct from the *Mortgage Maturity*, defined as the number of years after which the entire principal must be repaid to the lender. In some countries these two contractual terms coincide, in Switzerland they often do not. Fully amortizing mortgages are rare and not very popular in Switzerland for tax reasons: Even for owner-occupied property, borrowers can deduct interest payments from their taxable income, and outstanding mortgage debt from their taxable wealth (in some cantons/states of the Swiss Confederation), respectively. For this reason, households tend to amortize only at the minimum speed required by the regulator. Since July 2012, regulation requires that the *Loan-to-Value (LTV)* ratio must be reduced to 67% within at most 20 years after the date of the purchase, and since July 2014 within at most 15 years. Yet, after this period has expired, many households just keep the remaining debt outstanding and invest any surplus savings into other asset classes rather than amortizing their mortgages. The amortization schedules resulting from these regulatory requirements are decoupled from the mortgage rate's fixation period. This allows us to analyze the preferred fixation periods as stated by borrowers and lenders *independently* from the amortization schedules.

A third relevant term in that respect is the *Contract Period* of a mortgage: This is the number of years for which neither lender nor borrower can leave the existing contract without incurring a penalty. At the end of the contract period, Swiss borrowers typically repay not out of their savings, but by refinancing or rolling over their mortgage (or tranche) either with the same or with another lender. In many countries the option to prepay before the end of the initially agreed contract period is frequently exercised, giving rise to *prepayment risk* for lenders (see *Campbell & Cocco, 2003; Green & Wachter, 2005*). Swiss mortgage contracts, by contrast, typically contain "*yield maintenance clauses*" as described in *Green & Wachter (2005)*: when households prepay, they must (at least) fully compensate the bank for any interest foregone as a consequence of their prepayment. Therefore, households usually prepay a mortgage only if they are forced to sell their property, for example due to a change of jobs or divorce, but not for strategic reasons.

use the annual debt service paid by households and the return of the mortgage amount to the bank replaces the principal payment at maturity. The mortgage spread of each tranche is computed by subtracting the refinancing costs from the offered rate after full hedging for interest rate risk, given by the swap rate for the same fixation period.

2.2 Data on Mortgage Demand and Supply

Our key data source is the Swiss website *Comparis*. The dataset provides information on individual mortgage requests submitted to the *Comparis* website between 2010 and 2013.[8] For each request, we observe the responses from multiple banks. On the household side, the data contain comprehensive information on the property to be bought (including size, age and location zip code of the property), on the household's finances (including income, wealth, pension savings, debt, further real estate holdings) and the requested mortgage amount and *fixation period*. To submit a request, a household had to pay CHF 148 (about USD 150).

Comparis then sent the anonymized requests to participating mortgage lenders. These included both banks and insurance companies. After screening the requests, banks decided whether to make a binding offer and specified the terms of the offer. While they had to take the requested mortgage *amount* as given, banks could deviate from the requested *fixation period*. Furthermore, besides choosing the mortgage's average fixation period, they could also decide to split the mortgage into up to three tranches with different tranche-level fixation periods and tranche-specific rates. For example, one way to obtain an average fixation period of five years was to offer the entire mortgage with a five-year fixation period, while another was to offer half of the amount with a fixation period of 8 years and the other half with a fixation period of 2 years. For fixed-rate tranches, i.e. tranches with fixation periods of one or more years, the fixation period typically coincided with the *contract period* of that tranche. For our baseline analyses, we focus on the tranche-weighted offered FP, *Weighted Offered FP*, as well as the duration of the entire mortgage.

This dataset has several characteristics that are advantageous for our empirical analysis: First, we observe separately requests and offers and thus distinguish between the preferences of households and those of banks. Second, we observe for each request the response from not just one but several banks, and can fully rule out possible self-selection, even of a time-variant type, of different types of households to different types of banks. Third, all banks have access to exactly the same set of anonymized information that we observe and control for, so we can rule out that bank responses depend also on the additional soft information generated in other contexts through relationship banking.

[8] At the end of 2013, *Comparis* changed its business model.

In Table 1, Panel A presents summary statistics on the 5'914 requests submitted between 2010 and 2013, while Panel B shows market benchmark yields to characterize the macroeconomic environment. Panel C shows data on the share of rejections among the 20'117 bank responses submitted by the 27 banks, while Panel D presents details on the 16'349 responses that were offers. Finally, Panel E shows characteristics of the participating banks, also at the response level so as to give each bank the same weight as in our response level regressions. In principle, households can choose between ARM, with *FP* of 0, 0.25 or 1 year, and FRM with *FP* of 2-10 years. For our baseline estimates, we focus on *FP* of 0-1, 5 and 10 years, which together account for 83% of all requests: This allows us to use the same requests also for multinomial analyses, for which the intermediate *FP* brackets of 2, 3, 4 and 6, 7, 8, 9 years are not sufficiently well populated.[9]

Panel A of Table 1 shows that the average requested fixation period of the requests we consider is 7.3 years. Moreover it shows that 15% of mortgage requests are for fixation periods of 0-1 years, 25% are 5 years, and 60% are for 10 years. The *Payment-to-Income (PTI)* ratio[10] amounts to 26% on average, with 17% of all submitted requests exhibiting *Payment-to-Income (PTI)* ratios which exceed 33%. The *Loan-to-Value (LTV)* ratio amounts to 65% on average, with 55% of all submitted requests exhibiting *Loan-to-Value (LTV)* ratios in excess of 67%, while 8% of all submitted requests specify *LTV* ratios in excess of 80%. In addition, our empirical analysis draws on detailed household characteristics. On average, household wealth (used in logs in our regression given its skewed distribution) reaches CHF 293,608. Almost a quarter of the captured households already own some type of real estate, while 22% report outstanding debt. Our average request is submitted by a customer aged 46 with the intention to purchase a property built on average 28.5 years ago.

Panel B shows two benchmark yields prevailing during the month when banks respond. Rows 1 and 3 show the spread of 10-year over 3-month mortgages, and of 10-year over 1-year Swiss federal government bonds respectively. Rows 2 and 4 show the average yields on 10-year mortgages and Swiss federal government bonds respectively.

[9] ARM capture three sub-categories, “Libor mortgages” for which rates reset automatically every 3 months, “Variable rate” mortgages for which banks have the option to adjust rates at their discretion, while households may terminate the contract type at any time without incurring a prepayment penalty, and 1-year mortgages.

[10] The numerator of this ratio, the payment, consists of 5% of the mortgage amount for "calculatory" interest payments, 1% for house maintenance, and 1% for amortization when the LTV ratio exceeds 67%.

The term premiums amounted to 1.15% and 0.96% respectively, thus reflecting a usual, i.e. upward sloping, yield curve: It implies that mortgages with longer fixation periods were more expensive for borrowers, while they allowed banks that borrow at shorter and lend at longer fixation periods to earn a term premium - if they are willing to take on, or hedge at a cost, the resulting interest rate risk, as we discuss in Section 3 below.

Panel C presents summary statistics on banks' responses. We observe a total of 20'117 or about 4 answers per request. This is because not all 27 banks are active in all regions of Switzerland. Among all bank responses the rejection rate amounts to 19%, reducing our sample to 16'349 offers, or about 3 bank bids per request.

Panel D exhibits details on these bank offers. It shows that, on average, the offered fixation period weighted across tranches, *Weighted Offered FP,* was roughly 7.5 years. In line with this number, the tranche-weighted duration offered by the banks, *Weighted Offered Duration*, came to 7.0 years. Banks offered mortgage rates of about 2.2% on average, with the weighted spread above the market swap rates reaching 0.97%. In about 19% of offers banks proposed a fixation period that deviated from that requested by households: Hence banks do often, but not always accommodate households' preferences. Below we investigate when and why banks deviate from requested fixation periods.

2.3 Supervisory Data on Bank Characteristics

We complement the *Comparis* data on mortgage demand and supply with key characteristics of the banks submitting the supply responses, obtained from the Swiss Financial Market Supervisory Authority *FINMA*. Panel E of Table 1 provides the summary statistics on these characteristics. They have been computed at the response level, so banks that submit more responses receive larger weights. This ensures that the summary statistics are representative of the sample on which we run our regressions.

We start with measures of banks' pre-existing interest rate risk (*IRR*) exposures, taken from quarterly *Interest Rate Risk Reports* that individual banks submit to the Swiss regulator. The original reporting form is displayed in Figure 1 and shows that each quarter banks report the cash flows resulting from their assets and liabilities by asset and liability categories as well as by 18 different repricing brackets. All flows are reported *after* hedging. Unfortunately, cash flows *before* hedging are not reported separately. Yet, we do observe *whether* a bank did use

any interest swaps in a given quarter: As line 4 of Panel E shows, 96% of responses in our sample were submitted by banks that did use interest rate hedges.

Rows 1-3 of this panel show the interest rate risk (*IRR*) exposure resulting from these cash flows. All three measures are duration gaps and indicate the percentage change in the present discounted value and hence in the bank's equity resulting from a parallel shift of the yield curve by 100 basis points (bp).

Formally, for fixation period brackets *b = 1,…,18*, *CF(b)* gives the net cash flow as the difference between incoming and outgoing cash flows. A 100 basis points change in interest rates will change these cash flows for each of the 18 brackets, resulting in the following losses:

$$IRR_{b,t} = \sum_{b=1}^{18} CF(b)[DF(b)^{+/-100bps} - DF(b)] \quad (1)$$

where *DF(b)* is the discount factor based on the risk-free rate for maturity *b* and $DF(b)^{+100bps}$ is the hypothetical discount factor following a parallel shift of the yield curve by 100 bp.[11]

Our data report the impact of the *more adverse* of the two possible shifts, up or down, and add a negative sign if and only if the loss arises in the case of an upward shift of the yield curve, which is the far more common case amongst the banks studied. When the decision studied is whether to grant a mortgage rate fixation period of 5 or 10 rather than up to 1 year, then for the typical bank financed largely through deposits (see summary statistics), the more relevant risk is indeed an upward shift of the yield curve. To facilitate interpretation, we thus multiply the *IRR* measures by -1 so that *higher* values imply greater pre-existing exposure to interest rate *increases*. By contrast, the very few negative values of the resulting measure indicate banks whose net present value would suffer in the case of an interest rate *de*crease and who would hence *benefit* from a rate increase. Their pre-existing maturity mismatch would be reduced rather than increased by the granting of mortgages with longer fixation periods, which is why we include them in the sample as well with *IRR* values with negative sign. Dropping them from the sample does however not materially influence our results given the low number of cases.[12]

[11] *Esposito et al (2015)* outline the Italian implementation, which is quite similar except that 14 instead of 18 brackets are used.

