Residential mortgage defaults and positive equity: Lessons from Europe

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ABSTRACT

We empirically investigate mortgage default behavior in the European market where mortgages are recourse loans, i.e. borrowers are responsible upon default for the difference between the value of the outstanding debt and the value of the house. We show that the majority of defaults happen when collateral would be in principle enough to repay the debt. We find that equity at default is significantly negatively related with the households income at origination, which is consistent with the threat of recoursability being greater for borrowers with a higher marginal utility of consumption. Moreover, a tightening in credit conditions reinforces the relation between equity at default and income and negative shocks to house prices have a larger impact on the default probability of low-income borrowers, everything else controlled for. This evidence poses the question on what is best between principal reduction or temporary payment moratorium to prevent borrowers from losing their homes during crisis periods.

JEL classification: D1, G21
Keywords: Residential Mortgage Default, Recourse, Positive Equity, Income, Financial Constraints

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1 Introduction

It is quite common to read that the European mortgage market is less risky and has performed better than its counterpart in the US either because of (1) the lack of moral hazard on the part of lenders due to a less widespread use of OTD models of origination and/or (2) because in Europe nearly all mortgages are full recourse. However, mostly due to lack of data, we know very little about mortgage performance in Europe. There is a large literature that investigates the drivers of mortgage defaults using data from the US mortgage market, especially since the recent subprime crisis. Though, there are many institutional differences between mortgage markets in Europe and the United States, including differences in mortgage characteristics and financing structures, which are likely to affect borrowers' behavior and loan performance.

In this paper, we aim to fill this gap by empirically investigating mortgage default behavior in Europe (Euro Area plus UK) using a novel database of loan-level data that is provided by the European DataWarehouse (ED henceforth). ED is a centralised European platform for ABS loan level data. In particular, ED collects information on securitized residential mortgages backing RMBS that banks pledge as collateral in ABS transactions with the European Central Bank. The main focus is on understanding what triggers the default decision in a setting where mortgages are recourse loans (no debt forgiveness), i.e. when borrowers are responsible upon default for the difference between the value of the outstanding debt and the value of the house.

Using the loan balance as detailed in the ED data set, we identify loans with 90+ days of delinquency, which we classify as defaults. We then compute the implied equity at the time of default by comparing the current estimated value of the property with the outstanding balance. We find that a large fraction of defaults in Europe happens at positive equity: the majority of borrowers who default on their loan occurs when the value of their collateral would be in principle enough to repay the debt, with estimated equity at default averaging about 25%.

Our evidence may seem puzzling as, from a theoretical viewpoint, a rational borrower should always prefer to sell the house and prepay rather than default, if equity is positive. Alternatively, the borrower may try to renegotiate the terms of the loan or to refinance it. The result that many borrowers find themselves forced to default on their loans shows that either of these options appear out of reach for a significant fraction of the European market.

In the presence of lender recourse, there is an additional channel for the decision to default. As the value of the collateral decreases, borrowers are facing the threat that the value of their equity may turn negative, and therefore they may be deemed liable of the remaining balance through personal assets. This implies that, in equilibrium, borrowers would tend to anticipate their decision to default in the positive equity region. If this is the case, everything else constant, we expect that the threat of lenders recourse would be mostly feared by borrowers with higher marginal utility of consumption, higher assets to be seized, or both. We test this prediction on our data by relating equity at default with income and various borrowers characteristics.

We find that equity at default is significantly negatively related with the households income at origination. This result persists even after controlling for the loan-to-value and loan-to-income ratios, and when scaling equity by price volatility. A simple back of the envelope calculation shows that borrowers in the bottom quartile of the income distribution leave about 6% of equity on the table more than those in the top quartile, which in monetary terms corresponds to about 10'000 EUR, or 60% of their annual income. Our argument above implies that the decision to leave money in the table may come from the inability to renegotiate the loan, or refinance it to defer the foreclosure. To test this channel, we look at differential effects in the cross-section of borrowers and over time. We find that the equity-income relation is stronger for young and elder borrowers, and that equity is higher when the loan is either granted to a single borrower or when the borrower is a non resident. In addition, we interact the borrowers income with two proxies for the strength of credit supply, namely the CDS spread on the country debt and the fraction of non-performing loans at the loan originator level. In both cases, we find that a tightening of credit conditions reinforces the relation between equity at default and income.

Thus far, our analysis is conditional on the borrower having defaulted on the loan. If our evidence that low-income borrowers leave more equity on the table is driven by their higher sensitivity to changes in the value of collateral, we should observe this behavior also when analyzing the decision to default on the full panel of loans. To this end, we estimate a linear and probit model for the probability of default on the 42 million loan-year observations from ED. We find that negative shocks to house prices have a larger impact on the default probability of low-income borrowers, everything else controlled for. This result shows that such borrowers are more exposed to a deterioration in the value of house prices, either through a reduced ability to access credit or through an increased likelihood of negative equity in the future.

The remaining of the paper proceeds as follows. Section 2 reviews the literature on mortgage default decision. Section 3 describes the data and provides summary statistics. Section 4 presents the analysis of equity at default. The analysis of default rates is collected in Section 4.4. Finally, Section 5 offers concluding remarks.

2 Literature Review

Since the turmoil in the US housing market, a large literature has emerged that attempts to understand what fuelled the credit expansion and lead to the collapse of the subprime mortgage market in February 2007. Mian and Sufi (2009) emphasize the unsustainable increase in lending to poor credit quality borrowers, suggesting a relaxation of credit standards and moral-hazard issues on the part of originators. Adelino, Schoar, and Severino (2016) challenge this standard view on the causes of the crisis and shows that the contribution to the increase in debt was shared across the entire distribution of borrowers, thus emphasizing the role of middle and high-income borrowers in pushing up default rates.

Understanding the drivers of default is important for efficient market regulation. In particular, research on default behaviour can help lenders and policy makers to decide what is best between principal reduction or temporary payment moratorium to prevent borrowers from losing their homes during crisis periods (e.g. Elul et al. (2010), Geanakoplos (2014)).

Default is usually described in the finance literature as the exercise of a real option and should therefore be observed when doing so increases their lifetime wealth. In absence of frictions and costs of default, borrowers should default on their loans as soon as equity turns negative, even if they could afford to pay (see Campbell and Cocco (2015) for a comprehensive model of mortgage default).

The literature on mortgage default has mostly focused on understanding how widespread strategic default is in practice and thus on assessing the relative importance of negative equity versus illiquidity as trigger of default. Several papers have found that ruthless default is uncommon at moderate levels of negative equity and that borrowers tend to default only when negative equity is combined with a negative income shock (Bajari, Chu, and Park, 2008; Elul et al., 2010; Foote, Gerardi, and Willen, 2008). Bhutta, Shan, and Dokko (2010) look at the defaults by subprime borrowers in the US and find that the median borrower does not default until equity falls below -62 percent of the current value of the property, suggesting that borrowers face very high costs upon default. In their sample, only 20 percent of the defaults seem to be purely driven by negative equity.

