Maturity Choice of Private Mortgage Borrowers*

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Abstract

This paper asks what factors influence the maturity choice of private mortgage borrowers and if the choice is rational. Using a unique data set from the German market with more than 50,000 financed projects, we find a significant influence of personal and macroeconomic factors. A high income, a low loan value, and a low value to income ratio lead to short maturities; so do economically good times with high GDP growth and low unemployment. In addition, we show that the importance of pricing variables is age dependent and declining for older borrowers. Moreover, we demonstrate that borrowers behave irrational and not according to the recommendations of models on optimal mortgage choice when choosing the maturity of their mortgage.

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1 Introduction

In household finance, the mortgage decision is one of the most interesting topics because it usually is the largest single financial decision a household takes. A mortgage is associated with certain risks that can be threatening to the welfare of a household. In particular, mortgages with an adjustable interest rate can result in excessive payments when the interest level has risen. In order to study who is especially prone to the interest rate risk, this paper investigates the determinants of the maturity choice of private mortgage borrowers. What influence do pricing variables have? Do personal and macroeconomic variables matter? Is the borrowers' behavior in line with the results of models on optimal mortgage choice? This paper makes a further step in answering these questions.

So far most studies have focused on the United States where borrowers can choose between adjustable-rate mortgages (ARMs) and fixed-rate mortgages (FRMs). As FRMs usually have a maturity of 30 years, the downside risk of interest changes is negligible. This is different for ARMs which have periods of fixed interest rates of up to 5 years[1]. All studies agree in the importance of pricing variables. By contrast, the influence of personal traits is highly controversial. Most studies such as Dhillon et al. (1987) or Brueckner and Follain (1988) find no or only very weak significance for borrower specific variables. Nevertheless, Sa-Aadu and Sirmans (1995) point out that ARMs must be treated as differentiated products since there exists a difference whether the magnitude of the payment is readjusted every six months or every five years only. We conduct the first study where the exact length of the period of fixed interest rate up to 15 years is known. This allows an in-depth investigation of the drivers for the maturity decision and verifies the importance of personal variables.

[1] Cf. Sa-Aadu and Sirmans (1995).

We use a unique data set from a large German direct bank containing 52,148 projects that were financed between January 2005 and July 2010. Since the data was taken directly from the bank's database, it is of a very high quality. We have information on the mortgage such as the interest rate, the loan value, or the maturity and information on the borrower such as age, occupation, marital status, or income. Furthermore, we have detailed insights into the calculation of the interest rate and can consequently control for several premiums. Particularly, we do not only know the interest rate that the borrower has to pay for the chosen maturity but also the interest rates that she would have paid for other maturities. An important feature of our dataset is that the borrowers' characteristics are not used for interest rate adjustments. We can hence observe the unbiased influence of personal variables on the mortgage decision while usually the bank's anticipation influences the pricing of the mortgage causing a modified maturity choice. We comment on this in more detail in section 4. In addition, we use data from the German Bundesbank for macroeconomic data.

Since we want to identify the influence of various variables on the chosen maturity, we use maturity as dependent variable and regress it on pricing, personal, and macroeconomic variables. In the literature, logit or probit models have been used to distinguish between ARMs and FRMs. As our dependent variable can assume numerous values, we run an OLS regression. Hence, we can for the first time also estimate the economic influence of the explanatory variables. As a robustness check, we use an ordered logit model with the three most popular maturities.

Thanks to the large and detailed data set we can show which personal variables matter. We find that borrowers with a smaller income and higher loan values prefer longer maturities. The same is true for younger and first-time bor-

rowers. Non-German borrowers prefer shorter maturities. Furthermore, we can show that the macroeconomic situation has a significant influence on the mortgage decision. In economically good times – characterized by high GDP growth and low unemployment –, borrowers reduce the maturity of their mortgage even though they should expect interest rate increases and therefore save the current interest level for longer.

We compare the actual behavior of borrowers with the recommendations of Campbell and Cocco (2003). We find that, on average, people act in contradiction to the results of their life-cycle model. While households with large houses relative to their income, volatile labor income and single borrowers should prefer a reduced interest rate risk, they actually choose shorter maturities. The only exception is risk aversion. We find – in line with Campbell and Cocco (2003) – that high risk aversion results in longer maturities. In addition, we have a closer look at the unquestioned influence of pricing variables. We find that their impact is high on younger borrowers and steadily declining for older borrowers. Finally, we confirm the influence of the household decision rule proposed by Koijen et al. (2009).

We contribute to the literature in several ways. First, this is the first study to investigate the mortgage market of Germany which is the largest economy in the European Union. Second, we use a detailed and thus far largest data set and hence overcome the concerns of Sa-Aadu and Sirmans (1995) who state that "a major constraint on the mortgage literature is that large, detailed data sets are not available." (p. 500) Third, since we are not restricted to the decision between ARMs and FRMs, we can use the actual maturity and treat the mortgages as differentiated products. Fourth and most importantly, this exceptional data set allows answering new questions. We investigate the influence of the macroeconomic situation and the influence of the borrower's age on the importance of

pricing variables. In addition, we are the first to verify the predictions of the model in Campbell and Cocco (2003) explicitly. We can hence test whether the decisions of mortgage borrowers are reasonable.

The paper proceeds as follows. In section 2 the literature on the empirical and optimal choice between different maturities is presented. Section 3 contains a description of German mortgage market. The dataset is presented in section 4. After the presentation of the models in section 5, section 6 discusses the empirical results. Section 7 concludes.

2 Literature

In his Presidential Address to the American Finance Association, John Campbell said that "there has been surprisingly little work on mortgage decisions from the perspective of the household." (Campbell (2006), p. 1577) This is especially true for studies on optimal mortgage choice. The first investigation about whether certain characteristics of a household should lead to a preference for either an ARM or a FRM was conducted by Campbell and Cocco (2003). They solve a life-cycle model and account for both income risk and interest-rate risk and find that couples should prefer ARMs. As aforementioned, the same is true for "households with smaller houses relative to income, more stable income, lower risk aversion, more lenient treatment in bankruptcy, and a higher probability of moving" (p. 1489).