[12] The same bank-level supervisory data on Interest Rate Risk (*IRR*) Exposure are also used by *Beutler et al (2017)*, who analyze the impact of already realized interest rate risk on lending to firms. A similar measure has also been used by *Chaudron (2016)* who analyses size and development of Dutch banks' interest rate risk positions in the banking book.

In Panel E, we display three variations of this measure that differ in their treatment of the assets and liabilities with unspecified fixation periods, such as sight deposits, reported in Columns 5-17 of the form. Our first and baseline measure uses banks' own assumptions on the effective fixation period of these positions, our second measure uses the average assumption computed across the reports from all banks in a given quarter, and our third measure uses an assumption that is invariant both across banks and across periods and is set to two years. The table shows that the average response in our sample is submitted by a bank that would lose 7% of its equity through a 100 basis point upward shift of the yield curve based on the bank's own assumptions, 5% based on average assumptions, and 8% based on fixed assumptions.

The next line shows that contrary to what *Vuillemey (2017)* reports for US banks, not all but the large majority of banks in our sample do use interest rate derivatives. [13] Nonetheless, in line with the arguments put forward in both *Vuillemey (2017)* and *Rampini et al (2017)*, banks do by no means hedge all interest rate risk but rather retain a sizable amount on their balance sheets in face of the costs of hedging. Furthermore, as in *Rampini et al (2017)*, we find that in our sample the amount of interest rate risk retained after hedging is negatively correlated with bank capitalization (not displayed in the table to save space).

The subsequent lines of Panel E show that the average bank in our sample has total assets of close to CHF 10'000 million, of which we use again the log due to its skewed distribution. Furthermore, about 6% of the average bank's total assets were financed with Core Equity Tier 1 (CET1) capital, 70% with deposits, and 20% with wholesale funding.

2.4 External Validity

As pointed out before, our multi-borrower-multi-lender setup grants the internal validity of our estimates by avoiding typical the self-selection concerns of households to bank. Online mortgage intermediation, however, accounts only for a small share in the overall mortgage market. Hence, the question arises whether our analyses are externally valid. Put differently, while our estimates allow us to analyze the demand and supply of mortgage fixation periods in an online context, we need to show that our results carry over to the rest of the Swiss mortgage market. A priori, the answer is not clear. On the one hand, households that fail to get a mortgage offer from their existing bank end up using the *Comparis* platform. On the other hand, only low

[13] *Purnanandam (2007)* finds that interest rate derivatives are predominantly used by larger banks, likely reflecting economies of scale and scope of operations, and that dealing with them allows banks to hedge against possible interest rate shocks.

risk customers with confidence and expertise in financial issues might use the platform. Indeed, we observe a wide range of both house and household characteristics, but some bias on *unobservables* could remain. For this reason, we compare our data with, to the best of our knowledge, all publicly-available datasets on the Swiss mortgage market: first, with "Banks in Switzerland" a publication by the Swiss National Bank (SNB, 2014), and second, with a survey of mortgage borrowers conducted by Seiler (2013). The drawback of the former is that it captures only the stock of mortgages already on banks' balance sheets rather than specifically the set of mortgages granted or refinanced in a given year. The drawback of the latter is that, due to a different research question (the use of pension money for house purchases) the survey itself does not warrant a representative picture of the entire market itself. Yet, these are the best sources known to us. *Table 10* reveals that the geographical composition of our sample aligns well with both studies and suggests that our sample matches the distribution of the Swiss population as a whole. Our dataset appears to have slightly higher weights on the German-speaking cantons when compared to the SNB data (Panel A), but slightly lower ones when compared to the data reported by Seiler (2013) (Panel B). More importantly, there is no clear evidence of a bias in favor or against the more urban areas, neither when we look at the distribution of the number of requests, nor when we look at the implied mortgage volumes.

3 Hypotheses and Empirical Strategy

The first two parts of this section present our hypotheses and empirical strategy on pure, un-intermediated household preferences. In particular, we discuss a widespread, but so far unproven assumption of the existing literature which implies that observed mortgage *FP* reflect purely the choices of households. In the third part of the section, we turn to hypotheses on banks' responses and discuss how these could vary with their pre-existing interest rate risk exposures as well as with key borrower characteristics. Finally, the last subsection describes our empirical strategy for testing these hypotheses.

3.1 Household Behavior: Hypotheses

Which factors drive households to select a specific mortgage rate fixation period (*FP*)? The household has to balance the costs of a mortgage contract against its implied risks.

Existing papers have developed and tested empirically a number of hypotheses on households' choices. However, their analyses are typically based on aggregated data or, at best, on data

covering individual mortgages but only *after* bank interference. The only exceptions known to us are *Fuster & Vickery (2015)* and *Foà et al (2015)*, both of which show that contracted mortgage types do vary with bank or market characteristics. This already casts some doubt on choices being made exclusively by households. Our unique data set features *un-intermediated* mortgage requests and, hence, allows us to isolate borrowers' choices.

First, motivated by, amongst others, *Koijen et al (2009), Ehrmann & Ziegelmeyer (2017)* and *Badarinza et al (2017)*, we posit that households pay attention to the term premium as the relative price between shorter and longer *FP*:

> *Hypothesis 1: Households tend to request longer fixation periods (FP) when the term premium between long and short fixation periods (FP) is lower.*

The existing literature, which usually focuses on a binary choice between Fixed Rate Mortgages (*FRM*) and Adjustable Rate Mortgages (*ARM*) uses just one term premium between shorter and longer fixation periods as the relative price of *FRM* relative to *ARM*. In our setup we have up to 12 different *FP*, although for some analyses we focus on the three most frequent ones. To simplify interpretation, we use the term premium between 10-year returns and 1-year returns on Swiss government bonds, available from *Bloomberg* at daily frequency. In variations, we also employ average mortgage rates by banks in Switzerland as reported on the *Swiss National Bank* website at monthly frequency.

More importantly, we exploit the richness of our dataset. This allows us to investigate the role of further household and property characteristics. Of particular interest given the concept of "household risk management" developed by *Campbell & Cocco (2003)* are the *Payment-to-Income* (*PTI*)[14] and the *Loan-to-Value (LTV)* ratios. The households with the highest *PTI* or *LTV* ratios are also those which are most likely to be budget- and liquidity-constrained and they might just attempt to minimize current mortgage costs. Or, in the words of *Rampini & Viswanathan (2016)*, poor households might prioritize consumption smoothing over time relative to that across states of the world. In the following, we re-visit some aspect of the hypotheses developed by *Campbell & Cocco (2003)*, but we apply them to our context.

[14] We follow the standard procedure applied by most Swiss banks and use a hypothetical mortgage rate of 5% to compute the *PTI* ratio.

With respect to the *PTI* ratio, we expect households to face the following trade-off: Households that have to spend a higher share of their income on mortgage payments are more likely to become liquidity-constrained when mortgage rates rise, making it more advisable for them to implicitly "insure" against such rate increases by requesting a longer fixation periods (*FP*). Put differently, high-*PTI* customers might pay an insurance premium corresponding to the term spread, to postpone their exposure to future interest rate rises. On these grounds we posit:

> *Hypothesis 2a: Households tend to request mortgages with a **longer** fixation period (FP) if they have **higher** Payment-to-Income (PTI) ratios.*

Households with higher *LTV* ratios are inherently more risky from a bank's perspective. These households might be unable to roll over a mortgage at maturity (e.g. if adverse house price shocks occur and their LTV ratios fall below the critical threshold). For this reason, they might prefer longer mortgage fixation periods (*FP*).

> *Hypothesis 2b: Households tend to request mortgages with a **longer** fixation period (FP) if they have **higher** Loan-to-Value (LTV) ratios.*

Note that this hypothesis is not obvious: High-*LTV* households face higher debt service costs on account of the *credit risk premium*. They might prefer shorter *FP* to save the *term premium* as an additional charge, invest it and use the proceeds to pay down a higher share of the outstanding mortgage at maturity. Hence, households might trade off the expected *credit risk premium* charged by banks against the opportunity costs of saving the money and earn interest on it.

3.2 Household Behavior: Empirical Strategy

To test these hypotheses on household behavior empirically, we start by treating the *Requested Fixation Period (RFP)* as a continuous variable with values 0 for adjustable rate mortgages, 0.25 years for 3-month *LIBOR* mortgages, and 1-10 years for Fixed Rate Mortgages.

We relate this dependent variable to a set of exogenous variables which indicate the term premium between long and short fixation periods, to the *Payment-to-Income (PTI)* ratio, the *Loan-to-Value (LTV)* ratio, and to a set of household control variables.

The existing literature, which usually focuses on a binary choice between Fixed Rate Mortgages (*FRM*) and Adjustable Rate Mortgages (*ARM*), uses proxies for the relative cost of *FRM* relative

to *ARM*. In our dataset, however, we observe 12 different mortgage fixation periods (*FP*). In our refined multinomial analysis, we focus on the three most frequently requested *FP*, namely 0-1 years, 5 years, and 10 years, as the other FP have only few observations. Besides, we want to reduce the complexity of our benchmark regressions. As a benchmark rate that is generally observable by households and informs their expectations of the term spread, we resort to Swiss government bond yields available from *Bloomberg* at daily frequency. Alternatively, we use average mortgage rates as reported on the *Swiss National Bank* website at monthly frequency.[15]

In particular, we start by estimating the following linear relationship using *Ordinary Least Squares* while calculating heteroscedasticity robust standard errors:

$$RFP_{i,t} = \alpha + \beta_1 Term\ Premium_t + \boldsymbol{PTI_i'\beta_2} + \boldsymbol{LTV_i'\beta_3} + \boldsymbol{Z_i'\beta_4} + \varepsilon_{i,t} \qquad (2)$$

where $Term\ Premium_t$ proxies the term premium between the average ten-year and the average one-year government bond yields in month *t*. Moreover, we include several household and property characteristics of request *i*: As it is not clear a priori whether the effect of *PTI* will be linear, we include as exogenous variables both the *Payment-to-Income* ratio as a continuous variable (*PTI*) and as a dummy variable for the *Payment-to-Income* ratio exceeding 33% (*PTI>33% (0/1)*). Moreover, we include the *Loan-to-Value (LTV)* ratio, which indicates the loan amount relative to the value of the house, as a continuous variable, and additionally add a separate threshold dummy variables for those *Loan-to-Value (LTV)* ratio exceeding 67% and 80%. We control for further household characteristics subsumed by vector $\boldsymbol{Z}$: a dummy for holdings of other real estate (*Other real estate (0/1)*), a dummy for the presence of other debt (*Debt (0/1)*), the age of the mortgage borrower (*Age*). We also control for the key characteristics of the property to be financed, its *Property age*, and type (single-family home, apartment, etc.).

