Mortgage arrears in Europe: The impact of monetary and macroprudential policies

Petra Gerlach-Kristen and Seán Lyons

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Mortgage arrears in Europe:
The impact of monetary and macroprudential policies

Petra Gerlach-Kristen[a,*] & Seán Lyons[b]

[a]Swiss National Bank

[b]Economic and Social Research Institute, Dublin and Trinity College Dublin

*Corresponding author[1]

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Abstract: Mortgage arrears arise if a household faces affordability problems and/or is in negative equity. Because widespread arrears pose a risk to the stability of banks and limit households' future access to credit, a crucial question is how monetary or macroprudential policies influence their incidence. We use a European household data set to analyse what drives arrears and find that affordability problems, such as unemployment, low income and high mortgage payments, matter, which suggests that monetary policy has an impact. Households facing the dual trigger of affordability problems and negative equity are more likely to go into longer-term arrears; macroprudential regulation preventing high loan-to-value (LTV) ratios can thus also have an impact.

Keywords: Arrears, negative equity, monetary policy, loan-to-value ratios

JEL codes: D14, E58, G28

1. Introduction

One important feature of the financial crisis that began in the summer of 2007 is mortgage arrears. In the US, 5% of mortgage households had missed their payments by over 90 days in 2010. In many European countries, arrears also rose to unprecedented heights. In 2014, they were highest in Ireland at 12%.

Mortgage arrears matter for four reasons. First, they imply reduced income for commercial banks and thus endanger the soundness of their balance sheets. Ultimately, they can threaten financial stability. Second, mortgage arrears damage a household's future creditworthiness. The less creditworthy a household, the more difficulty it will have smoothing consumption when income declines. A rise in arrears can therefore cause greater volatility in future consumption and reduce the overall level of consumption, both on a household and an aggregate level. Third, arrears reflect the extent of financial difficulties faced by households and the distributional effect of an economic downturn. Aggregate measures, such as GDP, do not indicate how large a fraction of households is exposed to economic hardship and social stigma. Arrears figures do capture an element of this problem. Fourth, mortgage arrears may indicate that households are unable (or unwilling) to move to a cheaper dwelling. Arrears are thus associated with diminished labour mobility, which may reduce the speed with which an economy recovers from a recession.

One natural question is what policies can help reduce the incidence of arrears. In this paper, we examine the impact of monetary policy and macroprudential measures, particularly the loan-to-value ratio. We analyse these issues using panel microdata from the European Survey on Income and Living Conditions (EU-SILC). Our EU-SILC data set contains information on over 900,000 households from 18 countries over the period 2004 to 2011.

The literature suggests two main drivers of mortgage arrears: affordability problems and negative equity. Households with affordability problems are unable to meet the payment obligations arising from the mortgage when income drops or the mortgage payment rises. We also show that a decline in house prices can lead to affordability problems if consumption is financed through mortgages.

If the household expects financial difficulties to ease soon, it may be optimal to go temporarily into arrears, in the hope of honouring the missed mortgage payment in the near future. If unemployment is expected to be permanent, it is generally optimal to sell the property and move to a more affordable place. However, selling the property may not be possible if the price is lower than the outstanding mortgage, i.e., if the household is in negative equity. A negative-equity household can downsize if it has savings that make it possible to pay back the mortgage in full or if it has access to new credit. If neither is the case, staying put and going into arrears is optimal. The literature refers to this situation as "dual-trigger" arrears because it is caused by a combination of affordability problems and negative equity. Households facing the dual trigger should make up the bulk of longer-term arrears cases.

Negative equity on its own should not cause arrears in Europe because there is no debt forgiveness. Certain US states have non-recourse mortgage legislation, which means that if a negative equity household sells its property, the shortfall between the mortgage and the property value is borne by the lender. In Europe, in contrast, recourse legislation, in which the household remains responsible for the negative equity, is the norm, and the only way to discharge a debt is to declare personal bankruptcy. In certain European countries, even bankruptcy does not lead to a discharge.

Using data from EU-SILC, we examine whether affordability problems and the dual trigger do indeed matter for mortgage arrears in Europe and what influence monetary and macroprudential policies have on the incidence of mortgage arrears. We find that affordability problems, as captured by unemployment, low income, falling house prices and high mortgage payments, have a clear impact. In terms of policy, this impact suggests that the central bank can reduce mortgage arrears by cutting interest rates because lower interest rates reduce mortgage payments (on both existing contracts, if

they are variable-rate, and new or renewed mortgages) and unemployment and increase income. Of course, monetary policy is not and should not be set to steer arrears – what we show is that it affects arrears as a side effect.

We also find evidence that the dual trigger causes longer-term arrears. These findings imply that negative equity matters and that macroprudential policy limiting loan-to-value (LTV) ratios can help reduce arrears. However, when including typical LTV ratios alongside our measure of negative equity, we cannot identify a separate impact of the LTV ratio.