Van Hemert et al. (2005) investigate mortgage choice with simultaneous consideration of the optimal financial portfolio in a continuous-time model with CRRA preferences. This study differs from Campbell and Cocco (2003) by neglecting income risk but including wealth risk in a more complex way. It concentrates on the influence of risk aversion and finds that a borrower with a low

risk aversion should prefer an ARM whereas a borrower with a higher risk aversion should choose an FRM. In a life-cycle model that also includes the housing tenure and house size choice, Van Hemert (2009) finds that only older, risk-averse borrowers should hold FRMs.

While there are few papers showing what borrowers should do, there are quite a number of research projects on the question what parameters do influence the decision between FRMs and ARMs. However, most of the studies could not find a significant influence of personal factors as the literature on optimal mortgage choice predicts.

The first examination of the influence of price and borrower variables was conducted by Dhillon et al. (1987) using a single-city data set with 78 observations. They find a prevalent impact of the pricing and only a weak impact of the borrower characteristics. In detail, households with co-borrowers, married couples, and short expected housing tenures as well as wealthier borrowers tend to prefer ARMs. The t-value of all these variables is relatively low so that only the mobility variable is significant on a 10% level. The influence of age, education, first-time home buying, and self-employment is insignificant. Brueckner and Follain (1988) use 475 observations from a national broker survey. They also show the high impact of pricing factors. A high spread between the initial interest rates of ARMs and FRMs and a high rate for FRMs increase the probability of taking an ARM. So does a high borrower income and the fact that someone is new to the respective metropolitan area. However, one has to note that the significance of these variables is rather low. The other characteristics – i.e. whether there are children in the household, the borrower age, and the fact that the borrower is a repeat homebuyer – have no significant impact at all.

A considerably larger data set was used by Tucker (1989). It contains 20,697

mortgages from a fifty-month period. Once again, the impact of the spread between ARM and FRM interest rates is found. Furthermore, a rising CPI and lower T-bill rates lead to a higher probability of an ARM choice. The significance of the offered FRM interest rate cannot be replicated. Phillips and VanderHoff (1991) split the ARM-FRM-spread into the temporary ARM rate reduction and the fully adjusted ARM interest rate. An increase in both components significantly raises the probability of choosing an ARM, as does an increase of the spread between ten-year U.S. Treasury bonds and one-year Treasury bill yields and an increase of house prices. Once again, the personal characteristics mobility, whether the borrower is a repeat homebuyer, and whether there are children in the household have no significant influence. For this study, 755 mortgages from a three-year period are used.

A sample of 6,818 observations is used by Phillips and VanderHoff (1994). This study confirms the findings for the ARM-FRM-spread. A further result is that households with a high ratio of mortgage loan to house value and households in a region with high income growth per capita prefer ARMs. The borrower characteristics income, reported assets, and reported debts have no impact. So far the only study to account for the frequency of interest rate adjustment is Sa-Aadu and Sirmans (1995). The frequency ranges from semiannual to every five years. In this respect, this study comes closest to ours. However, there are only 345 mortgage loans from a six-year period in the data set. In line with previous findings, short adjustment periods are influenced strongest by a relative increase of the mortgage's price. Households that have lived less than two years at the current address, that are younger, and that expect their income to rise prefer ARMs. By contrast, the current income and the liquid assets of the borrower are not significant.

The first study that uses non-US data is Duffy and Roche (2005) analyzing 36,810 loans from the largest mortgage provider in the Republic of Ireland. The borrowers can choose between standard ARMs, 1 year discounted ARMs and FRMs with maturities from 1 to 5 years. The authors find that the higher the ARM-FRM-spread, the higher the probability for an ARM. Both a higher loan to value ratio, a higher house price to income ratio, and the use of mortgage brokers increase the probability for the one year fixed rate mortgage. Households that are first-time buyers and those with a co-borrower prefer FRMs. By contrast, a male borrower tends to choose an ARM. The ARM-FRM-spread has a bigger impact on first-time than on repeat homebuyers. An emphasis on the employment sector of the borrower is placed by Cutts et al. (2006). They find that households working in stable sectors prefer FRMs. Furthermore, households with high debt, young college graduates, and self-employed people prefer ARMs. Once again, the relative price of ARMs and FRMs influences the decision as well. The data for this study was taken from five survey years (1989 through 2001) of the Survey of Consumer Finances.

Paiella and Pozzolo (2007) conduct a study for Italy, using 421 mortgages reported in the Bank of Italy's Survey of Household Income and Wealth. They find that households facing a low variable interest rate or a high ARM-FRM-spread prefer ARMs. Borrower characteristics have a minor influence. Older borrowers and borrowers with children prefer FRMs (on a 5% significance level). The type of employment, income, and wealth have no significant impact on the decision. The stronger the competition in the local bank market, the higher the probability of taking on ARMs. Analyzing 1,367 loans from a Korean survey from 2004 to 2006, Shin (2008) cannot find a significant influence of age and household size.

In a nutshell, the present empirical literature has not been able to identify certain personal characteristics that influence mortgage choice.

3 The German Mortgage Market

Our analysis is applied to the housing market in Germany. This market differs from the mortgage market in the United States in some respects; however, we think that the German market is especially appropriate for our research.

First, mortgages in Germany are with recourse, i.e. German mortgage borrowers usually guarantee with their entire assets and not with the hypothecated house only. This lowers the degree of speculation and hence reveals the maturity preferences better.

Second, the maturity decision is not based on ARM vs. FRM – instead, borrowers can choose how long the interest rate is to be fixed. This can be any maturity and 10 years is most popular. When the fixed interest period is over, the remaining mortgage amount must be refinanced at the current interest rate. It is also possible to fix the interest rates to an earlier point of time by using a forward mortgage. Hence, the borrowers have a high freedom of choice and can opt for the maturity that fits best. The German markets allows to overcome the limitations of a decision with only two alternatives.

Third, there is a prepayment penalty when the mortgage has a maturity of less than 10.5 years.[2] This means that the borrower is only allowed to redeem the mortgage before maturity when he or she compensates the bank for incurred losses of interest payments. Therefore, lower interest rates do not cause mortgage refinancing. After 10 years, the mortgage can be called by the borrower with a time limit of half a year. For mortgages with longer maturities, the value of the

[2]The bank that provided our data set only charges a penalty fee if the yearly prepayment exceeds 5% of the original amount.

prepayment option usually is not included in the interest rates which exposes mortgage providers to a prepayment risk for mortgages with long maturities. Consequently, the maturity spread tends to be smaller than in the United States.