We consider this estimation an intuitive and therefore sensible first approach, but it is restrictive in that it assumes a linear relationship between the explanatory variables of interest and the *Requested Fixation Periods (RFP)*. Furthermore, it does not take into account that *RFP* are non-negative, and households cannot request *RFP* above 10 years in the setup studied. Therefore, and in line with the probit analyses conducted in amongst others *Ehrmann & Ziegelmeyer*

[15] Two other macroeconomic factors households should take into account when choosing their *FP* are interest rate and inflation expectations (*Malmendier & Nagel, 2016)*. We do not explicitly investigate these here for lack of suitable measures with sufficient variation within our sample.

(2017), we re-examine the relationships studied in Equation (2) by means of multinomial logit and probit analyses.

Households typically request mortgages with *Requested Fixation Periods (RFP)* of 0-1 years, 5 years and 10 years which make up roughly 83% of all requests. We classify these three mortgage fixation periods (FP) as short-term, medium-term and long-term horizon and focus on these three most commonly *Requested Fixation Periods (RFP).*[16]

In the case of our multinomial analyses, we thus assume that there are three *unordered, exhaustive* and mutually *exhaustive* buckets of mortgage *Fixation Period (FP)* outcomes *j=ST, MT, LT.* In particular, *FP* assumes the value *j=ST* if the *FP* is up to one year, *j=MT* if the *FP* is five years, and *j=LT* if the *FP* is ten years. In line with a standard multinomial logit model, we denote the probability that request *i* chooses alternative *j*, given the household characteristics $x_{i,t}$ as:

$$P(FP_i^* = j \big| \boldsymbol{x_{i,t}}) = \pi_{i,j} \ , \ j=ST, MT, LT \qquad (3)$$

We assume that the following relationship exists between the probability shown in (3) and the vector of exogenous characteristics $x_{i,t}$, as a linear index structure $x'_{i,t}\beta_j$ with an outcome-specific parameter vector β_j to be estimated:

$$\pi_{i,j} = \frac{\exp(\boldsymbol{x'_{i,t}\beta_j})}{\sum_{j=1}^{J} \exp(\boldsymbol{x'_{i,t}\beta_j})} \quad , \ j= ST, MT, LT \qquad (4)$$

Where the vector $x_{i,t}$ indicates the same set of exogenous variables that are employed in equation (1). The estimated parameters β_j differ across alternatives *j*.

The model is estimated using maximum likelihood with the (log-) likelihood function for a sample of *i=1,…,n* requests given by:

$$\log L = \sum_i^n \sum_{j=1}^3 I_{i,j} log\ \pi_{i,j} \ , \ j= ST, MT, LT \qquad (5)$$

[16] Vice versa, *Requested Fixation Periods (RFP)* for 2, 3, 4, 6, 7, 8 and 9 years together contain only about 17% of all requests. Including each of these brackets separately would produce unreliable and difficult to interpret estimates, whereas lumping 2-4 and 6-9 years would seem to be too coarse. As a robustness test, we use this set of FP also in our OLS analyses. Further robustness checks drawing on all requests (including FP of 2-4 and 6-9 years) produce qualitatively similar results.

Where $I_{i,j}$ is a binary indicator taking on the value of one if the request *i* chooses alternative *j* (zero otherwise).

We present our results in two different ways: First, we show log-odds ratios where the baseline category is *j=ST* (i.e. the requested fixation period is 0-1 years). In addition, we provide marginal effects for each outcome variable (evaluated at the mean of an independent variable if it is a continuous variable or at zero in case of a binary variable).

3.3 Bank Behavior: Hypotheses

In the second part of our empirical analysis, we examine the determinants of banks' responses to households' *Requested Fixation Periods* (*RFP*). Also in this context, our data allow for a contribution that to the best of our knowledge has not been possible before.

Fuster & Vickery (2015) observe data only at the bank level and can therefore not investigate to what extent banks' choices deviate from requested fixation periods, or how such deviations depend on the characteristics of individual customers. *Foà et al (2015)* do observe data at the level of individual customers, but cannot control for time-variant selection of different customers into different banks, as they observe an offer from only one specific bank per customer. The only paper we are aware of that addresses the possible sorting of different borrowers to different lenders is *Gomez et al (2016)* who exploit lending to firms that deal with different banks.[17] But to the best of our knowledge this is the first paper that is able to similarly analyze interest rate risk taking in lending to households, for which it is rare to observe more than one bank relationship.[18]

In our setup, banks can influence contracted fixation periods in three different ways. First, they can *reject* any request with stated fixation periods or customer characteristics that do not suit their portfolio. Second, they can make an offer in response to inconvenient characteristics but offer a *FP* that differs from the one requested. We coin this behavior *non-compliance*. Third, they can offer the requested *FP* but charge a higher markup on the mortgage rate they offer over their refinancing costs assuming that they fully hedge their exposure to interest rate risk.

[17] They analyze the impact on lending of realized interest rate risk, while we analyze the impact on the supply of individual mortgages of pre-existing interest rate risk exposure before that risk has been realized.

[18] Rampini et al (2017) investigate the impact of bank capitalization on bank interest rate risk taking at the bank level. They do not analyze how the choice of how much interest rate risk to take on for a particular loan depends on borrower characteristics, but in their case this is less central as they analyze interest rate risk taking after hedging.

One may assume that banks have some (unobserved) target level of their pre-existent exposure to interest rate risk (*IRR*). If these target values are similar across banks, banks with higher actual *IRR* are, ceteris paribus, more heavily exposed to interest rate risk. These banks might have preferences for shorter FP in order to reduce their interest rate risk exposure. Hence, we posit the following hypothesis:

> *Hypothesis 3: Banks already more exposed to upward shifts in the yield curve, for which the average repricing period of the assets exceeds that of the liabilities on average more, ceteris paribus prefer shorter mortgage rate fixation periods, and so:*
>
> *(a)* ***Reject*** *requests more often the* ***longer*** *the Requested Fixation Period.*
>
> *(b)* ***Non-comply*** *more often the* ***longer*** *the Requested Fixation Period.*
>
> *(c)* ***Charge higher mark-ups*** *over fully IRR-hedged refinancing costs for* ***longer*** *Requested Fixation Periods.*

Note that this hypothesis is not obvious: Alternatively one might hypothesize that banks with higher pre-existing exposure to interest rate increases (*IRR*) deem such increases less likely anyway, or are simply willing to take on more interest rate risk, and therefore will continue to offer longer fixation periods also now. Therefore only a solid empirical analysis, ideally one that can fully condition on any possible sorting of customers, can tell which of these ways of reasoning provides a better description of bank behavior. This is what we provide below.

In our data set, we can observe the full set of risk characteristics of each individual household. Hence, we can examine how banks' *IRR* and their balance-sheet structure interact with distinct household characteristics. In *Hypotheses 2a* and *2b* above we have argued that households who are prudent risk managers should request longer *FP* if they have higher *PTI* or *LTV* ratios. Of course this reasoning is potentially relevant also for lenders. If a household with a high *PTI* or *LTV* ratio takes out only a short fixation period and does then struggle to honor the resulting mortgage obligations after a rate increase, then this may result in arrears or, in the case of high *LTV* ratios, in difficulties of the household to roll over the mortgage. So while across all households a high-IRR bank may prefer shorter FP, this may differ for clients with high PTI or LTV ratios:

> *Hypothesis 4: For clients with high PTI or high LTV ratios, banks will ceteris paribus prefer longer mortgage rate fixation periods, and so*

(a) ***Reject*** *requests more often the* ***shorter*** *the Requested Fixation Period (RFP).*

(b) ***Non-comply*** *more often the* ***shorter*** *the Requested Fixation Period (RFP).*

(c) ***Charge higher mark-ups*** *over fully IRR-hedged refinancing costs for* ***shorter*** *Requested Fixation Periods (RFP).*

While we formulate this as our hypothesis, a priori it also possible to reason differently. For *FRM* with mortgage fixation periods *(FP)* of between 1 and 10 years the *FP* does coincide with the contract period and maturity. Therefore a bank might alternatively prefer *shorter* fixation periods for clients with higher *PTI* or *LTV* ratios in order to reduce the amount of time during which it is exposed to the credit risk associated with these clients. Again we will let the data decide which of these ways of reasoning about the relationship between *PTI* and *LTV* ratios on the one hand and mortgage rate fixation periods on the other hand does better fit bank behavior.

3.4 Bank Behavior: Empirical Strategy

To test *Hypotheses 3-4,* we relate banks' choice variables (rejection decisions, offered fixation period and duration, and pricing decisions) to proxies of banks' exposure to interest rate risk *(IRR)* as well as to further bank and household characteristics. In principle, we estimate the following relationship:

$$Y_{b,i} = G\left(\boldsymbol{x}'_{\boldsymbol{i,t}}\boldsymbol{\gamma} + \boldsymbol{z}'_{\boldsymbol{b,t}}\boldsymbol{\delta}\right) + \varepsilon_{b,i} \qquad (6)$$

where $Y_{b,i}$ represents one of the choice variables a bank has. $\boldsymbol{x}_{\boldsymbol{i,t}}$ represents the vector of request characteristics and $\boldsymbol{z}_{\boldsymbol{b,t}}$ represents a vector of bank characteristics which are a proxy for the interest rate risk exposure of the bank (*IRR*) and further bank characteristics (log of total assets, as well as the proportions of total assets funded through respectively CET1 capital, deposits, and whole-sale funding).

In this setup, *G(.)* is a well-defined link-function. For continuous choice variables of the bank (*Weighted Offered FP, Weighted Offered Duration, Weighted Rate, Weighted Spread), G(.)* is a linear function, i.e. $G(\boldsymbol{x}'_{\boldsymbol{i}}\boldsymbol{\gamma} + \boldsymbol{z}'_{\boldsymbol{b,t}}\boldsymbol{\delta}) = \boldsymbol{x}'_{\boldsymbol{i}}\boldsymbol{\gamma} + \boldsymbol{z}'_{\boldsymbol{b,t}}\boldsymbol{\delta}$, that we estimate using OLS. If the banks' choice variable is binary (*Explicit Rejection*), we consider a logistic transformation $G = \frac{exp(\boldsymbol{x}'_{\boldsymbol{i}}\boldsymbol{\gamma}+\boldsymbol{z}'_{\boldsymbol{b,t}}\boldsymbol{\delta})}{1+exp(\boldsymbol{x}'_{\boldsymbol{i}}\boldsymbol{\gamma}+\boldsymbol{z}'_{\boldsymbol{b,t}}\boldsymbol{\delta})}$ that we estimate using *Maximum Likelihood (ML).*

For our baseline estimates, we restrict the sample to requests for the largest categories, 0-1 years, 5 years, and 10 years, so as to increase comparability with our household side estimates.[19] For each request we use bank characteristics from the end of the previous quarter to ensure these are taken as given when the response is chosen. As our bank data start only with the first quarter of 2010, a few requests from that first quarter that were used on the household side are not used on the bank side.