The rest of the paper is structured as follows. Section 2 provides a brief survey of the literature. Section 3 presents the data, and Section 4 discusses how to model arrears. Section 5 presents the estimates and discusses their implications. Section 6 concludes.

2. Related literature

Studies on what drives mortgage arrears typically concentrate on one country. Elmer and Seelig (1999), Bhutta *et al.* (2010) and Elul *et al.* (2010) study the US. They use microdata sets and find that the probability of a household going into arrears is higher if there is negative equity and affordability problems. Whitley *et al.* (2004) find that for the UK, unemployment is a major driver of arrears.[2] May and Tudela (2005) obtain the same finding and also report that high LTV ratios (for which negative equity emerges fastest if house prices decline) are associated with a higher probability of arrears. For Ireland, Connor and Flavin (2013) find that negative equity and unemployment matter for arrears, while Lydon and McCarthy (2013) also show that the repayment burden, i.e., the mortgage payment-to-income ratio, matters. Aristei and Gallo (2012) find that for Italian households, the probability of going into arrears increases when income drops.[3] Finally, Ampudia *et al.* (2014) show that low wealth, rather than income, seems to be a major driver of arrears in Portugal and Spain.

In terms of how macroprudential tools affect mortgage arrears, the literature is limited. The Hong Kong Monetary Authority (2011) examines the role of the LTV ratio on mortgage delinquency in a panel of 13 countries. It appears that a decline in property prices or GDP growth increases arrears less often in countries where maximum LTV ratios are used as a policy tool. Borio *et al.* (2001) discuss LTV regulations for another panel of 13 countries and argue that LTV ratios can be used as a policy instrument to limit the procyclicality of the financial system. Gete and Reher (2014) provide a theoretical model of mortgage arrears and derive optimal LTV regulation.

Three papers choose a panel approach similar to ours. Duygan-Bump and Grant (2009) use European data from the 1990s and find that affordability problems are a major driver of arrears. Magri and Pico (2009), who use European data from 2005 and 2006, find the same. They also show that mortgage arrears in 2005 and 2006 were particularly high in Ireland and Spain. Because both these papers cover a time period when house prices were rising in most of the countries considered, negative equity is not a common feature in their data.[4] Blanco and Gimeno (2012) consider arrears by Spanish province and year and test for the impact of macroeconomic variables. They find that a rise in regional unemployment and increasing interest-rate burdens drive up the incidence of arrears. A drop in credit growth has the same effect. The authors do not explore the role of negative equity.

A number of studies have used cross-country data sets to examine the impact of institutional and cultural factors on mortgage arrears. Japelli *et al.* (2008) show that the enforcement of contracts and efficient bankruptcy regulation affect the probability of households going into arrears. Duygan-Bump

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[2] Whitley *et al.* only use data up to 2002, a period with few incidences of negative equity.
[3] Aristei and Gallo do not test for the impact of negative equity, but they provide an excellent survey of the literature.
[4] For a discussion of the available European microdata, see Gomez-Salvador *et al.* (2011).

and Grant (2009) also find an institutional role. Georgarakos and Furth (2012) find that cultural factors, such as religiosity, explain geographical differences in arrears. Diaz-Serrano (2004) report that uncertain economic circumstances, as captured by income volatility, also increase the incidence of arrears. Frade and Abreu Lopes (2009) examine the macroeconomic drivers of household financial stress and find that low GDP, difficult access to credit and income inequality play a role.

Ghent and Kudlyak (2011) distinguish between US states with and without recourse legislation and find that negative equity on its own is a trigger of arrears in non-recourse states. Gerardi *et al.* (2013) and Guiso *et al.* (2013) also analyse such "strategic" arrears. Li *et al.* (2011) show that US bankruptcy reform in 2005, which reduced the amount of debt discharged in personal bankruptcy, caused mortgage arrears to rise.

Given the considerable differences in judicial systems, to our knowledge, no papers exist that link mortgage arrears in a cross-country data set to bankruptcy laws. Gerhardt (2009) compares consumer bankruptcy laws and personal insolvencies in Germany, France, Ireland, Italy, Spain, the UK and the US. She argues that European legislation focuses on protecting the creditors' interests, whereas US law, and to a lesser extent UK law, is more "consumer-friendly".[5] Niemi (2009) reviews when national personal bankruptcy laws were introduced across Europe. She does not report summary statistics for these laws. Armour and Cumming (2008) analyse the role of personal bankruptcy laws for entrepreneurship in an international data set. Entrepreneurship is also the topic in Gropp *et al*. (1997), Fan and White (2003) and Berkowitz and White (2004), who provide comparisons across US states, and in Fossen (2011), who provides a detailed examination of the impact of bankruptcy law reform in Germany in 1999. Finally, Claessens and Klapper (2005) examine what drives commercial bankruptcy laws in 35 countries from 1990 to 1999 and find that bankruptcies are more frequent in common-law countries and market-oriented financial systems.