Fourth, equity extraction is not possible. This guarantees that the mortgage is used for real estate financing only. Fifth, interest payments are only tax deductible when the house is rented.

There are two common ways for taking out a mortgage: Borrowers can either approach one or several banks and request a loan offer, or they can contact a mortgage broker who compares the offers of a larger number of banks. Since the broker is paid by the mortgage provider and this payment might depend on the maturity, we control for the influence of brokers in the following.

Mortgages provided by banks to individuals amount to more than one trillion Euros. In contrast to the USA, the market share of both variable and 30-year mortgages is low. In 2009, according to data from the German Bundesbank about 17% of the issued mortgages were floating or had a maturity of less than one year. In this figure, interim financing is included. We have no interim financing in the data set because it does not reflect a deliberate decision. The share of mortgages with a maturity of more than 10 years amounted to about 25%.

4 Data and Descriptive Statistics

We use a unique dataset from a large German mortgage provider acting both via direct marketing and mortgage brokers. It contains 88,774 single mortgages originated between January 2005 and July 2010. However, it is not uncommon to take out several loans at once which allows more flexibility in redeeming the loans. As a consequence, the number of unique borrowers is reduced to 69,384. We totalize mortgage sizes and monthly repayments and take weighted arithmetic

means of the interest rate, the repayment rate, and the maturity.

Furthermore, we remove some of the data. Most importantly, we delete all forward mortgages. The bank that provided our data set allows to settle the new conditions up to three years beforehand. Having no information about this time span, we decided to remove the 16,834 forward mortgages. Furthermore, we remove 72 mortgages from a temporary special offer with maturities of more than 15 years. Last but not least, we also remove 330 mortgages where some information is missing; 52,148 mortgages remain. For the ordered logit model, we use mortgages with a maturity of 5, 10, or 15 years only; 43,297 mortgages remain.

A major advantage of our dataset is that the bank does not use the information on the borrower for pricing. In perfect and complete financial markets, the borrower characteristics would be reflected in the pricing and other terms of the mortgage. Consequently, if banks know that certain borrowers prefer specific maturities they can adjust the interest rate in order to induce them to choose a maturity that is more profitable for the bank. In the end, we cannot observe the exogenous behavior of the borrower. In our dataset, however, the bank's interest rate is independent of information on the borrower for business model reasons. It depends only on the size of the mortgage (smaller mortgages are more expensive) and the loan to value ratio (higher loan to value ratios are more expensive). Depending on these parameters, the bank's offer is determined. If the potential borrower is interested, she can apply for the mortgage. In the last step, the bank calculates a creditworthiness score. Based on this score, the mortgage application is accepted or rejected. Importantly, there are no risk premiums added to the interest rates. We hence do not suffer from a maturity distortion caused by personal variables and can observe their true impact. This might explain why we

find a significant influence whereas earlier research could not.

We have no information on further relationships between the bank and the customer. However, since the majority of the mortgages is arranged by mortgage brokers and information on the borrower is not used for pricing, we consider relationship aspects negligible.

The macroeconomic data and interest rates for government bonds were taken from the website of the German Bundesbank. We can use GDP growth on a quarterly basis and the unemployment rate as well as the inflation rate on a monthly basis. The data of the Ifo Business Climate Index was taken from the website of the Ifo Institute. This think tank asks German companies about their current business situation and their business expectations in order to calculate the index on a monthly basis.

The general interest level is the interest rate charged for a mortgage with a notional value of EUR 100,000, a maturity of 10 years, and a loan to value ratio of 60%. The spread denotes the interest rate difference of mortgages with a maturity of fifteen and five years and the same size and loan to value ratio. Consequently, both figures depend only on the origination day and are independent of the maturity of the respective loan.

The house price to income ratio is calculated as collateral value divided by twelve times the reported monthly income. Stable Income covers borrowers who are civil servants or retired persons, i.e. people whose income is paid by the government and who cannot be laid off. Instable Income covers borrowers who are self-employed persons and freelancers.

We denote the natural logarithm by *log* and indicate with *dem* that the variable has been demeaned, i.e. its arithmetic mean has been subtracted.

Descriptive statistics are given in table 1. The chosen maturity varies between

one year and fifteen years which is the maximum maturity offered by the mortgage provider in order to limit the prepayment risk (cf. section 3). The average maturity is 11 years. The average mortgage amounts to EUR 165,000 but we can observe a high standard deviation due to very low and very high mortgage sizes. Only 20% of the mortgages in our dataset were directly taken out at the bank whereas 80% were taken out after the consultation of an independent mortgage broker. Mortgage brokers compare the conditions of a large number of national and local operating banks. They are usually paid a commission by the chosen bank and do not charge the mortgage borrower any fees.

[Insert table 1 here]

5 Model Specification

The chosen maturity ranges from one to fifteen years. It is therefore plausible to run an OLS regression. The model is in the form $Maturity_i = \alpha + \gamma_i\beta_1 + \lambda_i\beta_2 + \varepsilon_i$ where γ_i is the vector of explanatory variables depending on model specifications, λ_i is the vector of control variables and ε_i is the error term. Control variables depend on the model specifications and can include, for example, interaction terms and year fixed effects.

Since approximately five out of six loans have a maturity of either five, ten, or fifteen years, we also run an ordered-logit regression in a second step. Compared to a standard logit probability specification, the dependent variable y_i can assume more than two values. Here we assume $y_i \in \{5, 10, 15\}$. Then $\mathcal{P}(y_i = j) = \mathcal{P}(\alpha_{j-5} < \gamma_i\beta_1 + \lambda_i\beta_2 + \varepsilon_i \leq \alpha_j)$ where $\alpha_0 = -\infty$ and $\alpha_{15} = \infty$.

We demean the variables used in interaction terms except for dummy variables. This is a common approach dealing with interaction terms and eases the interpretation of the regressors.