In all regressions we exploit our setup of offers from multiple banks for each request by controlling for request fixed effects. Therefore we cannot estimate the main effects of the request characteristics requested fixation period (*FP Requested*), *PTI* and *LTV* ratio. Yet, we can estimate the effects of their interactions with the bank's *IRR*, as well as those of *IRR* itself, an indicator of whether the bank uses interest rate swaps (*Swap Use (0/1)*), and the interaction between *IRR* and the swap use indicator (*Swap Use (0/1)*).

4. Results

4.1 Household Behavior: Results

We start by testing *Hypothesis 1* using *OLS* regressions and present the results in Table 2. The outcome variable in all columns is the Requested Fixation Period (*RFP*) in years, ranging between 0 and 10 years. The key explanatory variables of interest in all columns is the term premium between 1-year and 10-year government bond rates, *Spread (government bonds)*, on the day on which the request was submitted. Column (1) furthermore adds the *PTI* ratio, Column (2) additionally adds the *PTI >33% (0/1)* dummy variable, Column (3) further includes the interaction term between *PTI >33% (0/1)* and *Wealth (ln)*. Moreover, we also include the *LTV* ratio in the specification shown in Column (4) and *LTV >67% (0/1)* and *LTV >80% (0/1)* dummy variables in regressions displayed in Column (5) and Column (6) respectively. All regression results shown in all columns control for the log of household wealth, households' additional real estate holdings, existing household debt, the age of the applying household head, the property type (9 dummies for 10 categories), and property age.

The most robust finding that stands out across all columns is that households clearly request shorter *Fixation Periods* (*FP*) the higher the term premium and hence the higher the price of

[19] In robustness checks we have also used the entire sample and obtained very similar results.

longer FP relative to that of shorter ones is. More precisely, a one percentage point increase in the spread between 1-year and 10-year government bond rates decreases the Requested Fixation Period (*RFP*) by about 1.5 years. This confirms our *Hypothesis 1*. Similar empirical evidence has been reported in the existing literature, for example by *Koijen et al (2009)* or *Ehrmann & Ziegelmeyer (2013).* In contrast to these papers, we are able to show that this relationship is indeed driven by household demand and does not reflect banks' choices. We believe that this is less obvious than it may sound: Prima facie banks may have an incentive to push longer FP when term premiums are higher, allowing them to earn more. However, higher term premiums also reflect the market opinion that spot rates are more likely to rise, and are also associated with higher costs of hedging interest rate risk with interest rate swaps. Therefore a priori the relationship reported in the existing literature might also have been driven by banks, but our results confirm unambiguously that they are indeed driven by household behavior, thus corroborating what up until now had to be assumed.

More novel are our results relating to *Hypothesis 2*. Here our regressions include both the *PTI* and *LTV* ratios as continuous variables and dummies for values above the thresholds of 33% for the *PTI* ratio and 67% and 80% for the *LTV* ratio. These thresholds are often considered critical in the Swiss market for obtaining and granting mortgage loans. In particular, *LTV* ratios above these two thresholds (67% and 80%) also incur higher capital charges for banks, as explained in detail in *Basten & Koch (2015)*. We decide to use flexible specifications in which we include the continuous and discrete *PTI* and *LTV* variables subsequently in our regressions.

Regarding *Hypothesis* 2a, we first test whether our continuous measure *PTI* is a relevant factor for households' requested Fixation Periods (*RFP*) (Column (1)). The estimated coefficient of *PTI*, however, is not statistically significant at conventional levels. Neither are the dummy variable, *PTI >33% (0/1),* and its interaction with household wealth, *Wealth (ln),* (as displayed in Columns (2) and (3)). So interestingly we find that households who arguably would rationally benefit more from insurance against rate increases are not significantly more likely to buy such insurance. Instead, households appear to focus mostly on the current cost of a mortgage.

To test *Hypothesis* 2b, we first estimate the coefficient on our continuous *LTV* variable. The results displayed in Column (4) shows that it is not statistically significantly different from zero at all conventional significance levels. Prima facie, this may seem to suggest again that there is no evidence in favor of this hypothesis. However, results displayed in Columns (5) do show that households with *LTV* ratios in excess of two-thirds request Fixation Periods (*RFP*) that are

on average about 0.32 years *shorter*. The result displayed in Column (6) suggests that households with LTV ratios in excess of 80% request Fixation Periods (*RFP*) that are *another* 0.52 years shorter. These findings speak against the picture of "households as risk managers" given in a normative way in *Campbell & Cocco (2003*), and are instead consistent with the results in *Rampini & Viswanathan (2016)* whereby poor households are likely to take out less insurance as they prioritize consumption smoothing across periods over consumption smoothing across states of the world. Also in line with this are our findings that both lower additional wealth and the existence of further household debt are associated with requests for shorter FP.

Table 3 shows the results of investigating the effects of the same explanatory variables estimating a *Multinomial Logit Model*. We present our results on the choice of requested FP in two ways: Columns (1)-(2) of Table 3 show the raw coefficients which can be interpreted as log-odds ratios where all point estimates are compared to the baseline category, *FP requested (0-1)*. In addition, we provide marginal effects of the estimated coefficients of each variable at the mean for continuous variables and at zero for binary variables in Columns (3)-(5).

This table by and large confirms the results discussed above: An increase in the spread between 1-year and 10-year government bond rates, *Spread (government bonds),* decreases the propensity of choosing a mortgage with a ten year Fixation Period (*RFP*) relative to a short Fixation Period (*RFP*) of not more than 1 year. The estimated coefficient is statistically significant at all conventional significance levels. To get a better understanding of its economic magnitude, we also calculate marginal effects. The results displayed in Column (5) show the marginal effect of all explanatory variables on the choice of a Fixation Period (*RFP*) of 10 years. They suggest that a one percentage point increase in the spread between 1-year and 10-year government bond rates decreases the propensity to choose *FP requested (10)* by 26 percentage points.

We run several robustness checks which confirm these results: First, we can show that estimates based on *Multinomial Probit* instead of *Multinomial Logit Models* are qualitatively similar. Second, we use the term premium between *Libor* and 10-year average mortgage rates reported on the SNB website, instead of that between 1- and 10-year government bond rates. We again obtain qualitatively similar results. Last, we rerun our baseline estimation using only those about 50% of requests that are for roll-overs rather than for new mortgages, which again yields

qualitatively similar results. All of these robustness checks are left out for lack of space, but are available upon request.

4.2 Bank Behavior: Results

We start discussing our results on bank behavior with descriptive statistics split by requested fixation periods (*RFP*) in Table 4. Panel A of this table shows the requested fixation periods by fixation period bucket: *FP requested (0-1), FP requested (5),* and *FP requested (10)* for a total of 5,867 requests and the corresponding responses by bank.[20] It suggests that the rate of rejections is highest for requests that specify very short-term *FPs*, with one out of three requests being rejected (33%). For the other two categories, the share of rejections is 15% and 17% respectively. Simple mean comparisons in Columns (5) and (6) indicate that the differences of 19 percentage points and 17 percentage points are statistically different from zero. Overall, we interpret this as first descriptive evidence that banks do not necessarily offer the fixation periods (*FP*) that are requested by households. Instead, banks might use the opportunity to reject certain requests to differentially select the most preferred fixation period choices.

Panel B of Table 4 displays bank responses on the offer level. It shows descriptive evidence that banks do not always offer the fixation periods (*FP*) that households request: The second row shows the share of offers by banks that deviate in terms of the tranche-weighted fixation periods (*FP*). Column (1) indicates that banks, on average, do not comply in about 19% of all requests. A formal t-test suggests that the degree of FP non-compliance is statistically different from zero at all conventional significance levels. This is first descriptive evidence that banks also use this second channel of non-compliance with the requested fixation periods (*RFP*) in case they make an offer. The share of FP non-compliance is substantially higher in the case of short *FP requested (0-1)* (73%) (Column 2) than in the case of longer requested FPs (9% in the case of *FP requested (5)* (Column 3) and 12% in the case of *FP requested (10)* (Column 4)). In Columns (5)-(7), we test the corresponding differences in means and find that they are statistically different from zero at all conventional significance levels.

Panel B of Table 4 also suggests that banks exploit the third major channel to influence contracted fixation periods: the offered mortgage rate. In particular, we analyze banks' tranche-weighted offered mortgage rate and their tranche-weighted offered mortgage spread, i.e. the

[20] The number of requests is smaller compared to the previous section as we do not observe bank characteristics in the first quarter of 2010.

difference between the offered mortgage rates and the corresponding swap rate at that time. The third row shows the average tranche-weighted mortgage rate offered by the banks (*Weighted Rate*). We observe higher offered mortgage rates for longer the requested fixation period. This could reflect the increasing yield curve (Columns (2)-(4)).[21]

To better understand whether banks use mortgage pricing to channel borrowers towards certain fixation periods (*FP*), we analyze the average tranche-weighted mortgage spread offered by the banks (*Weighted Spread*). Results displayed in the fourth row of Panel B suggest that banks' responses differ with respect to the offered mortgage spread: The average spread is higher for short-term requests *(FP requested (0-1))* (1.36) than for the longer term requests (0.85 and 0.94). Mean differences displayed in Columns (5) and (6) indicate that the differences of are statistically different from zero at all conventional significance levels. These results can be interpreted as first descriptive evidence that banks, on average, are reluctant to offer short-term *FP* of up to 1 year. The fifth row shows the average tranche-weighted mortgage spread offered by the banks (*Weighted Spread*) if the tranche-weighted offered fixation periods (*Weighted Offered FP*) equal the requested fixation periods (*RFP*). The results confirm qualitatively the numbers shown in the fourth row.

We take this as first tentative evidence that banks do not necessarily offer what is requested. More specifically, we find that, unconditionally, banks seem to prefer longer fixation periods (*FP*), where they can earn profits if they conduct maturity transformation. But how do banks' preferences relate to their pre-existing exposure to interest rate risk (*IRR*) as featured in *Hypothesis 3*?

For a first idea, Table 5 provides descriptive statistics that relate their decisions to three measures of their pre-existing exposure to interest rate risk (*IRR*). These descriptive statistics show that, across all three measures, rejections tend to come from banks with higher pre-existing *IRR* exposure (Panel A). By contrast, conditional on making an offer, banks that offer a tranche-weighted fixation period (FP*)* or duration above the sample median tend to be those with higher pre-existing *IRR* on measure 1, but with lower pre-existing *IRR* on measures 2 and 3 (Panels B and C). Overall, the evidence by these descriptive analyses remains inconclusive.

[21] We acknowledge that the mortgage rates are shown relative to the requested FP but not offered FP. There might be some differences as banks deviate with respect to their offered FP from what is requested.