Only few papers look at the effect of lender recourse on default behaviour. Ghent and Kudlyak (2011) compare default in recourse and non-recourse states in the US and find that the threat of recourse reduces the probability to default at any given level of negative equity. However, they find that unconditionally there is no difference in default rates, which runs counter the claim that lender recourse is the reason Europe has much lower default rates (e.g. Feldstein (2008)).

There are many institutional differences between mortgage markets in the euro area and the United States, including differences in mortgage characteristics and in mortgage financing structures. According to Campbell (2012) among others, the United States has much to learn from practices in certain parts of Europe.

Few papers use European mortgage data. Van Bekkum, Gabarro, and Irani (2017) use data on mortgage origination in the Netherlands to show that the relaxations of collateral eligibility criteria by the ECB in 2012 lead to an increase of lending to risky borrowers and thus a performance deterioration of loans. Acharya et al. (2017) examine how the February 2015 introduction of loan-to-value and loan-to-income limits on the issuance of residential mortgages in Ireland affected bank risk taking and household availability of credit. They show that banks most affected by the policy originated safer mortgages while they increased risk taking in corporate lending and security portfolios. Flodén et al. (2017) examine registry-based data on Swedish households and find that households that are highly indebted and have adjustable-rate mortgages respond stronger to changes in the monetary policy rate (cash-flow channel of monetary policy).

Mostly due to data limitations, there is yet very little direct empirical evidence on borrowers behaviour in the European mortgage market. This paper aims at filling this gap, focusing in particular on the wave of mortgage defaults that followed the European debt crisis that began in late 2009.

3 Data and variable construction

3.1 Loan data and sample selection

Our study makes use of loan-level data that are provided by the European DataWarehouse (ED henceforth). ED is a centralised European platform for ABS loan-level data. In particular, ED collects information on securitized residential mortgages backing RMBS that banks pledge as collateral in ABS transactions with the European Central Bank.[1] In order for an ABS to be eligible as collateral in Eurosystem refinancing operations, banks are re-

[1] See Van Bekkum, Gabarro, and Irani (2017) and Ertan, Loumioti, and Wittenberg-Moerman (2017) for other studies that use ED data.

quired since January 2013 to provide detailed loan-level information regarding the pool of cash-flow generating assets at least at quarterly frequency. For each loan in the pool, banks are required to report loan, borrower and collateral characteristics at origination, as well as updated information on loan performance. For loans that defaulted or prepayed before 2013, the database reports retroactively information on the default or prepayment date, as well as the outstanding balance at default and possible accumulated recoveries[2].

We focus our analysis on the nine European countries with the largest number of loans in the ED database, namely Belgium, France, Germany, Ireland, Italy, the Netherlands, Portugal, Spain and the United Kingdom. According to the Association for Financial Markets in Europe (AFME), these are also the countries with the largest RMBS markets by outstanding volume in Europe and account for 53% of the overall European market. The database contains more than 12 million residential mortgages originated from January 2000 until December 2015,[3].

In Figure 1, we collect statistics on the coverage of ED data for the RMBS and mortgage market. In Panel A, we compare the aggregate issuance volume at country level with the one reported by the Association for Financial Markets in Europe (AFME) for the period 2005-2015. We can compute the total RMBS issuance volume in ED because originators are required to provide information on issue date and issued amount of all the tranches (eligible and non-eligible) of a submitted RMBS deal. As we can see, ED data reflect on average about 78% of a country's RMBS total issuance volume (AFME).

The mortgages reported to ED also represent a relevant fraction of the overall issued mortgages in most European countries. For the period 2004-2005, we plot in Panel B the aggregate mortgage origination volume in ED as a percentage of the volume reported by the

[2] To be precise, this information is mandatory for all loans that are active in the pool at the time of submission. Banks are also strongly encouraged to submit information for all inactive loans, i.e. loans for which no cash-flows are expected in the future. In the database there are more than 3.4 million loans that are reported as inactive at first submission. For the average (median) inactive loan 47% (58%) of the mandatory fields are populated. Compared with the average (median) reporting ratio of 78% (82%) for active loans, this suggests that banks are quite keen to provide loan-level information for all loans in a pool.

[3] To exclude years with few originations from our sample, we do not consider loans originated before 2000. This choice ensures that we can compute the regional semiannual HPI index based on the property valuation at origination contained in our data for most regions.

European Mortgage Federation (EMF). This fraction is around 20% for most countries, and grows to in Belgium. This figure drops below 5% in the UK and Germany. For Germany, this figure is consistent with the evidence that most German mortgages are financed through covered bonds (*Pfandbriefe*) rather than RMBS.[4]

For each loan in the sample, ED provides an identifier for the mortgage originator. This might be either the name of the originator of the loan or an anonymous alphanumeric code. Our sample contains the main mortgage providers of each country as well as smaller ones. We compute the aggregate volume of originated mortgages in the sample period by originator id. In Table 2 we report for each country the origination share for the five largest originators in the sample without disclosing their names. We note that even though some providers account for a large fraction of the loans, originations are not concentrated in few providers.

We apply a series of filters to the raw data set. Specifically, we require information on loan amount, loan maturity, property valuation at origination, household income as well as origination date to be non-missing. Moreover, we filter out loans with missing detailed geographical information on the property location.[5] Within each country, we trim household income, property valuation and loan amount to the 1st and 99th percentile. We also trim LTV and LTI ratios to get rid of reporting errors. Finally, we restrict our attention to purchase loans[6] and eliminate loans that get repurchased by the seller at any point during their lifetime.

Borrowers can take on multiple small size loans with possibly different characteristics (maturity, interest rates, repayment method, etc.) to finance the purchase of a property. This practice is common in the Netherlands and is sometimes observed in other countries as well. The observation unit in ED is a loan part. In order not to overestimate the equity of a

[4]See the European Corporate Bond Fact Book 2016 by the European Covered Bond Council available at https://hypo.org/ecbc/publications/.

[5]Banks are required to report information on the geographic location of the property backing each loan. There is some heterogeneity in the reporting practices, whereas some banks report the zip code (at least 2 digits), while other report a nuts code or the name of the city. In order to obtain comparable geographical areas, we map the available information to nuts 3 codes. Nuts 3 regions therefore constitute the smallest geographical unit in our dataset. The location is identified for more than 90% of the loans in our sample in every country except for UK (56%).

[6]The purpose of the loan is a mandatory field and includes purchase, construction, renovation, equity release, debt consolidation and remortgage. For all countries, purchase loans are the most frequent and account for about two-thirds of the total.

borrower into a property it is important that we conduct our analysis at mortgage level. As in Van Bekkum, Gabarro, and Irani (2017), we therefore aggregate loans originated at the same time by a single borrower on a single property into a single mortgage. The resulting mortgage size is the sum of the principal of its loan parts, while loan characteristics are computed as mortgage balance-weighted averages.