6 Results

6.1 Influence of personal traits

In contrast to the literature, we find a clear and significant influence of personal traits of the borrower on the maturity decision. Column (a) in table 2 shows that borrowers with a higher income choose shorter maturities whereas a higher loan value results in longer maturities. This might be due to financial constraints. Borrowers with a low income and a large mortgage cannot bear the risk of interest rate increases. Therefore, they prefer not to have an adjustment soon. This is in line with the influence of the loan to value ratio: The smaller the equity share the longer the maturity of the mortgage. Interestingly, this influence depends on the income of the borrowers. In table 3 we show that the loan to value ratio has no significant influence for borrowers with an income of less than EUR 2,500 and an increasing influence with rising income. This indicates that less wealthy borrowers cannot afford to increase the maturity of their loan when having a high loan to value ratio.

[Insert table 2 here]

[Insert table 3 here]

When borrowers refinance their mortgage they choose a maturity that is on average about 0.6 years shorter than the mortgages of borrowers who take out a loan for the first time. Borrowers who did well with their first mortgage might be more willing to take on a higher interest rate risk. In addition, recalling the steadily falling interest rates over the last decades, they also might want to react to interest rate changes faster.

Foreigners usually choose shorter maturities by about 0.7 years. Since we have no information about their provenience, there are two possible explanations:

First, these borrowers come from countries where ARMs or mortgages with short periods of fixed interest rates are more common. Thus, they prefer this kind of loans in Germany as well. Second, Germans are more risk averse than other nationalities and therefore want to fix their repayments for a longer time.

The number of children in a household increases the maturity slightly. However, the economic significance is low. When using squared age as additional explanatory variable, the number of children also loses statistical significance. Therefore, the impact of this variable is not definite.

When the borrowers are not going to live in the financed real estate themselves, the maturity of the mortgage is reduced. Financing an owner-occupied house might lead to a higher risk aversion since a foreclosure does not only mean the loss of a financial asset but of one's home.

Older borrowers choose shorter maturities than younger ones. A ten year difference in age results on average in a 0.4 year difference in maturity. In column (c) of table 2 we show that age has a quadratic impact. There, the linear term has a positive sign. However, the combination of the linear and quadratic term has a negative influence for all borrowers older than 28 years. The effect consequently is especially pronounced for relatively old borrowers.

As column (b) in table 2 shows, controlling for year-fixed effects does not change any result notably. We also control for the influence of a mortgage broker. Using a mortgage broker leads to longer maturities. We cannot exclude the explanation that other banks pay higher commissions for mortgages with shorter maturities than our dataset provider. Therefore, no meaningful interpretation is possible and we decided to treat this variable as a control.

Furthermore, we control for some interaction terms. As a consequence of the amortization payments, the loan to value ratio is lower for mortgages that are

renewed. In order to get the influence of the loan to value ratio for a first-time mortgage, we use this interaction term. Because of tax considerations the loan to value ratio might be higher for not owner-occupied real estate. Therefore, we also control for the interaction of loan to value ratio and owner occupation. Last but not least, we control for the interaction of loan value and income since borrowers with a higher income can afford large loans.

Using the ordered logit model whose results are shown in table 4, we do not find major differences. The only notable deviation is the loss of significance of the loan to value ratio when controlling for year fixed effects.

[Insert table 4 here]

Wooldridge (2002) recommends the percentage of correctly predicted outcomes as a measure of goodness of fit. In a binary response model, it is sufficient to know whether the probability for one outcome is larger or smaller than 50 percent. In an ordered logit regression with three possible outcomes, we might lose some observations because it is possible that none reach this threshold. Hence, we assume the value with the highest probability. Using the model of column (c) in table 4, this approach yields 26,666 correct and 16,631 wrong predictions (61.59% correctly predicted outcomes).

It is also interesting to see how good the single outcomes can be predicted. The model predicts 300 mortgages with a maturity of 5 years, which is true for 137 mortgages (45.67%). 156 mortgages have a maturity of 10 years and 7 mortgages have a maturity of 15 years. The prediction is best for mortgages with a maturity of 10 years: 20,319 of 32,129 mortgages (63.24%) are correctly specified whereas 3,331 mortgages have a maturity of 5 years and 8,479 mortgages have a maturity of 15 years. 10,868 mortgages are predicted to have a maturity of 15 years. This

is true for 6,210 of them (57.14%). 102 mortgages have a maturity of 5 years and 4,556 have a maturity of 10 years. The results are also depicted in table 5.

[Insert table 5 here]

6.2 Influence of the macroeconomic environment

We can show that the macroeconomic environment has a weak but significant influence on the maturity decision: In economically good times, borrowers prefer shorter maturities. This is especially interesting since economic upswings usually lead to interest rate increases and borrowers hence should choose longer maturities.

[Insert table 6 here]

As column (a) in table 6 shows, an increase of the GDP growth by 1% leads to a decrease in maturity of 0.03 years. While this is economically irrelevant, it is highly statistically significant. The same is true for the ifo Business Climate indicator which consists of business expectations and the current business situation (Table 6, column (b)). An increase of the indicator by 1 point decreases the maturity by 0.02 years. A decrease of the unemployment rate by 1 percentage point leads to a reduction of the maturity by 0.22 years (Table 6, column (c)).

Column (d) in table 6 shows that a higher inflation rate leads to longer maturities. This is in line with the hypothesis mentioned above, namely that borrowers anticipate an increase of the interest rate level and choose longer maturities beforehand. An increase of the inflation rate by 1 percentage point results in a maturity increase of 0.11 years.

Since it might need some time until borrowers anticipate the macroeconomic situation, we also use regressors lagged by three months and can not find a notable

change (results not reported). The results of the ordered logit model in table 7 confirm our results.

[Insert table 7 here]

6.3 Rationality of mortgage borrowers

Solving a numerical life-cycle model, Campbell and Cocco (2003) find that "households with large houses relative to their income, volatile labor income, or high risk aversion are particularly adversely affected by the income risk of an ARM" (pp. 1452-3). In the German market, a long maturity reduces the income risk which is defined as the "short-term variability in the real payments that are required each month." (Campbell and Cocco (2003), p. 1452). We test in our study whether the factors mentioned lead to a longer period of fixed interest rates in reality. A further finding is that "for couples, an ARM delivers higher utility than a nominal FRM everywhere in the utility distribution." (p. 1472) We also test whether couples, i.e. mortgages with a co-borrower or with a married borrower, choose shorter periods of fixed interest rates. The results are depicted in table 8.