While the analysis reported in the main text does not take into account legal institutions, the Appendix reproduces the main estimations including data on investor protection form the World Bank Doing Business Report. Using these data implies excluding data from 2004 and 2005. The results regarding arrears are the same as in the main text, but our measure of investor protection is insignificant.

3. Data

The analysis uses data from five data sources: the EU-SILC, the Bank for International Settlements (BIS) and Eurostat for data on house prices, and data from the European Central Bank (ECB) and the European Mortgage Federation (EMF) on characteristics of typical mortgages by country. We review these data sets below.

3.1 EU-SILC data on individual households

EU-SILC is conducted annually in the member countries of the European Union. For the period 2004 to 2011, it contains information on over 1.6m households from thirty countries. Given the availability of the other variables in our analysis, we concentrate on 18 countries, for which more

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[5] Gerhardt (2009) identifies major differences in bankruptcy laws in Europe. For example, in the UK, if a household files for bankruptcy, the court transfers the household's possessions, exempting needs for employment and the home, to a trustee for liquidation. After a year, the debtor is automatically discharged from all remaining debt. In Spain, the household never is fully discharged of its debt. If it files for bankruptcy, it may see its repayment horizon lengthened (by a maximum of five years) or the debt amount reduced (by up to 50%). However, the lack of an eventual debt discharge rules out a fresh start after personal bankruptcy.

than 900,000 households were interviewed.[6] Of those households, we analyse mortgage households only, which constitute about a fifth of the sample. The EU-SILC questions that we use focus on mortgage arrears, unemployment and income. We also make use of information on the length of residency, which we treat as an indicator of when the property was bought, and we use the age of the reference person in the household, the number of household members and the highest education level in the household as additional controls.

Figure 1: Arrears (% of all mortgage households) by country
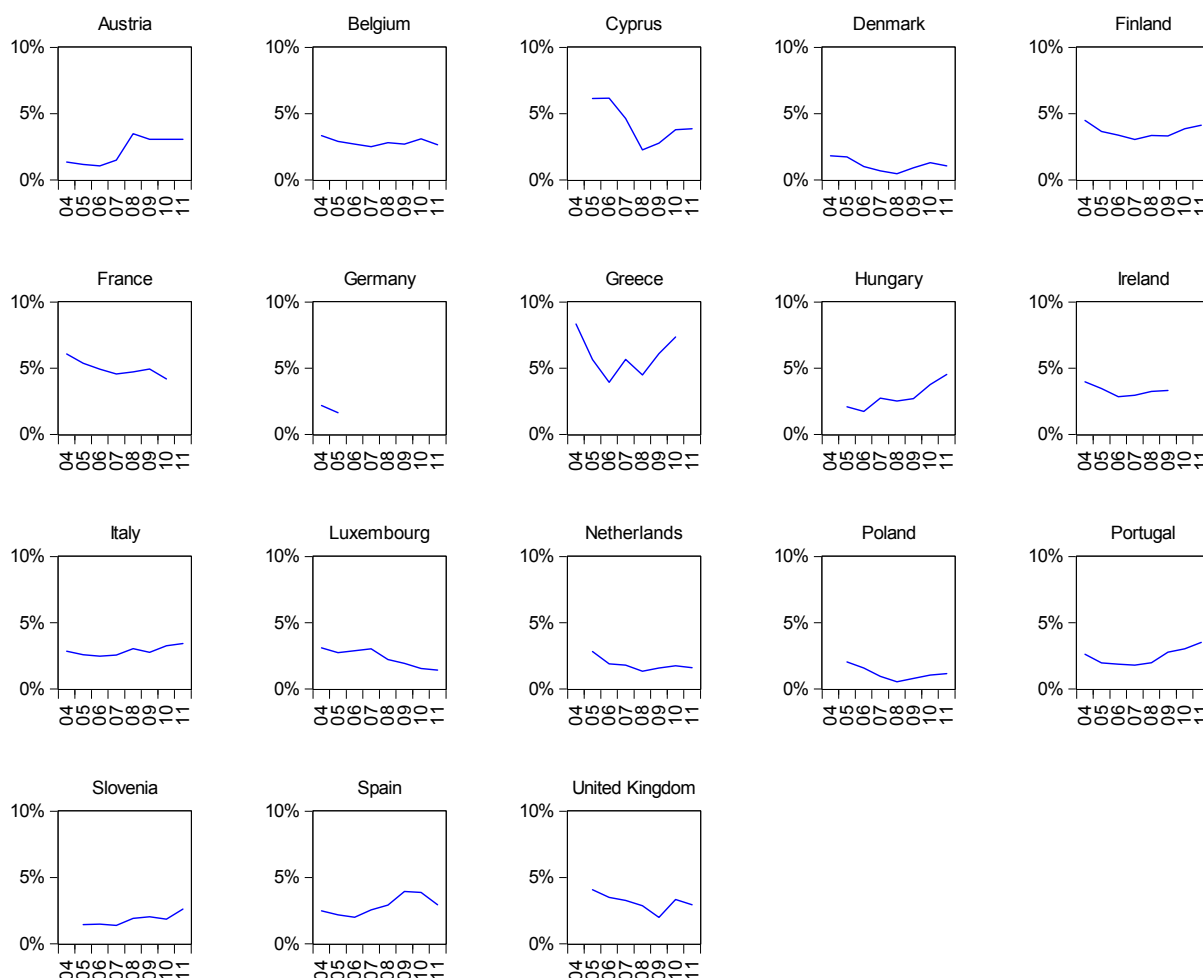
Figure 1 presents the percentage of mortgage households in arrears by year and country. One striking feature is that there are large differences across countries as to what fraction of households is in arrears. Arrears are very common in Greece, with almost 10% of mortgage households being in arrears in 2004. Arrears are rarest in Denmark and Poland. It should be noted that there has been no uniform increase in arrears after the onset of the global financial crisis. That said, some countries have seen clear rises, e.g. Hungary and Portugal.