Table 1 collects summary statistics for the resulting sample. Panel A reports the total loan amount and number. We rank countries based on the total dollar volume of loans issued. The largest volume is observed for France, totaling about 190 billion EUR from about 1.6 million loans. The smallest markets are Portugal and especially Germany. For the sake of completeness we keep German data in the sample, but our main results remain unaffected if we instead exclude it. The overall amount issued of more than 760 billion EUR captures a wealth of outstanding European households' mortgage debt.

In Panel B of the table, we look at loan characteristics at origination averaged across all loans. The average loan amount issued is about 137k EUR, against more than 199k EUR for the value of collateral. The resulting average loan-to-value (LTV) ratio is about 73%. However, we note significant dispersion among countries, with values of LTV ranging from 64% (Italy) to more than 85% for Germany and the Netherlands. Even more pronounced differences are observed for the ratio of loan to annual income (LTI), which averages about 4.1 but varies from as low as 2.8 (for Germany) to as high as 6.3 (for Portugal). The average loan maturity is about 24 years, with loans from Portugal being the longest at 34 years.

Overall, about 53% of the loans are fixed-rate. There is, however, very limited within-country variation in interest rate types. Four countries exhibit nearly all fixed-rate loans (these are France, the Netherlands, Belgium, and Germany; henceforth, FRM countries) while in other four countries loans are almost exclusively floating (namely, Spain, the U.K., Ireland, and Portugal; henceforth, ARM countries). Only in the case of Italy do we observe a significant fraction of either type, with about 23% loans being fixed-rate.

An additional loan characteristics, the number of lien is optional in ED's reporting template. The vast majority of loans with non-missing lien (58%) are first-lien.[7]

Finally, Panel C collects statistics for borrower's characteristics. Average income is lowest in Portugal, Italy, and Spain, while it exceeds 60k EUR in Ireland and the U.K. The average borrower is 38 years old, and is employed for about 70% of the loans. About half of the loans contain information on the number of borrowers that are responsible for the mortgage. This number averages at 1.6, with about 43% of such loans having a single borrower.[8]

3.2 Variable definitions and summary statistics

Our focus is on the relationship between a borrower's decision to default on a mortgage and the level of equity. To this end, we define a loan to be delinquent at a certain date t if payments are reported 90 or more days late for two consecutive quarters,[9], or if the loan is reported as in foreclosure or in default. We then define the "time of default" as the month when the loan reaches the 90+ day delinquency mark for the first time or as the date when it is first reported in default.

We construct our measure of equity at default for a given loan i as follows. Let V_{i,t_0} be the value of the property at the time of loan origination. Let H_{i,t_0} be the house price index at the same time for the county (nuts 3) where the property of mortgage i is located, computed as average property price across all loans in the region. We estimate the value of the property at a given time t as:

$$\widehat{V}_{i,t} = V_{i,t_0} \frac{H_{i,t}}{H_{i,t_0}} \tag{1}$$

[7] We do not have additional information on other loans outstanding for a borrower beyond that reported in the ED database. Given that the identity of the borrower is not disclosed, it would be in any case impossible to map ED data with other borrower-level information.

[8] In case of multiple borrowers, banks can report the primary and the secondary income as two separate fields. We refer to the sum of these two income values as household income. LTI at origination is computed as the ratio of the face value of the loan to the income at household level.

[9] Two consecutive submissions might be one month or one quarter apart, depending on the submission frequency of a specific deal. We consider two consecutive quarters in order for our definition of default not to depend on the submission practice. In robustness checks we use three additional definitions of default: as soon as reported in arrears and only defaulted.

We then compute the percentage equity stake of the borrower at the time of default as:

$$\widehat{E}_{i,t} = \frac{\widehat{V}_{i,t} - B_{i,t}}{\widehat{V}_{i,t}} \tag{2}$$

where $B_{i,t}$ is the outstanding balance on loan i at time t as reported in the ED database.

To the best of our knowledge there is no publicly available HPI index calculated at county level for Europe. Therefore, we compute $H_{i,t}$ from the ED database as the average property price across all loans originated in semester t in the same county where the property of loan i is located. For this computation, we consider all mortgages in ED, not only purchase mortgages. To reduce noise from counties with few observations, we require a county to have at least 30 observations (loan originations) in semester t to produce a valid house price average $H_{i,t}$. In case either H_{i,t_0} or $H_{i,t}$ cannot be used for the estimation of equity, we use the OECD annual price index. We compute implied annual country-level indices and we plot them against the index from OECD in Figure 2. We note that the two series move quite closely together. In fact, the correlation in returns to our HPI index and the OECD series is as high as 0.80. This evidence corroborates the reliability of our HPI estimates and mitigates concerns of sample selection biases in our data.

We use $\widehat{E}_{i,t}$ as our main dependent variable in our analysis in Section 4. As an alternative, we also scale the amount of equity by house price volatility. Similarly to Ghent and Kudlyak (2011), the variable is constructed as:

$$DD_{i,t} = Pr(E_{i,t} > 0) = 1 - \Phi\left(\frac{\ln B_{i,t} - \ln \widehat{V}_{i,t}}{\sigma_{i,t}}\right) \tag{3}$$

We compute the volatility of house prices for the county in which the loan is originated, $\sigma_{i,t}$, as the rolling standard deviation of the semi-annual HPI index return over the past 8 observations (4 years).

Table 3 provides summary statistics for the sample of defaulted mortgages.

4 Empirical Analysis

4.1 Default under recoursability: testable predictions

If mortgages are non-recourse, default can be modeled as the exercise of a real option where the optimal trigger level of equity depends on the stochastic process of house prices and the cost of default (Campbell, 2012). Moreover, the trigger level of home equity also depends on the level of borrowing contraints. The immediate financial relief of default is more attractive when borrowing contraints bind, i.e. when marginal utility of consumption today high relative to future marginal utility. Negative home equity is a necessary but not sufficient condition for mortgage default. At positive levels of equity borrowers are always better off by selling the house and repaying the loan. However, at low levels of negative home equity only financially distressed borrowers with depleted assets and low income will default.

If the threat of lender recourse is successful, strategic default should be ruled out and borrowers default only if they cannot afford the payments. In this setting it is unclear how the current value of equity should affect borrowers' decision to default. Ghent and Kudlyak (2011) find a reduced sensitivity of default to negative equity in recourse states.