[Insert table 8 here]

An increase of the value to income ratio by 1 percentage point leads to a significant maturity decrease of 0.10 years. This is contradictory to the advice of Campbell and Cocco (2003). Borrowers whose houses are expensive relative to their income might need higher mortgages. In order to keep the interest payments low and overcome borrowing constraints, they are willing to accept a shorter maturity.

In order to test the influence of income volatility, we form two groups. The group "stable" contains all borrowers that are civil servants or retirees. Members

of both groups do not face the threat of a layoff or significant salary cuts. By contrast, the group "unstable" contains freelancers and self-employed individuals, i.e. borrowers with an unsteady income stream. We find that borrowers with a stable income choose a maturity which is 0.14 years longer than the maturity of the remaining borrowers. However, borrowers with an unstable income choose a maturity that is 0.47 years shorter than the maturity of the other borrowers. This is in line with the results of Cutts et al. (2006) but once again a violation of the recommendation in Campbell and Cocco (2003).

We find that a co-borrower leads to a maturity that is 0.36 years longer than that of single borrowers. When the borrower is married, maturity increases by 0.13 years compared to unmarried borrowers. These results show that borrowers do not make use of a reduced income risk which allows to take out mortgages with a shorter maturity and hence lower interest rates.

In order to test the influence of risk aversion, we use gender as a proxy. We remove all mortgages from the dataset that were taken out by a couple. We find that men choose a slightly shorter maturity than do women. Since many studies find that women are more risk averse than men,[3] this finding is the only one which is in line with the recommendation of Campbell and Cocco (2003).

The ordered logit regression in table 9 confirms our results.

[Insert table 9 here]

6.4 Influence of pricing variables

So far, all studies have shown the predominant influence of pricing variables. A high interest rate spread induces borrowers to choose the cheaper mortgage

[3]For example, Niessen and Ruenzi (2007) write that "perhaps the best documented difference between women and men is that women are more risk averse than men." A literature review is provided by Croson and Gneezy (2009).

and the reaction on the interest rate levels allows the conclusion that borrowers expect a mean reverting behavior of interest rates. Campbell and Cocco (2003) also suggest "when [the] yield spread is unusually high, more homeowners should take out ARMs, when it is unusually low, more homeowners should take out FRMs." (p. 1453)

We do find the well-studied maturity shortening influence of a higher interest level and a higher spread as well (not reported). Additionally, thanks to the large data set we can study whether different borrowers are affected differently by pricing variables. We find that older people are less influenced by both the yield spread and the general interest level. While borrowers in the 25 - 34 years age group reduce the maturity by 2.96 years when the spread increases by 100 basis points, borrowers in the 65 - 74 years age group react by a reduction of 1.44 years only. There is a steady decrease over all age groups (cf. table 10). The evidence is not so obvious for the influence of the general interest level. However, one has to note that the regressors for the 25 - 34 years age group and the 35 - 44 years age group are close and the standard deviation for the 65 - 74 years age group is high. Keeping this in mind, one also finds a decreasing influence of the general interest level.

[Insert table 10 here]

6.5 Influence of the household decision rule

Households might try to forecast future short-term interest rates and compare this prediction with current long-term interest rates when choosing the maturity of their mortgage. The simplest guess is assuming constant interest rates. This leads to the spread between current long-term interest rates and current short-term interest rates. As mentioned in section 6.4, we find this effect for the spread

between mortgages with a maturity of 15 years and mortgages with a maturity of 5 years as well.

A more sophisticated approach compares the current long-term interest rates with an average of recent short-term interest rates. This corresponds with the household decision rule of Koijen et al. (2009) which equals the long-term bond risk premium. With $y_t(T)$ denoting the interest rate for a maturity of T years at time t, we define the rule as $\kappa_t(\varrho) = y_t(15) - \frac{1}{\varrho}\sum_{u=0}^{\varrho-1} y_{t-u}(5)$ since 15 years is the longest maturity available and 5 years is a very popular short-term maturity. The look-back period ϱ is 360 days or 1800 days, respectively, and is calculated on a daily basis. The results are presented in table 11.

[Insert table 11 here]

We find that the household decision rule has a significant influence for both $\varrho = 360$ and $\varrho = 1800$. Analogous to the influence of the spread, an increase of the distance between long-term interest rates and the arithmetic mean of recent short-term rates reduces the chosen maturity. This effect is more pronounced for the longer look-back period where the reduction amounts to between one and two and a half years compared to the shorter look-back period where the reduction is less than one year.

Comparing these results with regression (1c) in table 2, we find that adding the household decision rule with $\varrho = 360$ to the explaining variables leads to a small increase of the adjusted R^2 only. The rise from 18.15 to 18.18 indicates no additional explanatory power. However, for $\varrho = 1800$ the household decision rule leads to an increase from 18.15 to 19.47 in adjusted R^2. This shows that it needs to be considered when explaining the chosen maturity. In a nutshell, we confirm the findings of Koijen et al. (2009) on the importance of the household decision rule provided that the look back period is long enough.

7 Conclusion

In this study, we were able to show that personal characteristics do have an influence on the mortgage choice. A high income, a low loan value, and a low loan to value ratio reduce the chosen maturity. When a mortgage is renewed, shorter maturities are preferred. Non-German borrowers choose also shorter maturities. The number of children in the borrower's household has no economic significant impact. The influence of the borrower's age has been controversial. We find that it is a variable which is complicated to handle but leads to shorter periods of fixed interest for older people. Due to its quadratic behavior, the impact is low for borrowers of average age and high for comparably older people. This might be a reason why the relation has not been found in earlier studies with smaller sample size. Additionally, how strongly a borrower reacts to pricing variables depends on the borrower's age. We were also able to show that the household decision rule proposed by Koijen et al. (2009) matters provided the look back period is long enough.

We can also show that the economy also influences mortgage choice. During an economic upswing, which is characterized by a high GDP growth, a good business climate, and a low unemployment rate, maturities are shortened. A higher inflation rate leads to longer maturities.

It is interesting to see that the predictions of the model in Campbell and Cocco (2003) are rarely fulfilled. A co-borrower or marriage as well as a low value to income ratio increase the chosen maturity. This is as irrational as the finding of a longer maturity for borrowers with a stable income and a shorter maturity for borrowers with an unstable income. The only prediction that we can confirm is a shorter maturity for borrower with a lower risk aversion when using gender as a proxy. Investigating if borrowers with a higher financial literacy

behave more rational and if other proxies for risk aversion yield the same result remains a direction for further research.