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[6] Data made available to us by Eurostat cover Bulgaria, Estonia, the Czech Republic, Iceland, Latvia, Lithuania, Malta, Norway, Romania, Slovakia, Sweden and Switzerland.

3.2 BIS and Eurostat data on national house prices

House price data come from the BIS website. We use the broadest BIS measure available and address data gaps, where possible, using Eurostat data. Figure 2 shows these data.

Figure 2: House prices by country (2010 = 100)
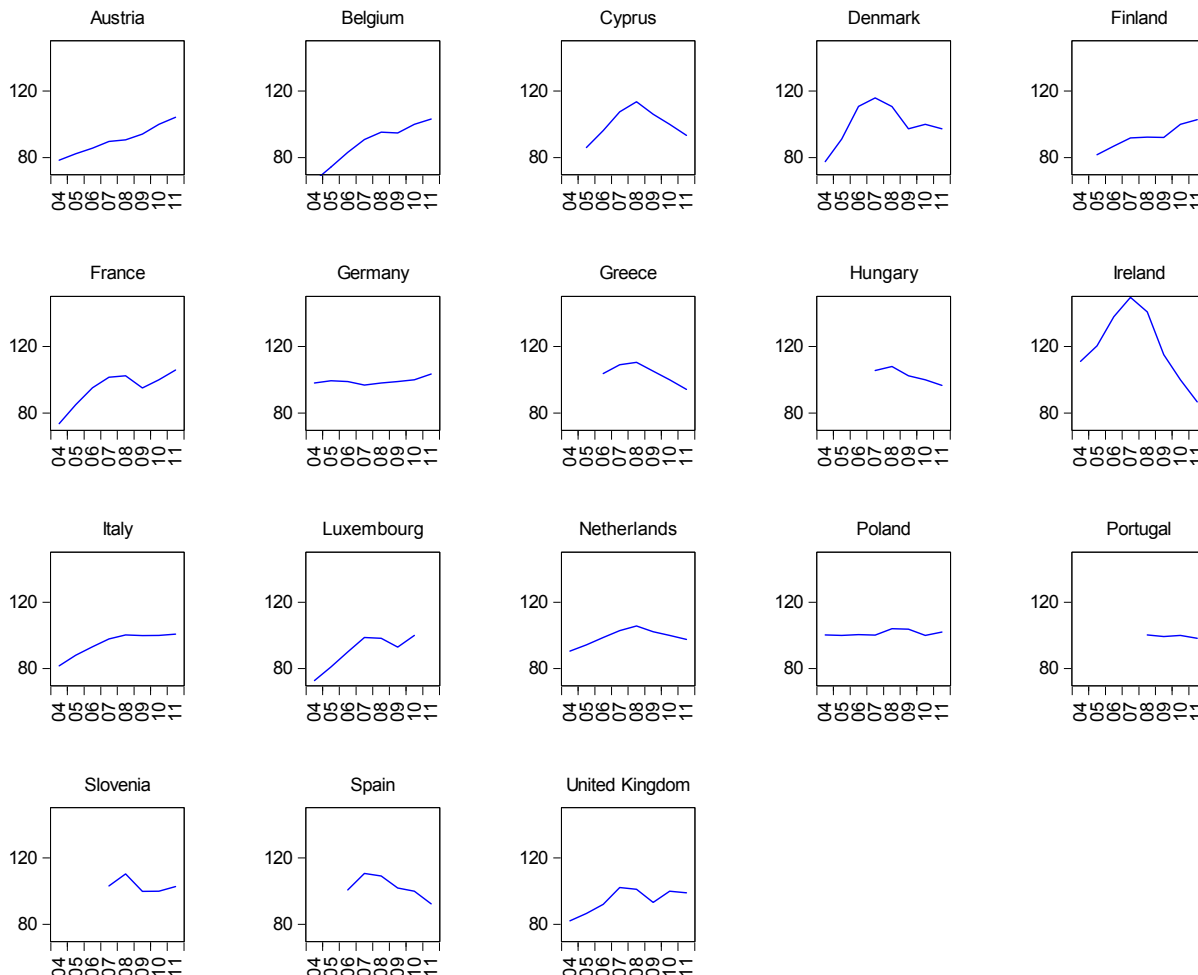
Note: House price indices (broadest measure available) from BIS; gaps, where possible, augmented with Eurostat data.