We posit that even without the embedded option of non-recourse mortgage contracts, there still exists a threshold level of equity that would trigger default. While the probability of equity becoming negative increases the value of waiting under non-recourse, postponing default is risky under recourse. If selling the house takes time, above water borrowers that are experiencing financial difficulties might decide to default now to avoid being forced into default with negative equity in the future. We should observe a positive relationship between the extent of borrowing contraints and the amount of equity left on the table upon default. We test this hypothesis in the data using household's income at mortgage origination to proxy the extent of borrowing contraints and higher marginal utility of consumption today. The hypothesis is therefore that equity at default is higher the lower the income at origination.

4.2 Equity at default

To assess that the positive relationship between equity at default and income is robust to the inclusion of observable loan and borrower characteristics we run the following cross-sectional regression on the subsample of defaulted loans:

$$
\begin{aligned}
E_{i,t} &= \beta_0 LnIncome_{i,t_0} + \beta_1 LTV_{i,t_0} + \beta_2 LTI_{i,t_0} + \beta_3 Maturity_{i,t_0} + \beta_4 UnempRate_{c,t-12} \\
&\quad + \alpha_l \times \alpha_{t_0} + \epsilon_{i,t} \qquad (4)
\end{aligned}
$$

where $E_{i,t}$ is the equity at default of loan i that defaulted in month t (in percentage terms), $LnIncome_{i,o}$ is the household income at origination in logs, LTV_{i,t_0} and LTI_{i,t_0} are respectively the loan-to-value and loan-to-income measured at origination, $Maturity_{i,t_0}$ is the remaining time to maturity of the loan at the time of default, and $Unemp_{c,t-12}$ is the unemployment rate in the region (nuts 2) in the prior year (source is Eurostat).

Finally, our baseline specification incorporates the interaction of county and origination semester fixed effects ($\alpha_l \times \alpha_{t_0}$) to control for local dynamics in house prices and income.

Table 4 presents the resulting regression estimates. In the first specification, we incorporate only country fixed effects in the regression. We uncover a strongly significant and negative relation between equity and income. The full-sample coefficient on log income is -5.56, with a t-statistic of -4.88. This estimate implies that a 10% decrease in household income at origination is accompanied with a 0.56 (percent) increase in the amount that is left on the table at the time of default. This effect is robust to the inclusion of the other control variables, and in particular LTV and LTI which enter with the expected negative sign – that is, higher leverage and lower levels of affordability are associated with a smaller proportion of equity at the time of default.

Specification (2) instead absorbs away unobservable time-county characteristics by including the interaction of origination semester and county fixed effects. As we can see, the negative relation between equity at default and income at origination is robust to this more demanding model setup.

To gauge nonlinearities in the relation between equity at default and income, specification (3) adds (log) income squared to the set of regressors. The estimated coefficient is positive and significant, meaning that a decrease in income leads to a more-than-proportional increase in equity. In specification (4), we follow the alternative of including separate dummy variables for borrowers in the top (Q1) to third (Q3) quartile of the income distribution (across all borrowers, defaulted or not) in a given country and month. We observe a similar pattern, namely that everything else constant borrowers at the vertex of the income distribution leave about 6% less equity on the table compared to their low-income peers. To better appreciate the economic magnitude of this effect, consider that borrowers in the bottom quartile of the income distribution who defaulted on their loan have an average income of about 17'000 EUR and an average house valuation of about 126'000 EUR across the panel. Our estimates imply that these borrowers leave about 10'000 EUR additional equity, i.e. about 60% of their annual income, compared to high-income households with similar loan characteristics.

In columns (5) and (6), we explore to what extent is the effect of income driven by the fixed versus floating terms of the loan. We thus separately estimate the regression separately for the group of countries with adjustable and fixed mortgages, as defined above. We observe that the loading on income at default is negative and highly statistically significant in both groups. In other words, the decision to leave money on the table at the time of default appears not to be triggered by the interest-rate sensitivity of the loan contract.

Columns (7) we test the robustness of our results to an alternative fixed-effect specification by including originator and payment method fixed effects. We observe that our main result, the negative relation between equity at default and income, remains statistically significant and economically large.

Finally, in the last column of the table we use as dependent variable the probability of positive equity defined in equation (3). The number of observations drops by about 40 percent due to data requirements to construct the volatility of home prices, as explained in section 3.2. Notwithstanding the reduced sample, we note that our findings are robust to using this alternative measure. A 10% decrease in income at origination is accompanied with an increase by about 0.4 percent in the probability of positive equity at default. This effect is statistically significant at the 1% level. LTV and LTI at origination also have the expected negative sign, and are strongly significant.

4.3 Subsample analysis

In this section, we augment our baseline regression with loan and borrower characteristics, some of which are optional fields and are therefore available only for a subset of the sample. We also add interaction terms of log income with variables reflecting the strength of financial constraints and changes in the supply of credit. The purpose of this analysis both to test the robustness of our main findings to the inclusion of additional controls, and to look for cross-sectional and time-series patterns in the determinants of equity at default that would reinforce our identification. We collect this analysis in Table 5.

We control for the property type which serves as collateral. We define the dummy $House$ to be one if the property is a house, and zero otherwise.[10] As a second control, we use the information on the seniority of the loan, which is present for about 75% of the sample of defaults. We define the dummy $FirstLien$ to be one if the loan is first has priority in case of liquidation of the property, and zero otherwise. As we can see from Table 5, our result of a negative relation between equity at default and income is robust to the inclusion of these additional regressors.

The second set of variables we consider are borrowers' characteristics. We include these variables in both level as well as interacted with log income to check for the additional impact of shocks to financial slack for some classes of borrowers.

We first look at the age of the borrower. We construct the dummy variable Age to be one if the age of the borrower is below 35 or above 70, and zero otherwise, to capture differential

[10] For the great majority of the loans, the property is either a house of a flat/apartment.

effects for middle-age borrowers. In column (3) we note that equity at default does not on average vary significantly with age. However, the coefficient on the interaction with (log) income is negative and significant, which implies that the expected equity at default for low-income borrowers is higher for this types of borrowers. The differential impact of income shocks may be on account of the higher fragility or lower financial literacy of this group of borrowers compared to middle-aged ones.

As a second borrower characteristic, we use the information on the number of households underneath a loan contract, which is available for about 60% of the sample of defaults. Specifically, we construct the variable $OneBorrower$ which equals one for loans with a single borrower, and zero otherwise. In column (5) we see that equity at default is about 0.8 percent higher for single borrowers. This finding is consistent with single-borrower loans, for which the income of one household's member accounts for most income of the family, being more sensitive to a deterioration in economic conditions.

On a similar vein, we might also expect that equity at default differs between foreign (i.e. non-resident) and domestic borrowers. Arguably, foreigners are expected to be on average less familiar with local economic conditions and less connected with domestic financial intermediaries than their resident peers. We define the variable $Foreign$ as one for borrowers that are not resident in the same country where the loan is being originated, and zero otherwise. Information on borrower's residence is available for only about one fourth of the sample of defaults. In column (7), we find that controlling for loan characteristics, foreign borrowers leave about 4.5% more equity on the table than resident borrowers. This evidence is consistent with the argument that, once exposed to negative income shocks, foreigners find it more difficult to renegotiate the terms of their loans and default on their loan more inefficiently than residents. The effect of log income on this subsample is somewhat reduced, but remains economically and statistically significant. There appears to be not, however, a differential effect of income shocks for foreigners, as the interaction term in column (8) enters with a small and largely insignificant coefficient.