The lessons from these results are twofold: On the one hand, banks can use our findings on the influence of personal factors for a more profitable pricing of their loans. On the other hand, we showed that borrowers need more support when choosing the mortgage in order to come to a more rational decision.

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Table 1: Descriptive statistics

This table presents descriptive statistics of the dependent variable and the regressors.

	Mean	Median	Standard deviation	Minimum	Maximum	N
Maturity (years)	11.08	10.00	3.02	1.00	15.00	52,148
General Interest Level (%)	4.31	4.25	0.43	3.50	5.45	52,148
Spread (%)	0.66	0.70	0.39	0.00	1.30	52,148
Income (EUR)	3,980	3,290	4,020	769	189,700	52,148
Age (years)	41.88	40.00	10.46	17.00	94.00	52,148
Number of Children	0.87	1.00	0.98	0.00	9.00	52,148
Loan to Value Ratio	0.70	0.73	0.20	0.05	1.00	52,148
Loan Value (EUR)	164,700	150,000	109,800	12,000	7,847,000	52,148
Foreigner (dummy)	0.05	0.00	0.21	0.00	1.00	52,148
Broker (dummy)	0.80	1.00	0.40	0.00	1.00	52,148
Renewal (dummy)	0.23	0.00	0.42	0.00	1.00	52,148
Not Self-occupied (dummy)	0.22	0.00	0.41	0.00	1.00	52,148
GDP Growth (%)	0.98	1.65	3.01	-6.62	4.51	52,148
Ifo Business Climate (points, 2005 = 100)	98.30	99.70	7.34	82.30	108.80	52,148
Unemployment Rate (%)	9.40	8.70	1.66	7.10	12.70	52,148
Inflation Rate (%)	1.56	1.52	0.89	-0.46	3.28	52,148
House Price to Income Ratio	4.88	4.65	2.35	0.04	39.45	52,148
Stable Income (dummy)	0.09	0.00	0.28	0.00	1.00	52,148
Unstable Income (dummy)	0.05	0.00	0.22	0.00	1.00	52,148
Co-Borrower (dummy)	0.74	1.00	0.44	0.00	1.00	52,148
Marriage (dummy)	0.72	1.00	0.45	0.00	1.00	52,148
Man (dummy)	0.16	0.00	0.37	0.00	1.00	52,148
Woman (dummy)	0.10	0.00	0.29	0.00	1.00	52,148

Table 2: OLS regression: Personal regressors

This table presents the OLS regression coefficients and standard deviations of chosen maturity on various independent variables. The pricing factors include the general interest level and the spread between 15- and 5-year interest rates. ***, **, * indicates statistical significance at the 1%, 5%, and 10% levels, respectively. We denote the natural logarithm by *log* and indicate with *dem* that the variable has been demeaned, i.e. its arithmetic mean has been subtracted.

	(1a)	(1b)	(1c)
log(Income)	-0.63 (0.03)***	-0.55 (0.03)***	-0.67 (0.03)***
log(Loan Value)	0.70 (0.03)***	0.65 (0.03)***	0.70 (0.03)***
Loan to Value Ratio	0.72 (0.08)***	0.62 (0.08)***	0.72 (0.08)***
Renewal	-0.63 (0.04)***	-0.59 (0.04)***	-0.65 (0.04)***
Foreigner	-0.74 (0.06)***	-0.72 (0.06)***	-0.73 (0.06)***
Number of Children	0.03 (0.01)**	0.03 (0.01)**	0.01 (0.01)
Not Owner-occupied	-0.36 (0.10)***	-0.35 (0.10)***	-0.30 (0.10)***
Age	-0.04 (0.00)***	-0.04 (0.00)***	0.02 (0.01)**
Age^2	- -	- -	-0.000 63 (0.000 08)***
Controlling for:			
Pricing Factors	yes	yes	yes
Broker	yes	yes	yes
Year Fixed Effects	no	yes	no
dem(Loan to Value Ratio) · Renewal	yes	yes	yes
Loan to Value Ratio · Not Owner-occupied	yes	yes	yes
dem(log(Loan Value)) · dem(log(Income))	yes	yes	yes
Intercept	15.22 (0.35)***	11.90 (0.40)***	14.18 (0.38)***
$Adj - R^2$	18.06	19.72	18.15
N	52,148	52,148	52,148

Table 3: Influence of income

This table presents the OLS regression coefficients and standard deviations of chosen maturity on various independent variables for five different income groups. The pricing factors include the general interest level and the spread between 15- and 5-year interest rates. The personal factors include age, squared age, number of children, loan to value ratio, loan value, owner-occupation, foreigner, broker, and renewal. ***, **, * indicates statistical significance at the 1%, 5%, and 10% levels, respectively. We denote the natural logarithm by *log* and indicate with *dem* that the variable has been demeaned, i.e. its arithmetic mean has been subtracted.

	-2499 EUR	2500-3499 EUR	3500-4499 EUR	4500-5499 EUR	5500+ EUR
Loan to Value Ratio	0.11 (0.14)	0.22 (0.14)*	1.45 (0.19)***	1.59 (0.19)***	2.51 (0.30)***
Controlling for:					
Pricing Factors	yes	yes	yes	yes	yes
Personal Factors	yes	yes	yes	yes	yes
dem(log(Loan Value)) · dem(log(Income))	yes	yes	yes	yes	yes
Loan to Value Ratio · Not Owner-occupied	yes	yes	yes	yes	yes
Year Fixed Effects	no	no	no	no	no
Intercept	9.54 (0.79)***	9.04 (1.02)***	8.80 (1.53)***	10.94 (1.21)***	11.24 (1.63)***
$Adj - R^2$	14.24	17.39	19.82	20.66	15.12
N	12,308	16,917	10,520	5,482	6,921

Table 4: Ordered logit regression: Personal regressors

This table presents the ordered logit regression coefficients and standard deviations of chosen maturity on various independent variables. The pricing factors include the general interest level and the spread between 15- and 5-year interest rates. ***, **, * indicates statistical significance at the 1%, 5%, and 10% levels, respectively. We denote the natural logarithm by *log* and indicate with *dem* that the variable has been demeaned, i.e. its arithmetic mean has been subtracted.