Therefore, we proceed to our main analysis which allows us to control for relevant bank characteristics. We present the main results in Table 6. It shows how banks' responses depend on their own pre-existing *IRR* as well as on key characteristics of the request submitted by the household. In line with *Hypothesis 3*, we find that banks with high pre-existing *IRR* tend to offer shorter fixation periods and durations for any given requested *FP* (Columns (3) and (4)). Interestingly, this does not vary with the use of interest rate swaps, as indicated by the interaction effect of our *IRR* variable with *Swap Use (0/1).* This is not surprising as the *IRR* measures employed in these analyses are already taking any hedging into account. Overall, this implies that we find evidence in favor of *Hypothesis 3*: After controlling for other key bank characteristics – size, capitalization, deposit ratio, and wholesale funding ratio – banks with higher pre-existing *IRR* exposure do not seem to be those that just deem rate increases less likely or that are more willing to take on interest rate risk. Rather, they seem to be banks that are currently above their, not directly observable, *IRR* exposure targets and therefore do now ceteris paribus prefer to grant shorter FP in order to reduce their *IRR* exposure.

Next, we analyze how bank responses relate to key household characteristics. As we employ request fixed effects, we cannot explicitly estimate the main effects of *PTI*, *LTV* and the corresponding dummy variables. However, we can estimate the effects of their interactions with the banks' pre-existing exposure to interest rate risk (*IRR*). This helps us to understand whether banks heavily exposed to interest rate risk are particularly reluctant to lend shorter *FP* to risky borrowers (*Hypothesis 4*).

We find that while in general higher *IRR* leads banks to offer shorter tranche-weighted *FP* and durations now, and *PTI* ratios do not seem to matter, banks offer even *shorter FP* to households with high *LTV* ratios. This means that we do not find evidence in favor of *Hypothesis 4*: Banks do not seem to prefer pushing highly leveraged households toward longer fixation periods, even if this might better protect themselves against arrears or defaults of these households after rate increases.

Tables 7 and 8 repeat these analyses: But now the *IRR* measure with bank-specific assumptions on the effective repricing period of assets and liabilities with unspecified repricing periods are replaced with respectively average assumptions across all banks within each quarter, and with a fixed assumption of two years. Results show that banks' responsiveness to the *IRR* measures increases as we close down first inter-bank and then also inter-period variation in banks' assumptions. We interpret this as saying that banks are more responsive to pure variations in

their own maturity mismatch than in the versions with varying assumptions reported to the supervisory authority.

We run a several robustness checks which confirm these results: These include the use of the *RFP* as a continuous rather than as a categorical variable. Moreover, we include all *RFP* categories rather than just the main ones. In both cases, the results are qualitatively the same as in the baseline version reported above. The same is true when we restrict the sample to requests for rollover mortgages, thus dropping the about 50% of requests that are for new mortgages. All of these robustness tests are available upon request.

5 Conclusion

In this paper we have investigated the choice of mortgage rate fixation periods (*FP*) by both households and banks. We contribute to both the literature on (household) mortgage choice[22] and to that on banks' management of interest rate risk[23]. The former has so far only analyzed aggregated data or, at best, data on individual mortgage contracts and has had to assume that these contracts were shaped exclusively by household preferences. By contrast, we analyze *un-intermediated* mortgage demand for different *FP*. Our results confirm that households care primarily about the term premium, i.e. the current relative price of longer vs. shorter fixation periods. This corroborates a key conjecture of the literature, which has so far required a non-trivial assumption. More importantly, we find no empirical support for the hypothesis of households acting as prudent risk managers: In fact, our results reveal those households who may be considered most in need of insuring against rate increases tend to request shorter fixation periods with the aim of minimizing current cost.

We also contribute to the literature on bank interest rate risk management which - except for *Gomez et al (2017)* who focus on lending to firms rather than to households - has not been able to control for the sorting of different borrowers to different lenders. By contrast, we compare offers from different banks to the same borrower, and combine our dataset on individual mortgage demand and supply with supervisory data on banks' interest rate risk exposure. We

[22] See, for example, *Campbell & Cocco (2003), Koijen et al (2009), Rubio (2011), Calza et al (2013), Malmendier & Nagel, (2016), Rampini & Viswanathan (2016), Ehrmann & Ziegelmeyer (2017),* and *Badarinza et al (2017).*

[23] See, for example, *Purnanandam (2007), Foà et al (2015), Fuster & Vickery (2015), Gomez et al (2016),* and *Rampini et al (2017).*

show that banks usually provide the requested fixation periods (*RFP*). However, they do promote different fixation periods (*FP*) in a significant number of cases, by offering deviating fixation periods either for specific tranches or for the entire mortgage while adjusting their respective pricing. In particular, we find that banks prefer shorter mortgage *FP* when their pre-existing exposure is already high. We also exploit our link between bank and household characteristics and show that the *Offered Fixation Periods (OFP*) do vary with household characteristics even after controlling for both the *Requested Fixation Period (RFP)* and bank characteristics. Specifically, we find that ceteris paribus banks prefer to offer *shorter FP* to households with particularly high *Loan-to-Value* (*LTV*) ratios.

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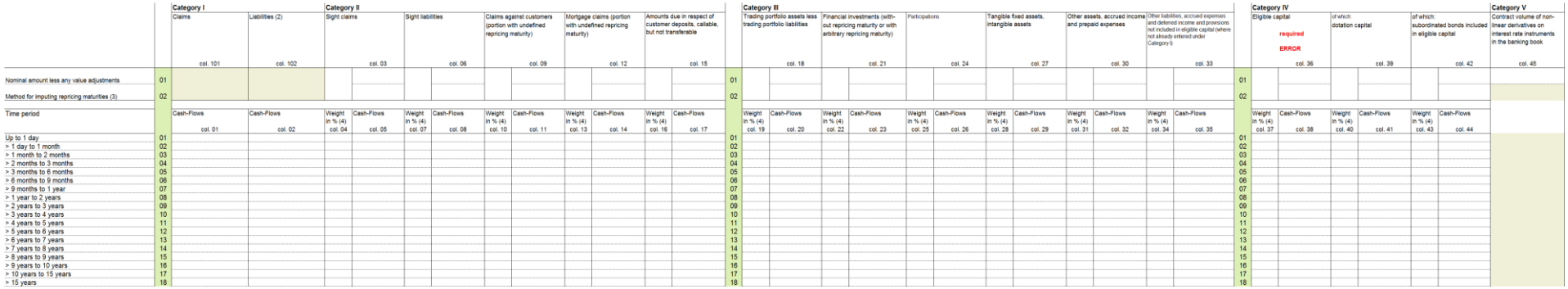
Figures and Tables

Figure 1: Supervisory Reporting Form on Banks' Interest Rate Risk Exposures



		Category I		Category II								Category III												Category IV						Category V
		Claims	Liabilities (2)	Sight claims		Sight liabilities		Claims against customers (portion with undefined repricing maturity)		Mortgage claims (portion with undefined repricing maturity)		Trading portfolio assets less trading portfolio liabilities		Financial investments (without repricing maturity or with arbitrary repricing maturity)		Participations		Tangible fixed assets, intangible assets		Other assets, accrued income and prepaid expenses		Other liabilities, accrued expenses and deferred income and provisions not included in eligible capital (where not already entered under Category I)		Eligible capital required ERROR		of which: dotation capital		of which: subordinated bonds included in eligible capital		Contract volume of non-linear derivatives on interest rate instruments in the banking book
		col. 101	col. 102	col. 03		col. 06		col. 09		col. 12		col. 18		col. 21		col. 24		col. 27		col. 30		col. 33		col. 36		col. 39		col. 42		col. 45
Nominal amount less any value adjustments	01																													
Method for imputing repricing maturities (3)	02																													
Time period		Cash-Flows col. 01	Cash-Flows col. 02	Weight in % (4) col. 04	Cash-Flows col. 05	Weight in % (4) col. 07	Cash-Flows col. 08	Weight in % (4) col. 10	Cash-Flows col. 11	Weight in % (4) col. 13	Cash-Flows col. 14	Weight in % (4) col. 16	Cash-Flows col. 17	Weight in % (4) col. 19	Cash-Flows col. 20	Weight in % (4) col. 22	Cash-Flows col. 23	Weight in % (4) col. 25	Cash-Flows col. 26	Weight in % (4) col. 28	Cash-Flows col. 29	Weight in % (4) col. 31	Cash-Flows col. 32	Weight in % (4) col. 34	Cash-Flows col. 35	Weight in % (4) col. 37	Cash-Flows col. 38	Weight in % (4) col. 40	Cash-Flows col. 41	Weight in % (4) col. 43	Cash-Flows col. 44	
Up to 1 day	01																													
> 1 day to 1 month	02																													
> 1 month to 2 months	03																													
> 2 months to 3 months	04																													
> 3 months to 6 months	05																													
> 6 months to 9 months	06																													
> 9 months to 1 year	07																													
> 1 year to 2 years	08																													
> 2 years to 3 years	09																													
> 3 years to 4 years	10																													
> 4 years to 5 years	11																													
> 5 years to 6 years	12																													
> 6 years to 7 years	13																													
> 7 years to 8 years	14																													
> 8 years to 9 years	15																													
> 9 years to 10 years	16																													
> 10 years to 15 years	17																													
> 15 years	18																													

Table 1: Summary Statistics on Requests and Responses

Panel A of this table shows the characteristics of the 5,914 initial requests submitted by households between 2010 and 2013. Panel B shows benchmark yields in percent at the monthly level. Panel C shows responses by banks at the response level. Panel D shows the responses at the offer level and Panel E shows bank characteristics. Definitions of variables are provided in the Appendix.