We use the BIS house price data to construct two variables. The first is $sincepeak$. This variable takes a value of zero if national house prices are increasing. If they are decreasing, it records how much they have declined since their last peak. Thus,

$$sincepeak_{j,t} = -\min(house\ price_t - house\ price_{last\ peak}, 0).$$

The larger $sincepeak$, the larger the house price decline. It should be noted that $sincepeak$ is the same for all households in a country because $house\ price$ is a national index.

The second variable that we construct also captures house price decreases, but it differs by household. We refer to this variable as $sincepurchase$. This variable is zero if house prices increased between the year in which the household bought the property and the year of the EU-SILC interview. If house prices declined, $sincepurchase$ records the size of this decrease, so that

$$sincepurchase_{j,t} = -\min(house\ price_t - house\ price_{time\ of\ purchase\ by\ household\ j}, 0).$$

One difficulty that arises is that some national series only start relatively late; we are thus unable to compute the change in house prices if the purchase took place a long time ago. As a consequence, the *sincepurchase* variable is available only for about a quarter of the full sample, and we thus perform most regressions using *sincepeak.*

3.3 ECB and EMF data on typical mortgages by country

The literature suggests that house price declines matter for arrears primarily because they push households into negative equity. To capture the incidence of negative equity, we need information on LTV ratios because a household with a high initial LTV ratio will more quickly find itself in negative equity if house prices decline than a household with a low LTV. Unfortunately, these ratios are not available by household. Therefore, we use data on typical mortgage contracts by country from ECB (2009) and EMF (2009 and 2012).[7] Table 1 lists this information.

Standard initial LTV ratios vary between 65% (in Slovenia) and 91% (in France), while mortgages are typically shortest in Greece and Hungary (15 to 20 years; the table reports the mid-range used in the econometric analysis below) and longest in Portugal (30 to 40 years). Variable interest rates are standard in most countries, with the exception of Belgium, France, the Netherlands and the UK.

Table 1: Characteristics of typical mortgages by country

	Loan-to-value ratio (in %)	Typical maturity (in years)	Variable rate?
Austria	84	30	Yes
Belgium	80	20	No
Cyprus	80	22.5	Yes
Denmark*	50	25	Yes
Finland	81	22.5	Yes
France	91	19	No
Germany	70	27.5	No
Greece	73	17.5	Yes
Hungary*	75	17.5	Yes
Ireland	83	33	Yes
Italy	65	22	Yes
Luxembourg	87	25	Yes
Netherlands	101	30	No
Poland*	87.5	27.5	Yes
Portugal	71	35	Yes
Slovenia	65	25	Yes
Spain	72.5	30	Yes
United Kingdom*	70	27.5	No

Note: Data for euro area countries from the ECB (2009). Information on countries marked with * are taken from EMF country fact sheets, which are from 2012 (Poland from 2009). Midpoints where the ECB/EMF report ranges; where the ECB reports "X years and above", another 5 years are added.

We use the data in Table 1 in three ways. First, when assessing the impact of interest rate changes, we examine whether their effect is greater in countries where variable-rate mortgage are typical. Second, we use the information on typical LTV ratios to examine whether fewer households go into

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[7] We also considered using data from the ECB Household Finance and Consumption Network (HFCN) survey. Because that survey asks respondents about their initial LTV ratios and the year in which they bought their property, one can, in theory, construct a LTV time series for each of the 15 participating countries. In practice, however, only 5,660 households are left in the HFCN sample after excluding observations that are missing either the initial mortgage or initial house value. As a consequence, the number of observations per country and year is very small, and the resulting time series are highly volatile. We therefore do not report results using HFCN data.

arrears in countries where LTV ratios are low. Third, we construct a proxy that captures how much principal remains outstanding per household.