Our third set of variables proxies for changes in credit supply and in the level of financial constraints to intermediaries. We consider the 5-year credit default swap spread on a country' sovereign debt as a first of such proxies. In column (9) we present the results when adding the CDS in level, as well as interacted with log income. To allow a proper interpretation of the coefficients, we de-mean the CDS in the time-series for a given country. The negative and statistically significant coefficient on the interaction term indicates that everything else constant, equity at default for low income borrowers is higher in periods when credit risk for a country is higher, i.e. when financial constraints are tightening. The effect is also economically quite relevant. With an average CDS standard deviation across countries of about 122 (bps), it implies that low income borrowers leave about 4% more on the table following a two-standard deviation positive shock to CDS.

As an alternative approach, we use the detail of the ED data and proxy for the extent of financial constraints at the originator level. To this end, we compute for each loan originator the ratio of cumulative loan losses to the total volume of loans outstanding at a given time. This measure, denoted *LoanRatio*, varies both across counties and in the time-series. We expect the effect of income shocks that impair the ability of low income borrowers to meet their loan obligations to be more severe when the originator has experienced higher losses on its assets, and therefore has less leeway to refinance the loan. In column (10) of the table we find that the interaction between $LnIncome$ and $LnLoanRatio$ is negative and strongly significant, which suggests that a deterioration in credit supply is accompanied with a higher equity stake at the time of default for low income borrowers.

4.4 Default sensitivity to equity shocks

Thus far, our analysis is conditional on the borrower having defaulted on the loan. If our evidence that low-income borrowers leave more equity on the table is driven by their higher sensitivity to changes in the value of collateral, we should observe this behavior also when analyzing the decision to default on the full panel of loans. To this end, Table 6 presents the estimates from a linear and probit model for the probability of default on the 42 million loan-year observations from ED.

We find that negative shocks to house prices have a larger impact on the default probability of low-income borrowers, everything else controlled for. This result shows that these borrowers are more exposed to a deterioration in the value of house prices, either through a reduced ability to access credit or through an increased likelihood of negative equity in the future.

5 Conclusions

Mostly due to lack of data, we know very little about mortgage performance in Europe. There is a large literature that investigates the drivers of mortgage defaults using data from the US mortgage market, especially since the recent subprime crisis. Though, there are many institutional differences between mortgage markets in the euro area and the United States, in particular the fact that in Europe nearly all mortgages are full recourse.

The financial literature mostly focuses on the decision to default in the context of non-recourse mortgages. The main predictions are that (1) falling house prices increase the probability of default by increasing the value of the embedded option to default (strategic default), (2) negative equity is a necessary but not sufficient condition of default and (3) the threshold level of equity is increasing in borrowing constraints.

Under recoursability, borrowers are liable thorugh personal assets of the remaining balance upon default. First, recoursability is expected to discourage borrowers from defaulting when equity is negative and in general should decrease the sensitivity of default to negative equity, as shown empirically in Ghent and Kudlyak (2011).

However, in this paper we posit that even without the embedded option of non-recourse mortgage contracts, there still exists a threshold level of equity that would trigger default. As the value of the collateral decreases, the recoursability threat becomes stronger and delaying default riskier. To avoid having their private assets seized in case of foreclosure, borrowers in financial distress might optimally anticipate their decision to default in the positive equity region. If this is the case, everything else constant, we expect that the threat of lenders recourse would be mostly feared by borrowers with higher marginal utility of consumption, higher assets to be seized, or both. We test this prediction on our data by relating equity at default with income and various borrowers characteristics.

We show that a large fraction of defaults in Europe happen when borrowers are above water: the majority of borrowers who default on their loan occurs when the value of their collateral would be in principle enough to repay the debt, with estimated equity at default of 25% on average. Consistent with the threat of recoursability being greater for borrowers with a high marginal utility of current consumption, we find that equity at default is significantly negatively related with the households income at origination. This result persists even after controlling for the loan-to-value and loan-to-income ratios, and when scaling the equity by price volatility. A simple back of the envelope calculation shows that borrowers in the bottom quartile of the income distribution leave about 6% of equity on the table more than those in the top quartile, which in monetary terms corresponds to about 10'000 EUR, or 60% of their annual income.

We also find evidence that a tightening in credit conditions reinforces the relation between equity at default and income and negative shocks to house prices have a larger impact on the default probability of low-income borrowers, everything else controlled for.

In Section 4.4 we show preliminary evidence that shocks to house prices increase the probability to default more for lower income borrowers. This higher sensitivity supports the idea that lower income borrowers tend to anticipate default when house prices are falling to avoid the facing recoursability at a later point.

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Table 1: Summary statistics

This table presents summary statistics for the loan-level dataset from ED for each country (in decreasing order of loan amount issued) and for the pooled panel (last column). Panel A reports the total loan amount and number. Panel B reports averages of loan characteristics. LTV is loan-to-value, LTI is loan-to-income, FRM is a dummy that equals one if the loan is fixed rate. Panel C collects averages of borrower characteristics. An asterisk denotes fields that are optional in the reporting templates to ED and are therefore missing for a subsample of loans. Sample period is 2000 to 2015.

	FR	**ES**	**NL**	**IT**	**BE**	**UK**	**IE**	**PT**	**DE**	***Total***
Panel A: Sample characteristics										
Issued loan amount (bn EUR)	189.8	153.8	149.8	102.5	59.8	42.5	31.5	22.8	9.2	*761.7*
Number of loans (thousands)	1’577	1’047	773	888	475	348	149	229	83	*5’570*
Panel B: Loan characteristics										
LTV (%)	71.1	73.7	85.1	63.6	75.3	70.8	75.4	77.6	87.6	*73.3*
LTI	3.1	5.9	4.0	4.3	3.3	3.0	4.0	6.3	2.8	*4.1*
Loan size (EUR)	120’368	146’847	193’711	115’359	125’880	121’898	211’463	99’458	112’042	*136’751*
Collateral value (EUR)	195’475	206’954	236’797	191’717	180’738	180’904	289’824	133’937	133’234	*199’674*
Loan maturity (years)	18	28	30	22	20	23	28	34	24	*24*
Interest rate (%)	3.1	2.8	4.2	2.0	2.8	3.4	2.7	1.0	3.1	*2.9*
FRM (%)	93.4	3.2	90.5	23.2	95.0	0.1	3.9	1.4	98.7	*53.0*
Interest only (%)	0.1	0.0	42.9	0.0	0.1	17.4	5.8	0.4	4.3	*7.3*
Mortgage loan parts	1.3	1.0	1.9	1.0	1.1	1.0	1.0	1.1	1.1	*1.2*
Lien *	1.4	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	*1.1*
Panel C: Borrower characteristics										
Household’s income (EUR)	45’511	32’609	51’588	31’255	47’649	59’147	58’766	22’226	52’242	*42’187*
Age	38	36	40	39	36	38	34	34	37	*38*
Employed (%)	66.3	66.7	80.3	66.8	70.8	53.9	81.6	66.5	84.7	*68.7*
Number of borrowers *	1.5	1.6	1.5	1.6	1.6	1.6	1.7	1.6	1.6	*1.6*

Table 2: Originators Market Share

ED data contain mortgage originator identifiers, which might either be the name of the originator of the loan or an anonymous alpha-numeric code. In this table we plot for each country the market share of the five largest originators by aggregate originated volume in the period 2000 - 2015.