	(1a)	(1b)	(1c)
log(Income)	-0.39 (0.03)***	-0.34 (0.03)***	-0.40 (0.02)***
log(Loan Value)	0.65 (0.02)***	0.64 (0.02)***	0.65 (0.02)***
Loan to Value Ratio	0.12 (0.07)*	0.02 (0.07)	0.11 (0.01)***
Renewal	-0.56 (0.03)***	-0.53 (0.03)***	-0.57 (0.03)***
Foreigner	-0.57 (0.05)***	-0.57 (0.05)***	-0.56 (0.00)***
Number of Children	0.01 (0.01)	0.01 (0.01)	-0.00 (0.01)
Not Owner-occupied	-0.52 (0.09)***	-0.53 (0.09)***	-0.49 (0.02)***
Age	-0.03 (0.00)***	-0.03 (0.00)***	- -
Age^2	- -	- -	-0.000 29 (0.000 01)***
Controlling for:			
Pricing Factors	yes	yes	yes
Broker	yes	yes	yes
Year Fixed Effects	no	yes	no
dem(Loan to Value Ratio) · Renewal	yes	yes	yes
Loan to Value Ratio · Not Owner-occupied	yes	yes	yes
dem(log(Loan Value)) · dem(log(Income))	yes	yes	yes
AIC	68,178	67,210	68,106
N	43,297	43,297	43,297

Table 5: Ordered logit regression: Goodness of fit

This table presents how good an ordered logit model predicts the chosen maturity. For example, the first line shows that 300 mortgages are predicted to have a maturity of 5 years. This is true in 137 cases. 156 have an actual maturity of 10 years and 7 have an actual maturity of 15 years.

	Actual chosen maturity			
	5 years	10 years	15 years	total
5 years predicted	137	156	7	300
10 years predicted	3,331	20,319	8,479	32,129
15 years predicted	102	4,556	6,210	10,868
total	3,570	25,031	14,696	43,297

Table 6: OLS regression: Macroeconomic regressors

This table presents the OLS regression coefficients and standard deviations of chosen maturity on various independent variables. The pricing factors include the general interest level and the spread between 15- and 5-year interest rates. The personal factors include income, age, squared age, number of children, loan to value ratio, loan value, owner-occupation, foreigner, broker, and renewal. ***, **, * indicates statistical significance at the 1%, 5%, and 10% levels, respectively. We denote the natural logarithm by *log* and indicate with *dem* that the variable has been demeaned, i.e. its arithmetic mean has been subtracted.

	(2a)	(2b)	(2c)	(2d)
GDP Growth	-0.03	-	-	-
	(0.01)***	-	-	-
Ifo Business Climate	-	-0.02	-	-
	-	(0.00)***	-	-
Unemployment Rate	-	-	0.22	-
	-	-	(0.01)***	-
Inflation	-	-	-	0.11
	-	-	-	(0.02)***
Controlling for:				
Pricing Factors	yes	yes	yes	yes
Personal Factors	yes	yes	yes	yes
Loan to Value Ratio · Renewal	yes	yes	yes	yes
Loan to Value Ratio · Not Owner-occupied	yes	yes	yes	yes
dem(log(Loan Value)) · dem(log(Income))	yes	yes	yes	yes
dem(GDP Growth) · dem(Spread)	yes	no	no	no
dem(Ifo Business Climate) · dem(Spread)	no	yes	no	no
dem(Unemployment Rate) · dem(Spread)	no	no	yes	no
dem(Inflation) · dem(Spread)	no	no	no	yes
Year Fixed Effects	no	no	no	no
Intercept	15.20	17.24	9.09	10.82
	(0.39)***	(0.47)***	(0.42)***	(0.43)***
$Adj - R^2$	18.26	18.37	19.49	18.57
N	52,148	52,148	52,148	52,148

Table 7: Ordered logit regression: Macroeconomic regressors

This table presents the ordered logit regression coefficients and standard deviations of chosen maturity on various independent variables. The pricing factors include the general interest level and the spread between 15- and 5-year interest rates. The personal factors include income, squared age, number of children, loan to value ratio, loan value, owner-occupation, foreigner, broker, and renewal. ***, **, * indicates statistical significance at the 1%, 5%, and 10% levels, respectively. We denote the natural logarithm by *log* and indicate with *dem* that the variable has been demeaned, i.e. its arithmetic mean has been subtracted.

	(2a)	(2b)	(2c)	(2d)
GDP Growth	-0.01	-	-	-
	(0.00)***	-	-	-
Ifo Business Climate	-	-0.01	-	-
	-	(0.00)***	-	-
Unemployment Rate	-	-	0.17	-
	-	-	(0.01)***	-
Inflation	-	-	-	0.11
	-	-	-	(0.02)***
Controlling for:				
Pricing Factors	yes	yes	yes	yes
Personal Factors	yes	yes	yes	yes
Loan to Value Ratio · Renewal	yes	yes	yes	yes
Loan to Value Ratio · Not Owner-occupied	yes	yes	yes	yes
dem(log(Loan Value)) · dem(log(Income))	yes	yes	yes	yes
dem(GDP Growth) · dem(Spread)	yes	no	no	no
dem(Ifo Business Climate) · dem(Spread)	no	yes	no	no
dem(Unemployment Rate) · dem(Spread)	no	no	yes	no
dem(Inflation) · dem(Spread)	no	no	no	yes
Year Fixed Effects	no	no	no	no
AIC	68,051	67,973	67,346	67,837
N	43,297	43,297	43,297	43,297

Table 8: OLS regression: Campbell/Cocco regressors

This table presents the OLS regression coefficients and standard deviations of chosen maturity on various independent variables. The pricing factors include the general interest level and the spread between 15- and 5-year interest rates. The personal factors include income, age, squared age, number of children, loan to value ratio, loan value, owner-occupation, foreigner, broker, and renewal. ***, **, * indicates statistical significance at the 1%, 5%, and 10% levels, respectively. We denote the natural logarithm by *log* and indicate with *dem* that the variable has been demeaned, i.e. its arithmetic mean has been subtracted.