Generally, the more house prices decline, the more households slide into negative equity. This effect should be stronger for households that recently purchased a property because there has not been much time for amortisation. *Ceteris paribus*, it should also be stronger in countries with a long typical mortgage maturity because amortisation takes longer.[8]

To capture a particular household's negative equity, we thus need to combine information on the house price decline in a given country with the remaining principal outstanding. We compute a proxy for the fraction of the remaining principal outstanding of household *j* as

$$principal\ outstanding_{j,t} = 1 - \min(\frac{years\ ownership_{j,t}}{typical\ mortgage\ maturity}, 1).$$

Thus, a household that bought its dwelling this year has not yet started amortising, such that $principal\ outstanding_{j,t} = 1$. Once a household has owned its property for longer than the typical mortgage maturity, we assume that it has become an outright owner.[9] We use the interaction between the house price decline and the principal outstanding to capture the extent of negative equity. A large house price decline combined with a large remaining principal should translate into large negative equity.

One important caveat is that the measure we use for negative equity is a proxy. Our analysis thus depends on the quality of this variable. A second caveat is that the LTV values reported in Table 1 are typical values, not regulatory LTV limits. The typical LTV ratio is potentially high in countries where banks are particularly risk loving. If macroprudential policy were to enforce a low LTV limit in such an environment, it is possible that banks' lending behaviour adjusts in other ways to maintain the same risk profile. In that case, the effectiveness of macroprudential policy in lowering mortgage arrears may be limited. We return to this issue below.

4. Modelling arrears

This section provides a discussion of when it is optimal for households to go into arrears. It should be noted that this model concentrates on households with mortgages for their primary residence; we do not consider buy-to-let properties to keep the analysis focussed.

To analyse the decisions taken and strategies chosen by households, we follow Foote *et al.* (2008) in using a model in which households buy a property in period 0 that they have to sell in period 2. In period 1, households must decide whether to pay the mortgage, move to another place or go into arrears. In contrast with Foote *et al.,* we assume that households consume and receive income in both periods 1 and 2 (households do not consume or earn income in period 2 in the original model).

We denote the amount of housing bought in period 0 by h_0 and the mortgage debt by d_0. For the sake of simplicity, we assume that this mortgage is an interest-only mortgage, so that only the interest rate m_1 is paid in period 1. In period 2, the household pays d_0 back to the bank, unless it has sold the house in period 1 and paid back the debt already.

We assume that the mortgage interest rate is flexible. For the sake of simplicity, we let it be set by the central bank. Regulation matters in determining the level of mortgage debt. In particular,

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[8] Amortisation rules differ between countries: for instance, the ECB (2009) reports that interest-only mortgages, where the principal is not amortised until the end of the mortgage contract, are common in Cyprus, Ireland and the Netherlands. We disregard these differences for lack of exact data.
[9] This assumption neglects the possibilities of rolling over a mortgage at expiry into a new mortgage and of obtaining equity release. Again, a lack of data makes this assumption necessary.

$d_0 = LTV h_0 p_0$, where LTV is the LTV ratio set by the regulator and p_0 is the price per housing unit h_0 in period 0. We return to the impact of policy variables in Section 4.2. First, we review the choices faced by households.

4.1 A simple model

Figure 3 presents the considerations that a household faces when it decides whether or not to make its mortgage payments. If it decides to pay, we refer to this choice as the "stay & pay" strategy, which is optimal in two cases: first, if the household can afford to make the mortgage payments and is in positive equity, and, second, if it can afford to make the payments, is in negative equity and is in a recourse environment, i.e., in a legal framework where it remains responsible for the negative equity after default. In a non-recourse setting, which is the case analysed by Foote *et al.* (2008) and which implies debt forgiveness at default, going into arrears and finally into default is optimal. In our European data set, where recourse is standard, we should not observe such "strategic arrears".

If the household is unable to pay its mortgage, the question arises about whether this problem is temporary or permanent. If income temporarily decreases, the mortgage payment increases or house prices decline and if the household is credit constrained, going into temporary arrears is optimal. If affordability problems are expected to last, it is optimal to downsize, i.e., to sell the property, pay back the mortgage and move to a new place. We assume that the new place is rented, with the rent proportional to the value of the rented property.

However, selling the house is not possible if the household is in negative equity, i.e., if the mortgage exceeds the selling price. We assume that the household has no previous savings that could be used to cover the negative equity. Thus, a household that cannot afford the mortgage payment and is also in negative equity is best off staying in its original dwelling and going into long-term arrears and eventually into default, which is the situation that the literature refers to as the dual trigger for arrears.