	1	**2**	**3**	**4**	**5**	**Sum**
BE	40.8	14.9	11.5	10.9	9.0	87.1
DE	43.7	32.2	21.8	2.3		100.0
ES	15.3	9.4	8.9	7.7	7.0	48.3
FR	12.8	7.1	7.1	3.6	3.4	34.0
IE	42.5	20.5	14.6	12.4	9.6	99.8
IT	19.9	11.6	7.8	5.6	5.2	50.1
NL	12.8	9.4	7.8	7.5	5.9	43.5
PT	18.9	18.2	14.2	11.7	10.9	73.9
UK	30.7	17.8	16.7	7.8	6.7	79.7

Table 3: Summary statistics for defaults

This table presents summary statistics for the sample of defaulted mortgages. Equity at default is expressed in percentage of the collateral value at the moment of default as defined in Section 3.2. Money left on the table is the difference between the property value and the outstanding balance at the moment of default. We compute the ratio between the money left on the table and income at origination. The remaining variables are defined as in Table 1.

	ES	**IT**	**IR**	**PT**	**NL**	**BE**	**FR**	**UK**	**DE**
Panel A: Sample characteristics									
Number of defaulted mortgages	90'994	46'337	20'424	10'472	6'784	4'745	3'550	2'534	54
Equity at default (%)	25.1	49.0	1.7	33.8	-29.1	27.3	39.1	40.3	33.8
Percentage of defaults with positive equity	74.3	91.4	48.6	79.3	20.4	80.9	62.8	93.2	87.0
Equity (%) conditional on $E > 0$	39.5	49.7	42.5	40.4	43.1	33.9	41.2	41.6	35.4
Money left on the table	51'480.5	102'133.4	35'153.1	53'499.6	-36'126.5	51'821.2	78'107.1	81'553.2	99'503.7
Money left on the table over income	1.8	4.2	0.7	3.9	-0.8	1.3	2.2	2.4	3.6
Age at default	34	36	41	43	44	40	45	45	50
TTM (years)	29.0	21.3	22.2	29.3	23.9	17.3	14.6	16.9	17.4
Panel B: Loan and borrower characteristics at origination									
LTV (%)	66.7	69.5	79.8	82.7	96.1	90.3	84.1	76.5	101.2
LTI	5.5	4.8	4.1	7.1	4.5	3.1	3.6	3.1	4.3
Loan size (EUR)	155'879.1	119'399.1	221'421.5	95'908.7	197'252.6	145'815.2	127'687.1	119'438.9	121'646.7
Collateral value (EUR)	244'496.9	179'600.9	284'823.8	119'626.1	211'566.3	168'735.8	166'686.4	160'242.1	125'457.2
Loan maturity (years)	27	23	29	35	30	23	21	25	26
Interest only (%)	0.02	0.01	7.62	0.17	43.46	0.32	0.79	25.41	29.63
FRM (%)	0.91	21.80	7.59	0.31	88.46	96.12	82.23	0.20	94.44
Lien *	1.0	1.0	1.0	1.0	1.0	1.0	1.3	1.0	1.0
Household's income (EUR)	38'444	28'176	59'685	19'253	45'429	55'023	42'631	40'567	30'885
Employed (%)	63.2	63.3	71.8	68.2	77.9	65.9	55.3	56.7	94.4
Number of borrowers *	1.7	1.8	1.6	1.6	1.4	1.6	1.2	1.4	1.4

Table 4: Analysis of Equity at Default

This table presents the results for the panel regression of equity at default onto log income and loan characteristics as defined in Table 1, and the unemployment rate *Unemp*. Income Q1 to Q3 are dummy variables for borrowers in the top (Q1) to third (Q3) quartile of the income distribution (across all loans, defaulted or not) in a given country and month. *t*-statistics based on standard errors clustered at the county (nuts 3) level appear in parentheses. *, **, and *** denote statistical significance at the 10%, 5%, and 1% level, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent Variable	E_t	E_t	E_t	E_t	E_t	E_t	E_t	DD_t
Countries	All	All	All	All	ARM	FRM	All	All
Ln Income	-5.56***	-4.88***	-41.31***		-4.21***	-6.62***	-3.44***	-3.93***
	(-4.88)	(-5.78)	(-5.52)		(-3.65)	(-9.24)	(-4.96)	(-5.10)
Ln Income Squared			1.73***					
			(4.58)					
Income Q1 (High)				-6.08***				
				(-6.87)				
Income Q2				-4.87***				
				(-8.42)				
Income Q3				-3.50***				
				(-9.64)				
LTV (%)	-0.91***	-0.97***	-0.97***	-0.98***	-1.05***	-1.06***	-1.00***	-0.62***
	(-33.63)	(-42.68)	(-42.59)	(-43.35)	(-47.62)	(-31.91)	(-39.31)	(-11.24)
LTI	-0.58***	-0.77***	-0.93***	-0.60***	-0.54***	-2.22***	-0.50***	-0.90***
	(-3.08)	(-4.91)	(-6.58)	(-5.17)	(-2.95)	(-8.34)	(-3.74)	(-5.10)
Maturity	-0.11***	-0.11***	-0.11***	-0.11***	-0.11***	-0.03***	-0.11***	-0.05***
	(-19.77)	(-20.69)	(-21.17)	(-20.61)	(-15.27)	(-4.67)	(-20.57)	(-7.19)
Lagged Unemp (%)	0.10	0.07	0.06	0.08	0.10	-1.48***	-0.39***	-0.58***
	(1.32)	(0.77)	(0.70)	(0.85)	(0.94)	(-4.33)	(-3.17)	(-8.58)
Observations	177,899	177,294	177,294	177,294	121,189	13,288	177,236	106,577
R-squared	0.51	0.63	0.64	0.63	0.56	0.70	0.66	0.53
County x Origination Semester FE	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	No	No	No	No	No	No	No
County FE	No	No	No	No	No	No	No	No
Country x Origination Semester FE	No	No	No	No	No	No	No	No
Originator FE	No	No	No	No	No	No	Yes	No
Interest only FE	No	No	No	No	No	No	Yes	No

Table 5: Equity at default: subsample analysis

This table presents the results for the panel regression of equity at default on the variables defined in Table 4, a dummy *House* that equals one if the property is a house, a dummy *FirstLien* that equals one if the loan is senior in case of default, a dummy *Age* that equals one if the age of the borrower is below 35 or above 70, a dummy *OneBorrower* that equals one if the loan has a single borrower, a dummy *Foreign* that equals one if the borrower is not a resident of the country where the loan is being originated, the demeaned country 5-year *CDS* spread, and the log ratio of the cumulative losses to total loan outstanding for the loan originator *LnLoanRatio*. *t*-statistics based on standard errors clustered at the county (nuts 3) level appear in parentheses. *, **, and *** denote statistical significance at the 10%, 5%, and 1% level, respectively.