	(4a)	(4b)	(4c)	(4d)	(4e)	(4f)
House Price to Income Ratio	-0.10	-	-	-	-	-
	(0.01)***	-	-	-	-	-
Stable Income	-	0.14	-	-	-	-
	-	(0.04)***	-	-	-	-
Unstable Income	-	-	-0.47	-	-	-
	-	-	(0.06)***	-	-	-
Co-borrower	-	-	-	0.36	-	-
	-	-	-	(0.03)***	-	-
Married	-	-	-	-	0.13	-
	-	-	-	-	(0.03)***	-
Man	-	-	-	-	-	-0.15
	-	-	-	-	-	(0.05)***
Controlling for:						
Pricing Factors	yes	yes	yes	yes	yes	yes
Personal Factors	yes	yes	yes	yes	yes	yes
dem(log(Loan Value)) · dem(log(Income))	yes	yes	yes	yes	yes	yes
dem(log(Value Income Ratio)) · dem(Income)	yes	no	no	no	no	no
Loan to Value Ratio · Not Owner-occupied	yes	yes	yes	yes	yes	yes
Year Fixed Effects	no	no	no	no	no	no
Intercept	13.94	14.25	13.78	14.73	14.34	14.434
	(0.38)***	(0.38)***	(0.38)***	(0.38)***	(0.38)***	(0.689)***
$Adj - R^2$	18.22	18.16	18.25	18.37	18.18	16.71
N	52,148	52,148	52,148	52,148	52,148	13,305

Table 9: Ordered logit regression: Campbell/Cocco regressors

This table presents the ordered logit regression coefficients and standard deviations of chosen maturity on various independent variables. The pricing factors include the general interest level and the spread between 15- and 5-year interest rates. The personal factors include income, squared age, number of children, loan to value ratio, loan value, owner-occupation, foreigner, broker, and renewal. ***, **, * indicates statistical significance at the 1%, 5%, and 10% levels, respectively. We denote the natural logarithm by *log* and indicate with *dem* that the variable has been demeaned, i.e. its arithmetic mean has been subtracted.

	(4a)	(4b)	(4c)	(4d)	(4e)	(4f)
House Price to Income Ratio	-0.08	-	-	-	-	-
	(0.01)***	-	-	-	-	-
Stable Income	-	0.14	-	-	-	-
	-	(0.03)***	-	-	-	-
Unstable Income	-	-	-0.42	-	-	-
	-	-	(0.01)***	-	-	-
Co-borrower	-	-	-	0.26	-	-
	-	-	-	(0.02)***	-	-
Married	-	-	-	-	0.09	-
	-	-	-	-	(0.02)***	-
Man	-	-	-	-	-	-0.14
	-	-	-	-	-	(0.04)***
Controlling for:						
Pricing Factors	yes	yes	yes	yes	yes	yes
Personal Factors	yes	yes	yes	yes	yes	yes
dem(log(Loan Value)) · dem(log(Income))	yes	yes	yes	yes	yes	yes
dem(log(Value Income Ratio)) · dem(Income)	yes	no	no	no	no	no
Loan to Value Ratio · Not Owner-occupied	yes	yes	yes	yes	yes	yes
Year Fixed Effects	no	no	no	no	no	no
AIC	68,025	68,060	68,001	67,969	68,062	18,818
N	43,297	43,297	43,297	43,297	43,297	11,447

Table 10: Influence of age

This table presents the OLS regression coefficients and standard deviations of chosen maturity on various independent variables for five different age groups. The personal factors include income, number of children, loan to value ratio, loan value, owner-occupation, foreigner, broker, and renewal. ***, **, * indicates statistical significance at the 1%, 5%, and 10% levels, respectively. We denote the natural logarithm by *log* and indicate with *dem* that the variable has been demeaned, i.e. its arithmetic mean has been subtracted.

	25-34 yrs	35-44 yrs	45-54 yrs	55-64 yrs	65-74 yrs
General Interest Level	-1.17 (0.07)***	-1.21 (0.06)***	-0.98 (0.08)***	-0.90 (0.14)***	-1.03 (0.21)***
Spread	-2.96 (0.08)***	-2.75 (0.07)***	-1.97 (0.09)***	-1.46 (0.15)***	-1.44 (0.22)***
Controlling for:					
Personal Factors	yes	yes	yes	yes	yes
dem(log(Loan Value)) · dem(log(Income))	yes	yes	yes	yes	yes
dem(log(House Price to Income Ratio)) · dem(Income)	yes	yes	yes	yes	yes
Loan to Value Ratio · Not Owner-occupied	yes	yes	yes	yes	yes
Year Fixed Effects	no	no	no	no	no
Intercept	12.48 (0.69)***	15.69 (0.58)***	14.25 (0.75)***	11.94 (1.26)***	12.07 (1.76)***
$Adj - R^2$	13.51	14.93	13.12	9.55	10.64
N	12,755	20,978	11,347	4,449	1,671

Table 11: OLS regression: household decision rule

This table presents the OLS regression coefficients and standard deviations of chosen maturity on the household decision rule $\kappa_t(\varrho)$ and various control variables. The personal factors include income, age, squared age, number of children, loan to value ratio, loan value, owner-occupation, foreigner, broker, and renewal. ***, **, * indicates statistical significance at the 1%, 5%, and 10% levels, respectively. We denote the natural logarithm by *log* and indicate with *dem* that the variable has been demeaned, i.e. its arithmetic mean has been subtracted.

ϱ	360	360	360	1800	1800	1800
$\kappa_t(\varrho, 15)$	-0.18 (0.04)***	-0.72 (0.04)***	-0.33 (0.04)***	-1.52 (0.05)***	-2.48 (0.05)***	-1.00 (0.03)***
Controlling for:						
General Interest Level	yes	yes	no	yes	yes	no
Spread	yes	no	yes	yes	no	yes
Personal Factors	yes	yes	yes	yes	yes	yes
dem(Loan to Value Ratio) · Renewal	yes	yes	yes	yes	yes	yes
Loan to Value Ratio · Not Owner-occupied	yes	yes	yes	yes	yes	yes
dem(log(Loan Value)) · dem(log(Income))	yes	yes	yes	yes	yes	yes
Year Fixed Effects	no	no	no	no	no	no
$Adj - R^2$	18.18	13.26	16.93	19.47	17.42	19.26
N	52,148	52,148	52,148	52,148	52,148	52,148