Figure 3: Arrears decision tree
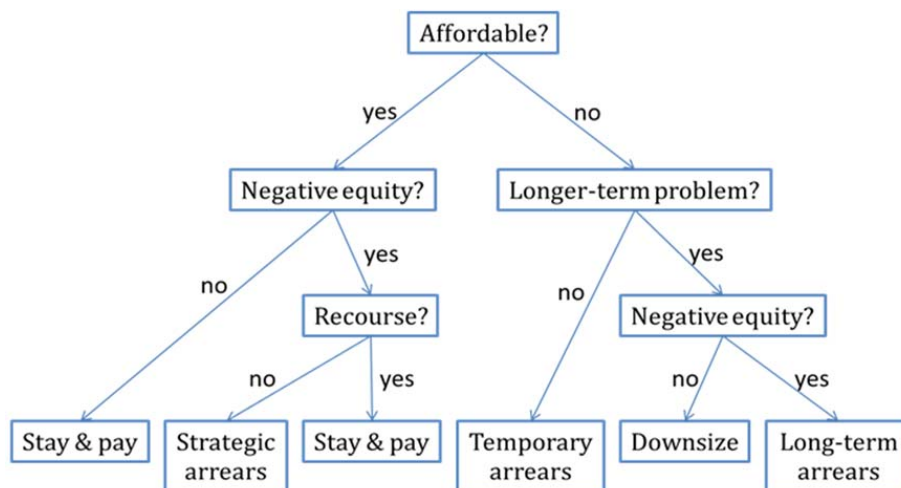
Table 2 summarises the household's optimisation problem and constraints. Because we analyse data from Europe, where households that can afford their mortgage payments should always make them (because there is no debt forgiveness), we ignore strategic arrears.

We assume a simple logarithmic utility function. The budget constraint reflects expenditures on non-housing consumption, c_t, and housing consumption, on the one hand, and income from labour, y_t,

and property sales, on the other. We treat consumption as the numeraire. The cost for housing consumption is either the mortgage payment, m_t, or the rent, $\rho p_t h_t$, and the income from selling the property is $p_t h_0 - d_0$. Moreover, we allow households to transfer funds from one period to the next using bonds, b_1, and denote the interest rate with r.

Table 2: Utility and constraints of alternative strategies

Strategy	Stay & pay	Temporary arrears	Downsizing	Long-term arrears
Utility function	$U_1 = \log c_1 + \alpha \log h_0$ $U_2 = \log c_2 + \alpha \log h_0$	$U_1 = \log c_1 + \alpha \log h_0$ $U_2 = \log c_2 + \alpha \log h_0$	$U_1 = \log c_1 + \alpha \log h_1$ $U_2 = \log c_2 + \alpha \log h_1$	$U_1 = \log c_1 + \alpha \log h_0$ $U_2 = \log c_2 + \alpha \log h_0$
Extra costs	0	Credit record costs ϕ	Moving costs μ	Credit record costs Φ
Budget constraint	$c_1 + m_1 + b_1 = y_1$ $c_2 + m_2 =$ $y_2 + (1+r)b_1$ $+ p_2 h_0 - d_0$	$c_1 + b_1 = y_1$ $c_2 + m_1 + m_2 =$ $y_2 + (1+r)b_1$ $+ p_2 h_0 - d_0 - \phi$	$c_1 + \rho p_1 h_1 + b_1 =$ $y_1 + p_1 h_0 - d_0 - \mu$ $c_2 + \rho p_2 h_1 =$ $y_2 + (1+r)b_1$	$c_1 + b_1 = y_1$ $c_2 =$ $y_2 + (1+r)b_1 - \Phi$

If there is a drop in income, the household can, in theory, adjust both consumption and housing. We assume, however, that adjusting housing involves moving costs, μ. If these costs are non-negligible, the household will only adjust consumption in response to a small drop in income and hold housing constant, which corresponds with the "stay & pay" strategy.

Appendix 1 derives consumption under the different strategies. Under the "stay & pay" strategy, consumption is the same in period 1 and 2 and given by

$$c_{stay\,\&\,pay} = \frac{1}{2+r}[(1+r)(y_1 - m_1) + y_2 - m_2 + p_2 h_0 - d_0].$$

Thus, if income decreases, consumption is reduced as well. The same is true for a rise in the mortgage rate and an expected fall in house prices in period 2. This last finding is important in that it gives house prices a role in consumption and arrears decisions, even if the household is not in negative equity. The pure fact that the property will be sold at one point and that these resources are taken into account in today's consumption decision (because these funds can be transferred between the periods in the form of consumption loans, i.e., a negative b_1) implies that falling property prices can give rise to arrears by reducing the collateral value of houses.[10]

Whether or not a decrease in income or future house prices or an increase in the mortgage rate makes moving optimal depends on how low $c_{stay\,\&\,pay}$ is, on how long affordability problems are expected to last and on whether or not the household can borrow. In what follows, we assume that the household is credit constrained and faces an income decreases that is so large that $c_{stay\,\&\,pay}$ in period 1 will fall below a certain minimum standard.