Panel A. Request characteristics (request level)

	Mean	St.Dev.	Min	Max	Observations
RFP	7.28	3.65	0.00	10.00	5,914
FP Requested (0-1) (0/1)	0.15	0.36	0.00	1.00	5,914
FP Requested (5) (0/1)	0.25	0.43	0.00	1.00	5,914
FP Requested (10) (0/1)	0.60	0.49	0.00	1.00	5,914
PTI	26.17	10.81	2.00	98.00	5,914
PTI >33% (0/1)	0.17	0.38	0.00	1.00	5,914
LTV	65.38	17.26	2.00	99.00	5,914
LTV >67% (0/1)	0.55	0.50	0.00	1.00	5,914
LTV >80% (0/1)	0.08	0.28	0.00	1.00	5,914
Wealth (ln)	12.59	1.07	8.52	16.81	5,914
Other real estate (0/1)	0.24	0.43	0.00	1.00	5,914
Debt (0/1)	0.22	0.41	0.00	1.00	5,914
Age	45.89	10.42	18.00	92.00	5,914
Property age	28.50	35.59	0.00	255.00	5,914

Panel B. Benchmark yields (monthly level)

	Mean	St.Dev.	Min	Max	Observations
Market Spread (mortgage rate)	1.15	0.33	0.63	1.65	46
Market 10-year mortgage rate	2.67	0.43	2.07	3.39	46
Spread (government bonds)	0.96	0.41	0.41	1.76	46
10-year government bond rate	1.18	0.50	0.53	2.08	46

Panel C. Bank responses (response level)

	Mean	St.Dev.	Min	Max	Observations
Explicit Rejection	0.19	0.39	0.00	1.00	20,117

Panel D. Bank responses (offer level)

	Mean	St.Dev.	Min	Max	Observations
Weighted Offered FP	7.53	3.28	0	10	16,349
Weighted Offered Duration	7.02	2.72	1	10	16,349
Weighted Rate	2.16	0.55	0	7	16,349
Weighted Spread	0.97	0.34	-2	7	16,349
FP not comply	0.19	0.39	0	1	16,349

Panel E. Bank characteristics (response level)

	Mean	St.Dev.	Min	Max	Observations
IRR (Bank Assumptions)	0.07	0.04	-0.05	0.18	20,117
IRR (Quarter-Average Assumptions)	0.05	0.03	-0.01	0.15	20,117
IRR (Bank- and Time-Invariant Ass.)	0.08	0.03	0.01	0.18	20,117
Swap Use (0/1)	0.96	0.19	0.00	1.00	20,117
Ln (Total Assets)	9.19	1.26	5.83	10.55	20,117
CET1 in % of TA	6.27	1.65	3.33	11.29	20,117
Deposits in % of TA	69.53	7.42	53.43	81.78	20,117
WS Funding in % of TA	19.62	8.32	6.08	34.07	20,117

Table 2: OLS Analysis of Requested Fixation Periods

This table shows the results of linear model estimated using *OLS* with the the fixation period requested by a household (*RFP*) as the left-hand side variable. Explanatory variables are household & house characteristics, as well as to the difference between 10-year and 1-year government bond yields prevailing on the day of the request. The sample includes requests for mortgages filed between 2010 and 2013. Observations are at the request level. House variables are indicator variables for the property type, *Property age*. The estimations do not include fixed effects. Heteroskedasticity robust standard errors are reported in brackets. ***, **, * denote statistical significance at the 0.01, 0.05 and 0.10-level respectively. Definitions of variables are provided in the Appendix.

Model	Linear					
Dependent variable	Requested Fixation Period (*RFP*)					
Column	(1)	(2)	(3)	(4)	(5)	(6)
Spread (government bonds)	-1.482***	-1.482***	-1.481***	-1.481***	-1.482***	-1.467***
	(0.111)	(0.111)	(0.111)	(0.111)	(0.111)	(0.111)
PTI	-0.008	-0.006	-0.006	-0.004	-0.004	-0.004
	(0.005)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
PTI >33% (0/1)		-0.096	-1.532	-1.525	-1.628	-1.359
		(0.167)	(1.500)	(1.500)	(1.499)	(1.504)
PTI >33% (0/1)*Wealth (ln)			0.115	0.113	0.122	0.104
			(0.120)	(0.120)	(0.119)	(0.120)
LTV				-0.004	0.003	0.006
				(0.003)	(0.005)	(0.005)
LTV >67% (0/1)					-0.316**	-0.325**
					(0.152)	(0.152)
LTV >80% (0/1)						-0.518***
						(0.191)
Wealth (ln)	0.103**	0.104**	0.085*	0.081*	0.077	0.073
	(0.045)	(0.045)	(0.049)	(0.049)	(0.049)	(0.049)
Other real estate (0/1)	-0.187	-0.185	-0.188	-0.185	-0.186	-0.188
	(0.119)	(0.119)	(0.119)	(0.119)	(0.119)	(0.119)
Debt (0/1)	-0.327***	-0.327***	-0.326***	-0.319***	-0.317***	-0.297**
	(0.120)	(0.120)	(0.120)	(0.120)	(0.120)	(0.120)
Age	-0.048***	-0.048***	-0.048***	-0.050***	-0.051***	-0.051***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Constant	9.781***	9.749***	9.984***	10.336***	10.110***	9.943***
	(0.717)	(0.720)	(0.761)	(0.819)	(0.829)	(0.830)
Observations	5,914	5,914	5,914	5,914	5,914	5,914
Unit of observation	Request	Request	Request	Request	Request	Request
Property variables	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effects	No	No	No	No	No	No
R2	0.055	0.055	0.055	0.056	0.056	0.058
Method	OLS	OLS	OLS	OLS	OLS	OLS

Table 3: Multinomial Logit Analysis of Requested Fixation Periods

This table shows the results of *Multinomial Logit Models* using *Maximum Likelihood* (*ML*) with the fixation period requested by a household as the left-hand side variable. Explanatory variables are household & house characteristics, as well as to the difference between 10-year and 1-year government bond yields prevailing on the day of the request. Columns (1)-(2) show the raw coefficients (baseline category is *FP requested (0-1) (0/1)*) and columns (3)-(5) show marginal effects of *Multinomial Logit Models* at the mean for continuous variables and at zero for binary variables. The sample includes requests for mortgages filed between 2010 and 2013. Observations are at the request level. House variables are indicator variables for the property type, *Property age*. The estimations do not include fixed effects. Heteroskedasticity robust standard errors are reported in brackets. ***, **, * denote statistical significance at the 0.01, 0.05 and 0.10-level respectively. Definitions of variables are provided in the Appendix.

Model	Multinomial Logit (raw coefficients / log-odds ratios)		Multinomial Logit (marginal effects)		
Dependent variable	FP Requested (5) (0/1)	FP Requested (10) (0/1)	FP Requested (0-1) (0/1)	FP Requested (5) (0/1)	FP Requested (10) (0/1)
Column	(1)	(2)	(3)	(4)	(5)
Spread (government bonds)	0.804***	-0.685***	0.035***	0.220***	-0.256***
	(0.105)	(0.095)	(0.012)	(0.028)	(0.025)
PTI	-0.013**	-0.006	0.001	-0.001*	0.000
	(0.006)	(0.005)	(0.000)	(0.001)	(0.001)
PTI >33% (0/1)	0.752	-0.828	0.048	0.232	-0.279
	(1.319)	(1.103)	(0.100)	(0.143)	(0.174)
PTI >33% (0/1)*Wealth (ln)	-0.076	0.059	-0.003	-0.020*	0.023*
	(0.105)	(0.087)	(0.008)	(0.011)	(0.014)
LTV	0.008*	0.007*	-0.001*	0.000	0.000
	(0.004)	(0.004)	(0.000)	(0.001)	(0.001)
LTV >67% (0/1)	-0.348**	-0.334**	0.034***	-0.010	-0.024
	(0.145)	(0.130)	(0.012)	(0.017)	(0.020)
LTV >80% (0/1)	-0.233	-0.393***	0.036**	0.017	-0.052**
	(0.160)	(0.139)	(0.015)	(0.020)	(0.023)
Wealth (ln)	-0.122***	0.011	0.002	-0.021***	0.019***
	(0.045)	(0.041)	(0.004)	(0.006)	(0.007)
Other real estate (0/1)	-0.183*	-0.174*	0.018**	-0.005	-0.012
	(0.106)	(0.092)	(0.009)	(0.013)	(0.015)
Debt (0/1)	-0.138	-0.228**	0.021**	0.009	-0.030**
	(0.104)	(0.092)	(0.009)	(0.012)	(0.015)
Age	0.008*	-0.030***	0.002***	0.005***	-0.008***
	(0.005)	(0.004)	(0.001)	(0.001)	(0.001)
Constant	0.987	3.507***			
	(0.732)	(0.677)			
Observations	5,914	5,914	5,914	5,914	5,914
Unit of observation	Request	Request	Request	Request	Request
Property variables	Yes	Yes	Yes	Yes	Yes
Fixed Effects	No	No	No	No	No
Pseudo R2	.058	.058	.058	.058	.058
Method	ML	ML	ML	ML	ML

Table 4: Descriptive Statistics on Bank Responses by Requested Fixation Periods

Panel A of this table shows banks' relative rejection frequencies at the bank response level in total (column (1)) and depending on the Fixation Periods (FP) requested by households (columns (2)-(4)). Panel B of this table shows banks' responses at the bank offer level. It shows the share of offers that deviate in terms of the tranche-weighted Fixation Periods (FP) offered by the banks from the requested Fixation Periods (FP) (which is indicated by the variable *FP not comply*). Moreover, it shows the average tranche-weighted mortgage rate offered by the banks (*Weighted Rate*) and the average tranche-weighted mortgage spread offered by the banks (*Weighted Spread*). Last, it shows the average tranche-weighted mortgage spread (*Weighted Spread*) offered by the banks if the tranche-weighted offered fixation periods equal the requested fixation periods (*Weighted Offered FP=FP Requested*). The means of all variables are shown in total (column (1)) and by the requested Fixation Periods (FP) by households (columns (2)-(4)). In both panels, columns (5)-(7) test the corresponding differences in means. The sample includes only requests filed between 2010 and 2013. ***, **, * denote statistical significance at the 0.01, 0.05 and 0.10-level respectively. Definitions of variables are provided in the Appendix.

Panel A. Requested fixation periods and banks' responses (bank response level)

Variable	Total	FP Requested (0-1)	FP Requested (5)	FP Requested (10)	Difference (2)-(3)	Difference (2)-(4)	Difference (3)-(4)
Column	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Explicit Rejection	0.187	0.334	0.146	0.167	0.188***	0.167***	-0.021***
	(N=20,117)	(N=3,021)	(N=4,704)	(N=12,392)	(N=7,725)	(N=15,413)	(N=17,096)

Panel B. Requested fixation periods and banks' offers (bank offer level)

Variable	Total	FP Requested (0-1)	FP Requested (5)	FP Requested (10)	Difference (2)-(3)	Difference (2)-(4)	Difference (3)-(4)
Column	(1)	(2)	(3)	(4)	(5)	(6)	(7)
FP not comply	0.187	0.728	0.093	0.119	0.635***	0.610***	-0.026***
	(N=16,349)	(N=2,013)	(N=4,019)	(N=10,317)	(N=6,032)	(N=12,330)	(N=14,336)
Weighted Rate	2.157	1.560	1.860	2.390	-0.300***	-0.830***	-0.530***
	(N=16,349)	(N=2,013)	(N=4,019)	(N=10,317)	(N=6,032)	(N=12,330)	(N=14,336)
Weighted Spread	0.968	1.358	0.847	0.939	0.511***	0.419***	-0.093***
	(N=16,349)	(N=2,013)	(N=4,019)	(N=10,317)	(N=6,032)	(N=12,330)	(N=14,336)
Weighted Spread if FP comply	0.942	2.308	0.819	0.908	1.489***	1.400***	-0.089***
	(N=13,284)	(N=547)	(N=3,644)	(N=9,093)	(N=4,191)	(N=9,640)	(N=12,737)

Table 5: Descriptive Statistics on Bank Responses by Banks' IRR

This table shows our proxy for the leverage adjusted duration gap (three variants of this proxy: *IRR (Bank Assumptions), IRR (Quarter-Average Assumptions), IRR (Bank- and Time-Invariant Ass))* by Offer vs. Explicit Rejection (Panel A), Weighted Offered FP (Panel B), Weighted Offered Duration (Panel C), Weighted Rate (Panel D), Weighted Spread (Panel E). In Panels B-E, we use the median in the distribution of each variable to distinguish between Low and High. The sample includes only requests filed between 2010 and 2013. ***, **, * denote statistical significance at the 0.01, 0.05 and 0.10-level respectively. Definitions of variables are provided in the Appendix.