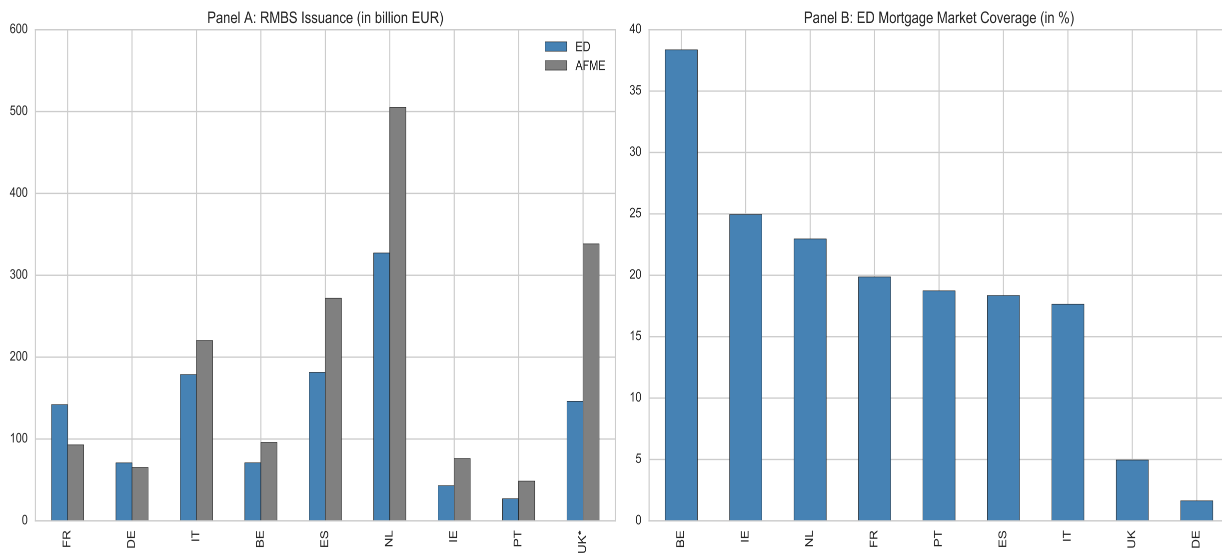
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
LnIncome	-2.27***	-2.49***	-2.32***	-1.05**	-3.33***	-3.16***	-1.67***	-1.53**	-1.01***	-2.41***
	(-5.42)	(-5.35)	(-5.15)	(-2.05)	(-5.94)	(-5.57)	(-5.66)	(-2.17)	(-3.31)	(-5.74)
LTV	-0.90***	-0.95***	-0.90***	-0.90***	-0.95***	-0.95***	-0.90***	-0.90***	-0.90***	-0.90***
	(-30.60)	(-26.43)	(-30.94)	(-30.96)	(-24.39)	(-24.41)	(-24.30)	(-24.26)	(-30.44)	(-29.45)
LTI	-0.46***	-0.46***	-0.46***	-0.48***	-0.68***	-0.67***	-0.42***	-0.42***	-0.46***	-0.44***
	(-6.51)	(-7.81)	(-6.55)	(-6.52)	(-8.72)	(-8.88)	(-9.57)	(-9.59)	(-6.87)	(-6.93)
TTM	-0.62***	-0.65***	-0.61***	-0.61***	-0.52***	-0.52***	-0.55***	-0.55***	-0.62***	-0.66***
	(-14.30)	(-15.54)	(-13.72)	(-13.76)	(-11.06)	(-11.07)	(-11.37)	(-11.38)	(-14.71)	(-18.71)
Unemp	-0.80***	-1.17***	-0.80***	-0.80***	-0.56**	-0.56**	-0.87**	-0.87**	-0.81***	-1.41**
	(-3.13)	(-4.47)	(-3.11)	(-3.10)	(-1.98)	(-1.98)	(-2.00)	(-2.00)	(-3.05)	(-2.32)
House	0.44	-0.82**	0.56	0.48	4.77***	4.76***	0.58	0.58		
	(0.45)	(-2.44)	(0.52)	(0.46)	(3.17)	(3.18)	(0.94)	(0.93)		
FirstLien		2.19**								
		(2.23)								
Age			-0.81	27.08***						
			(-0.88)	(3.34)						
LnIncome×Age				-2.71***						
				(-3.18)						
OneBorrower					0.83**	5.09				
					(2.38)	(1.01)				
LnIncome×OneBorrower						-0.42				
						(-0.88)				
Foreign							-4.47***	-2.74		
							(-5.59)	(-0.33)		
LnIncome×Foreign								-0.17		
								(-0.21)		
CDS									0.08***	
									(3.68)	
LnIncome×CDS									-0.01***	
									(-3.07)	
LnLoanRatio										14.56**
										(2.08)
LnIncome×LnLoanRatio										-1.86**
										(-2.40)
Observations	131,397	99,886	131,397	131,397	75,347	75,347	33,248	33,248	130,961	125,551
R-squared	0.68	0.74	0.68	0.68	0.64	0.64	0.75	0.75	0.68	0.69
County FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Origination Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Default Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 6: Analysis of probability of default

This table presents the results for the panel regression of default rates. The dependent variable is a dummy that equals one if the loan defaulted, and zero otherwise. The dependent variables are defined as in Table 4. *HPI Ret* is the return to the HPI in that county-semester. The regression is estimated with a linear probability model in columns (1)-(3), and as a probit in column (4). *t*-statistics based on standard errors clustered at the county (nuts 3) level appear in parentheses. *, **, and *** denote statistical significance at the 10%, 5%, and 1% level, respectively. For the probit specification, the R-squared is the pseudo R-squared.