Panel A. Explicit Rejection

	Offer	Explicit Rejection	Difference
	(1)	(2)	(3)
IRR (Bank Assumptions)	6.801	7.219	-0.418***
	(N=16'349)	(N=3'768)	(N=20'117)
IRR (Quarter-Average Assumptions)	5.087	5.323	-0.236***
	(N=16'349)	(N=3'768)	(N=20'117)
IRR (Bank- and Time-Invariant Ass.)	8.215	8.321	-0.106*
	(N=16'349)	(N=3'768)	(N=20'117)

Panel B.Weighted Offered FP

	Low	High	Difference
	(1)	(2)	(3)
IRR (Bank Assumptions)	6.821	6.912	-0.091***
	(N=7'236)	(N=12'881)	(N=20'117)
IRR (Quarter-Average Assumptions)	5.285	5.045	0.24***
	(N=7'236)	(N=12'881)	(N=20'117)
IRR (Bank- and Time-Invariant Ass.)	8.295	8.201	0.094*
	(N=7'236)	(N=12'881)	(N=20'117)

Panel C. Weighted Offered Duration

	Low	High	Difference
	(1)	(2)	(3)
IRR (Bank Assumptions)	6.811	6.926	-0.115*
	(N=8'169)	(N=11'948)	(N=20'117)
IRR (Quarter-Average Assumptions)	5.304	5.013	0.291***
	(N=8'169)	(N=11'948)	(N=20'117)
IRR (Bank- and Time-Invariant Ass.)	8.266	8.213	0.053**
	(N=8'169)	(N=11'948)	(N=20'117)

Panel D.Weighted Rate

	Low	High	Difference
	(1)	(2)	(3)
IRR (Bank Assumptions)	6.847	6.900	-0.052
	(N=7'855)	(N=12'262)	(N=20'117)
IRR (Quarter-Average Assumptions)	4.759	5.370	-0.611***
	(N=7'855)	(N=12'262)	(N=20'117)
IRR (Bank- and Time-Invariant Ass.)	8.244	8.229	0.015
	(N=7'855)	(N=12'262)	(N=20'117)

Panel E. Weighted Spread

	Low	High	Difference
	(1)	(2)	(3)
IRR (Bank Assumptions)	7.009	6.791	0.218***
	(N=8'169)	(N=11'948)	(N=20'117)
IRR (Quarter-Average Assumptions)	5.541	4.851	0.69***
	(N=8'169)	(N=11'948)	(N=20'117)
IRR (Bank- and Time-Invariant Ass.)	8.464	8.078	0.386***
	(N=8'169)	(N=11'948)	(N=20'117)

Table 6: Regression Analysis of Bank Responses, Baseline IRR

This table shows the results of a *Logit Model* (column 1) estimated using *Maximum Likelihood (ML)* (marginal effects presented) and linear models (columns 2-5) estimated using *OLS* with the following left-hand side variables: *Explicit Rejection, Weighted Offered FP, Weighted Offered Duration, Weighted Rate, Weighted Spread*. Explanatory variables are bank characteristics: *IRR (Bank Assumptions), Swap Use (0/1), Ln (Total Assets), CET1 in % of TA, Deposits in % of TA, WS Funding in % of TA*. The sample includes requests for mortgages filed between 2010 and 2013. Observations are at the bank response level. The estimations include request fixed effects but no bank fixed effects. Heteroskedasticity robust standard errors are reported in brackets. ***, **, * denote statistical significance at the 0.01, 0.05 and 0.10-level respectively. Definitions of variables are provided in the Appendix.

Model	Logit (marginal effects)	Linear	Linear	Linear	Linear
Dependent variable	Explicit Rejection	Weighted Offered FP	Weighted Offered Duration	Weighted Rate	Weighted Spread
Column	(1)	(2)	(3)	(4)	(5)
IRR (Bank Assumptions)	0.474	-28.237***	-22.509***	-2.374***	0.870**
	(4.110)	(2.861)	(2.256)	(0.418)	(0.367)
IRR (Bank Assumptions) * PTI >33% (0/1)	19.202***	-0.104	-0.173	0.197	0.005
	(0.989)	(0.742)	(0.610)	(0.164)	(0.120)
IRR (Bank Assumptions) * LTV >67% (0/1)	-0.104	-1.883***	-1.462***	0.352***	0.594***
	(0.818)	(0.461)	(0.378)	(0.098)	(0.077)
IRR (Bank Assumptions) * LTV >80% (0/1)	19.958***	-3.075***	-2.655***	0.295	0.126
	(1.302)	(0.987)	(0.805)	(0.210)	(0.176)
IRR (Bank Assumptions) * FP Requested (5) (0/1)	-15.352***	15.547***	12.406***	0.161	-3.292***
	(1.175)	(1.393)	(1.123)	(0.246)	(0.224)
IRR (Bank Assumptions) * FP Requested (10) (0/1)	-16.188***	42.070***	33.916***	2.215***	-2.644***
	(1.013)	(1.392)	(1.122)	(0.241)	(0.219)
IRR (Bank Assumptions) * Swap Use (0/1)	3.923	2.163	1.342	1.028***	1.211***
	(4.057)	(2.290)	(1.791)	(0.290)	(0.290)
Swap Use (0/1)	1.267***	-0.080	-0.077	-0.011	0.016
	(0.171)	(0.089)	(0.069)	(0.013)	(0.011)
Ln (Total Assets)	-0.146***	0.058***	0.048***	-0.001	-0.018***
	(0.036)	(0.016)	(0.012)	(0.003)	(0.002)
CET1 in % of TA	-0.116***	0.016*	0.003	0.031***	0.029***
	(0.022)	(0.008)	(0.007)	(0.002)	(0.002)
Deposits in % of TA	-0.089***	0.013**	0.012***	-0.004***	0.003**
	(0.012)	(0.005)	(0.004)	(0.001)	(0.001)
WS Funding in % of TA	-0.143***	0.031***	0.025***	0.000	0.001
	(0.012)	(0.005)	(0.004)	(0.001)	(0.001)
Constant	8.098***	5.214***	5.122***	2.192***	0.726***
	(1.233)	(0.493)	(0.387)	(0.100)	(0.123)
Observations	20,117	16,349	16,349	16,349	16,349
Number of requests	5,432	5,076	5,076	5,076	5,076
Unit of observation	Response	Response	Response	Response	Response
Request FE	Yes	Yes	Yes	Yes	Yes
Bank FE	No	No	No	No	No
Method	ML	OLS	OLS	OLS	OLS

Table 7: Regression Analysis of Bank Responses, Bank-Invariant IRR

This table shows the results of a *Logit Model* (column 1) estimated using *Maximum Likelihood (ML)* (marginal effects presented) and linear models (columns 2-5) estimated using *OLS* with the following left-hand side variables: *Explicit Rejection, Weighted Offered FP, Weighted Offered Duration, Weighted Rate, Weighted Spread*. Explanatory variables are bank characteristics: *IRR (Quarter-Average Ass.), Swap Use (0/1), Ln (Total Assets), CET1 in % of TA, Deposits in % of TA, WS Funding in % of TA.* The sample includes requests for mortgages filed between 2010 and 2013. Observations are at the bank response level. The estimations include request fixed effects but no bank fixed effects. Heteroskedasticity robust standard errors are reported in brackets. ***, **, * denote statistical significance at the 0.01, 0.05 and 0.10-level respectively. Definitions of variables are provided in the Appendix.

Method	Logit (marginal effects)	Linear	Linear	Linear	Linear
Dependent variable	Explicit Rejection	Weighted Offered FP	Weighted Offered Duration	Weighted Rate	Weighted Spread
Column	(1)	(2)	(3)	(4)	(5)
IRR (Quarter-Average Ass.)	-6.201	-36.790***	-26.118***	-3.717***	2.042***
	(4.532)	(2.287)	(1.739)	(0.500)	(0.405)
IRR (Quarter-Average Ass.) * PTI >33% (0/1)	23.191***	-0.329	-0.310	0.123	0.070
	(1.216)	(0.743)	(0.605)	(0.183)	(0.143)
IRR (Quarter-Average Ass.) * LTV >67% (0/1)	-1.063	-0.493	-0.310	-0.008	0.211**
	(1.040)	(0.441)	(0.355)	(0.107)	(0.089)
IRR (Quarter-Average Ass.) * LTV >80% (0/1)	22.296***	-2.121*	-1.880**	0.567**	0.280
	(1.576)	(1.107)	(0.892)	(0.245)	(0.200)
IRR (Quarter-Average Ass.) * FP Requested (5) (0/1)	-16.505***	28.416***	19.826***	2.048***	-4.384***
	(1.449)	(1.392)	(1.109)	(0.303)	(0.277)
IRR (Quarter-Average Ass.) * FP Requested (10) (0/1)	-16.544***	50.599***	36.564***	4.689***	-3.426***
	(1.238)	(1.391)	(1.108)	(0.301)	(0.273)
IRR (Quarter-Average Ass.) * Swap Use (0/1)	15.325***	-3.281*	-2.677**	0.208	0.860***
	(4.475)	(1.788)	(1.332)	(0.368)	(0.301)
Swap Use (0/1)	0.722***	0.198**	0.136**	-0.007	-0.018
	(0.198)	(0.094)	(0.069)	(0.019)	(0.014)
Ln (Total Assets)	-0.145***	0.059***	0.050***	0.000	-0.019***
	(0.036)	(0.012)	(0.009)	(0.003)	(0.002)
CET1 in % of TA	-0.110***	0.032***	0.016***	0.032***	0.028***
	(0.021)	(0.007)	(0.005)	(0.002)	(0.002)
Deposits in % of TA	-0.100***	0.026***	0.021***	-0.003***	0.004***
	(0.012)	(0.004)	(0.003)	(0.001)	(0.001)
WS Funding in % of TA	-0.142***	0.036***	0.029***	0.000	0.002
	(0.012)	(0.004)	(0.003)	(0.001)	(0.001)
Constant	9.058***	4.088***	4.351***	2.142***	0.718***
	(1.236)	(0.419)	(0.330)	(0.099)	(0.125)
Observations	20,117	16,349	16,349	16,349	16,349
Number of requests	5,432	5,076	5,076	5,076	5,076
Unit of observation	Response	Response	Response	Response	Response
Request FE	Yes	Yes	Yes	Yes	Yes
Bank FE	No	No	No	No	No
Method	ML	OLS	OLS	OLS	OLS

Table 8: Regression Analysis of Bank Responses, Bank- and Time-Invariant IRR

This table shows the results of a *Logit Model* (column 1) estimated using *Maximum Likelihood (ML)* (marginal effects presented) and linear models (columns 2-5) estimated using OLS with the following left-hand side variables: *Explicit Rejection, Weighted Offered FP, Weighted Offered Duration, Weighted Rate, Weighted Spread*. Explanatory variables are bank characteristics: *IRR (Bank- and Time-Invariant Ass.), Swap Use (0/1), Ln (Total Assets), CET1 in % of TA, Deposits in % of TA, WS Funding in % of TA*. The sample includes requests for mortgages filed between 2010 and 2013. Observations are at the bank response level. The estimations include request fixed effects but no bank fixed effects. Heteroskedasticity robust standard errors are reported in brackets. ***, **, * denote statistical significance at the 0.01, 0.05 and 0.10-level respectively. Definitions of variables are provided in the Appendix.