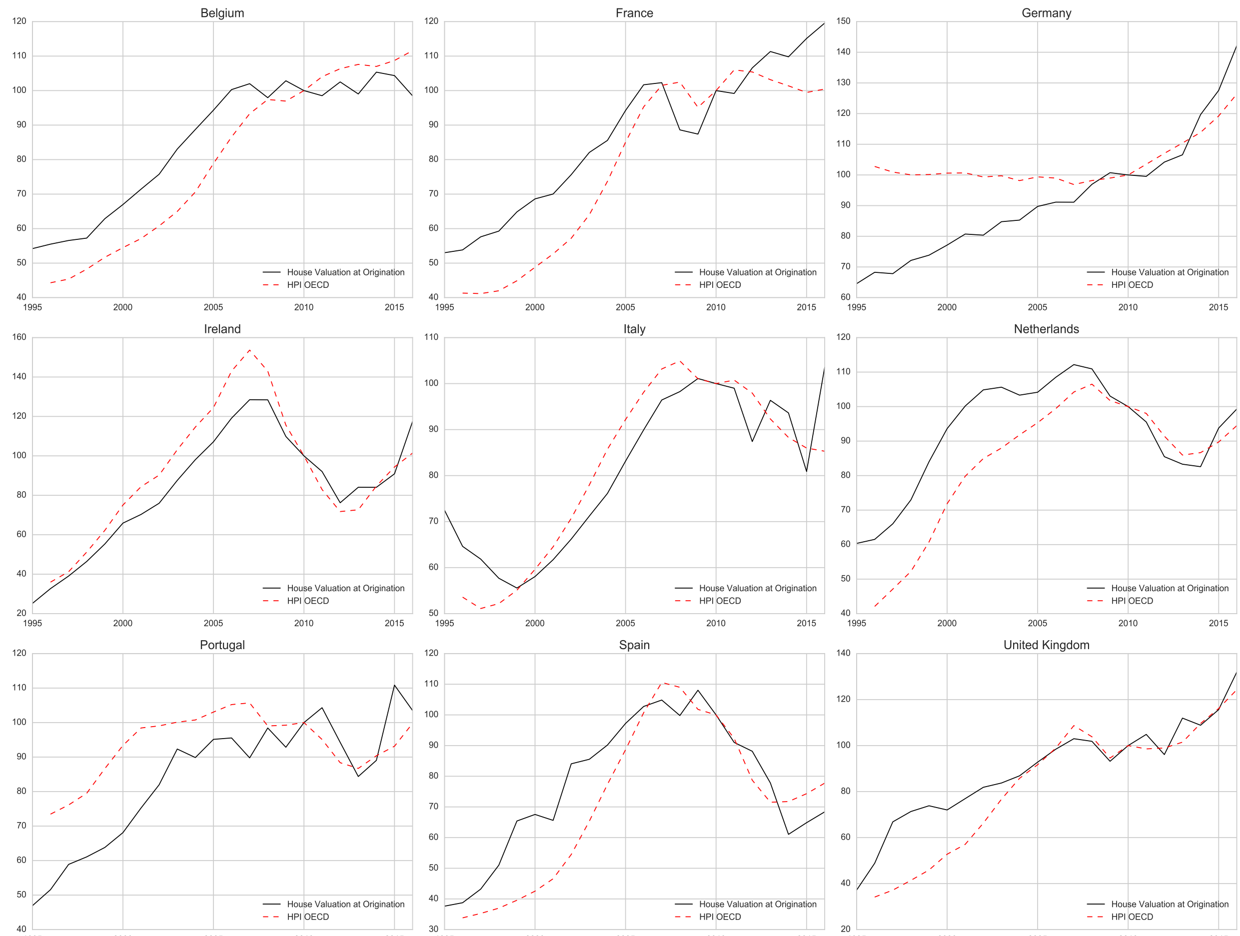
	(1) Linear	(2) Linear	(3) Linear	(4) Probit
$E_{i,t-1}$	-0.414***	-0.420***	-0.389***	-0.445***
	(-6.545)	(-6.389)	(-9.013)	(-6.388)
Income Q1 (High)	-0.051***	-0.056***	-0.067***	0.000
	(-5.013)	(-5.565)	(-6.928)	(0.012)
Income Q2	-0.043***	-0.050***	-0.055***	0.015
	(-4.999)	(-5.631)	(-6.296)	(0.780)
Income Q3	-0.016***	-0.019***	-0.022***	0.034***
	(-3.027)	(-3.308)	(-3.916)	(2.757)
HPI Ret	-0.694***	-0.711***	-0.427***	-1.249***
	(-7.427)	(-7.251)	(-4.139)	(-10.806)
HPI Ret× Income Q3	0.194***	0.200***	0.254***	0.229***
	(2.971)	(3.052)	(3.681)	(4.055)
HPI Ret× Income Q2	0.344***	0.344***	0.425***	0.347***
	(3.963)	(3.925)	(4.964)	(4.598)
HPI Ret× Income Q1	0.415***	0.401***	0.433***	0.262***
	(3.992)	(3.827)	(4.120)	(2.725)
TTM	-0.001	-0.001	-0.001**	-0.011***
	(-1.188)	(-1.445)	(-2.033)	(-5.223)
Unemp	2.460***	1.555***	1.038***	2.060***
	(4.901)	(5.776)	(4.961)	(8.557)
LTI	0.013***	0.013***	0.010***	0.029***
	(7.341)	(7.238)	(6.525)	(7.255)
Constant				-2.865***
				(-47.770)
Observations	49,124,528	49,124,528	49,124,525	49,124,528
R-squared	0.006	0.006	0.010	0.0428
County FE	Yes	-	-	-
OY FE	Yes	Yes	-	-
Year FE	Yes	Yes	-	-
Country FE	-	Yes	-	-
Country x OY x Year	-	-	Yes	-

Figure 1: Coverage of ED Data.



This figure provides an overview of the share of the RMBS market (Panel A) and of the underlying mortgage market (Panel B) covered by the ED database. Next to loan-level characteristics and performance updates, originators must submit to ED also information at tranche and security level for all (eligible and non-eligible) tranches of the RMBS deals. In Panel A, we plot the aggregate RMBS issuance volume by country against the data from the Association for Financial Markets in Europe (AFME). Since AFME started reporting RMBS issuance volumes in 2005, we consider RMBS issued between 2005 and 2015. For the UK we only consider the period 2009-2015 since pre-2009 RMBS vintages are almost never reported. Panel B plots the aggregate mortgage origination volume in ED as a percentage of the volume reported by the European Mortgage Federation (EMF). We only consider mortgages originated between 2004 and 2015, which corresponds to the period covered by EMF data.

Figure 2: Implied House Price Index.



We plot the annual country-level HPI index calculated using loan originations in the ED database against the HPI index from OECD. For every year and country, the house price level is computed as the median value of the properties backing the newly originated loans. We require that currency information is non-missing, original balance non-missing and smaller than 3 million EUR, original LTV is non-missing, different from zero and smaller than 150%, For this calculation we consider all types of loan purposes.