Method	Logit (marginal effects)	Linear	Linear	Linear	Linear
Dependent variable	Explicit Rejection	Weighted Offered FP	Weighted Offered Duration	Weighted Rate	Weighted Spread
Column	(1)	(2)	(3)	(4)	(5)
IRR (Bank- and Time-Invariant Ass.)	-7.186	-54.618***	-42.668***	-4.329***	1.899***
	(4.818)	(2.697)	(2.119)	(0.483)	(0.387)
IRR (Bank- and Time-Invariant Ass.) * PTI >33% (0/1)	19.050***	-0.126	-0.205	0.222	0.051
	(0.915)	(0.446)	(0.383)	(0.162)	(0.116)
IRR (Bank- and Time-Invariant Ass.) * LTV >67% (0/1)	-0.892	-1.105***	-0.829***	0.106	0.297***
	(0.749)	(0.278)	(0.242)	(0.099)	(0.073)
IRR (Bank- and Time-Invariant Ass.) * LTV >80% (0/1)	18.975***	-1.366**	-1.365**	0.582***	0.126
	(1.203)	(0.671)	(0.582)	(0.222)	(0.165)
IRR (Bank- and Time-Invariant Ass.) * FP Requested (5) (0/1)	-14.045***	37.088***	28.224***	2.102***	-4.197***
	(1.058)	(0.770)	(0.655)	(0.262)	(0.226)
IRR (Bank- and Time-Invariant Ass.) * FP Requested (10) (0/1)	-13.672***	74.971***	58.990***	5.040***	-3.390***
	(0.889)	(0.757)	(0.644)	(0.257)	(0.223)
IRR (Bank- and Time-Invariant Ass.) * Swap Use (0/1)	14.415***	-2.616	-2.034	0.257	0.939***
	(4.866)	(2.554)	(1.987)	(0.383)	(0.315)
Swap Use (0/1)	0.468*	0.224	0.151	-0.006	-0.038**
	(0.270)	(0.176)	(0.136)	(0.027)	(0.019)
Ln (Total Assets)	-0.144***	0.076***	0.064***	0.001	-0.018***
	(0.036)	(0.013)	(0.011)	(0.003)	(0.002)
CET1 in % of TA	-0.110***	0.033***	0.017***	0.031***	0.028***
	(0.022)	(0.008)	(0.006)	(0.002)	(0.002)
Deposits in % of TA	-0.094***	0.030***	0.025***	-0.002*	0.004***
	(0.012)	(0.005)	(0.004)	(0.001)	(0.001)
WS Funding in % of TA	-0.138***	0.040***	0.033***	0.001	0.002
	(0.012)	(0.004)	(0.003)	(0.001)	(0.001)
Constant	8.784***	3.638***	3.840***	2.081***	0.738***
	(1.263)	(0.474)	(0.381)	(0.099)	(0.124)
Observations	20,117	16,349	16,349	16,349	16,349
Number of requests	5,432	5,076	5,076	5,076	5,076
Unit of observation	Response	Response	Response	Response	Response
Request FE	Yes	Yes	Yes	Yes	Yes
Bank FE	No	No	No	No	No
Method	ML	OLS	OLS	OLS	OLS

Table 9: Variable Definitions

Variable name	Definition	Source
Request characteristics		
RFP	Mortgage fixation period requested by the customer in years.	Comparis
FP Requested (0-1) (0/1)	Indicator of whether the mortgage fixation period requested by the customer is 0-1 years.	Comparis
FP Requested (5) (0/1)	Indicator of whether the mortgage fixation period requested by the customer is 5 years.	Comparis
FP Requested (10) (0/1)	Indicator of whether the mortgage fixation period requested by the customer is 10 years.	Comparis
PTI	Payment to income-ratio as specified in the application (in percent).	Comparis
PTI >33% (0/1)	Indicator of whether the payment to income ratio exceeds the value of 33%.	Comparis
LTV	Loan to value ratio (in percent).	Comparis
LTV >67% (0/1)	Indicator of whether the loan to value ratio exceeds the value of 67%.	Comparis
LTV >80% (0/1)	Indicator of whether the loan to value ratio exceeds the value of 80%.	Comparis
Wealth (ln)	Wealth including retirement savings as specified by the customer expressed in natural logarithm.	Comparis
Other real estate (0/1)	Indicator of whether the customer possesses further real estate.	Comparis
Debt (0/1)	Indicator of whether the customer reports any kind of debt.	Comparis
Age	Age of the customer in years.	Comparis
Property age	Difference between the year of the request and the year of property construction.	Comparis
Benchmark yields		
Market Spread (mortgage rate)	Difference between the average interest charged on 10-year fixed and 1-year mortgage rates in Switzerland (per month) (in percent).	SNB
Market 10-year mortgage rate	Average interest charged on 10-year fixed mortgage rate month in Switzerland (in percent).	SNB
Spread (government bonds)	Difference between the average interest charged on 10-year fixed and 1-year Swiss government bond yield (per month) (in percent).	SNB
10-year government bond rate	Average 10-year fixed Swiss government bond yield (per month) (in percent).	SNB
Bank response and bank offer characteristics		
Explicit Rejection	Indicator of whether the bank does not make a binding mortgage offer given that the request was sent.	Comparis
Weighted Offered FP	Tranche-weighted mortgage fixation period offered by the bank.	
Weighted Offered Duration	Tranche-weighted duration of the mortgage offered by the bank.	Comparis
Weighted Rate	Tranche-weighted mortgage rate offered by the bank (in percent).	Comparis
Weighted Spread	Tranche-weighted difference between mortgage rate offered by the bank and interest swap rate (in percentage points).	Comparis
FP not comply	Indicator of whether the tranche-weighted fixation period offered by the bank equals the one requested by the household.	Comparis
Bank characteristics		
IRR (Bank Assumptions)	Loss from 100bps increase in CHF LIBOR rates in % of CET1 capital, bank assumption on effective resetting period of assets and liabilities with unspecified resetting period.	FINMA
IRR (Quarter-Average Assumptions)	Loss from 100bps increase in CHF LIBOR rates in % of CET1 capital, with average assumption across all banks.	FINMA
IRR (Bank- and Time-Invariant Ass.)	Loss from 100bps increase in CHF LIBOR rates in % of CET1 capital, with bank- and time-invariant assumption of 2 years.	FINMA
Swap Use (0/1)	Indicator of whether the bank uses interest rate swaps.	FINMA
Ln (Total Assets)	Log of total assets.	FINMA
CET1 in % of TA	Core Equity Tier 1 capital in percent of total assets.	FINMA
Deposits in % of TA	Percentage of total assets funded with deposits.	FINMA
WS Funding in % of TA	Percentage of total assets funded through wholesale funding.	FINMA

Table 10: Our Sample and the Swiss Mortgage Market

Panel A of this table compares the cantonal shares of mortgages. The first column shows the percentage of mortgage volumes as reported by Swiss National Bank (SNB). Column (2) shows the percentage of mortgage volumes in the sample. Column (3) shows the share of mortgage applications in the sample. Panel B of this table compares the geographical composition in our sample to a survey conducted by Seiler (2013) by regions in Switzerland. Columns (1)-(3) show the distribution in Seiler (2013), where (2) shows that of purchases partly financed with pension money, (3) shows that financed without any pension money, and (1) shows the weighted average. Columns (4) and (5) show the distribution in our sample with (4) covering the distribution of mortgage volumes and (5) covering the distribution of the number of requests.

Panel A. Our sample vs. SNB statistics: the distribution across cantons

	SNB	Our sample	
	% of Volumes	% of Volumes	% of Number
	(1)	(2)	(3)
Zurich	19.19	24.88	21.91
Berne	10.77	11.74	13.70
Aargau	8.73	11.36	11.77
Vaud	8.07	9.90	8.84
St.Gallen	5.73	4.15	4.90
Geneva	5.06	3.90	2.52
Ticino	4.73	2.57	2.76
Lucerne	4.64	3.87	3.89
Basel Land	3.86	3.92	3.97
Valais	3.59	2.31	3.36
Thurgau	3.48	3.01	3.40
Solothurn	3.37	3.12	3.36
Graubünden	3.33	1.99	2.65
Fribourg	3.23	2.71	3.15
Schwyz	2.37	2.63	2.03
Zug	2.04	2.15	1.78
Basel Stadt	1.92	1.76	1.47
Neuchatel	1.53	0.91	1.03
Schaffhausen	0.94	0.80	0.95
Jura	0.75	0.32	0.46
Appenzell AR	0.62	0.37	0.51
Nidwalden	0.54	0.46	0.34
Obwalden	0.47	0.51	0.49
Glarus	0.44	0.34	0.42
Uri	0.40	0.30	0.29
Appenzell IR	0.18	0.05	0.05

Panel B. Our sample vs. survey by Seiler (2013): the distribution across regions

	Seiler (2013)			Our sample	
	Overall	Pension-financed	Not pension-financed	% of Volumes	% of Number
	(1)	(2)	(3)	(4)	(5)
Zurich	28	27	31	0	0
Eastern Switzerland	16	16	16	0	0
Mittelland	18	19	15	0	0
Northwestern Switzerland	13	14	12	0	0
Lake Geneva Region	10	11	9	0	0
Ticino	4	3	7	0	0
Central Switzerland	8	8	8	0	0