If consumption can be lifted above this minimum standard by skipping the mortgage payment in period 1, going into temporary arrears is optimal. In period 2, the household makes the mortgage payments for both periods. The household incurs costs ϕ under this strategy by damaging its credit record. A damaged credit record limits the household's future access to credit and reduces its ability

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[10] Buiter (2010) also argues that house price changes affect consumption because real estate can be used as collateral for consumer loans. See also Muellbauer (2009) and Duca *et al.* (2011).

to smooth future consumption; we do not explicitly model this here. The parameter ϕ also includes social stigma costs (see Foote *et al.,* 2008, for a detailed discussion).

If temporary arrears are not enough to maintain minimum consumption and/or if affordability problems are expected to be permanent, downsizing to a more affordable place is the solution. The "downsizing" budget constraint in Table 2 differs from the "stay & pay" constraint in that the rent, $\rho p_t h_1$, replaces the mortgage payment. Moreover, the house sale occurs in period 1 and adds to available resources at that point; the household simultaneously incurs moving costs, μ. Importantly, the utility function differs as well in that, under the downsizing strategy, both consumption and housing expenditures are optimally chosen in period 1. When faced with long-term affordability problems, the household reduces both non-housing and housing consumption.

However, downsizing may not be possible if the sale in period 1 does not yield enough funds to pay back the outstanding mortgage and if the household cannot borrow new funds. In this case of negative equity, housing consumption cannot be adjusted; the household is locked into its original housing choice, so that $h_1 = h_0$. To prevent consumption from dropping below the minimum living standard, the household stops its mortgage payments but incurs considerable credit record and stigma costs Φ, where the exact size of Φ depends on the national personal bankruptcy law. [11]

It is important to note that, in this model, negative equity leads to arrears only under a dual trigger constellation, i.e., when combined with long-term affordability problems. On its own, if we control for affordability problems and the dual trigger, negative equity should have no impact on arrears in Europe.

4.2 Model predictions

Table 3 summarises the model predictions. The model shows that not only unemployment or a drop in income but also a rise in mortgage payments or a fall in house prices can make a household's situation unaffordable. On its own, negative equity, which we capture by the interaction of house price decline and principal outstanding, should not increase arrears in our European data set because of the non-recourse framework. However, negative equity should matter if it coincides with affordability problems.

In terms of policy implications, if we indeed identify a significant impact of mortgage payments on arrears, monetary policy likely affects arrears in that lowering the policy rate has the potential to reduce mortgage payments. At the same time, looser monetary policy reduces unemployment, increases incomes and, in turn, also lowers the incidence of arrears.

A role for macroprudential policy would be identified if we found that the dual trigger mattered. A low LTV limit would reduce the incidence of negative equity for a given house price decline, so that fewer households would face the dual trigger.

Variables that are not included in Table 3 but are used as additional controls in Section 5 are (i) age group dummies, the household size and dummies for educational achievement; (ii) the principal outstanding on its own, where a high value might cause households to view the situation as hopeless, which would thus trigger arrears; and (iii) the interaction of the share of unemployed and principal outstanding for completeness. We use 35- to 44-year-olds as the baseline age group and treat tertiary education as the baseline education level.

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[11] Note that we omit $p_2 h_0 - d_0$ in the budget constraint of period 2 for the long-term arrears strategy. We thus implicitly assume that a household in long-term arrears does not pay back its mortgage, even at the end of the time period.

Table 3: Expected impact on arrears

Variable	Expected sign	Explanation
Share of unemployed household members	+	Arrears are more likely if household members are unemployed.
Ln(Household disposable income)	-	Arrears are less likely if income is high.
Ln(Mortgage payment)	+	Arrears are more likely if mortgage payments are high.
House price decline	+	Arrears are more likely for large house price declines, which reduce its ability to finance consumption out of housing wealth.
House price decline*principal outstanding	(+)	In non-recourse economies (e.g., some US states) arrears are more likely if there is negative equity, i.e., if there is considerable principal outstanding and the house price decline has been substantial. This should not matter in Europe.
House price decline*years of ownership*share of unemployed	+	Arrears are more likely if there is the dual trigger of unemployment and negative equity. The dual trigger should be particularly useful in explaining longer-term arrears.

5. Empirical analysis

Households in the EU-SILC database are interviewed for up to four years in a row. We analyse what drives arrears and what role policy can play by concentrating on this panel element of the EU-SILC data set. We estimate a household random-effects model, thus controlling for the fact that each household has special characteristics that are not captured by our right-hand side variables and that are constant over time. A random effects model is employed rather than the more general alternative of fixed effects because the mortgage-related variables that we use to capture national institutional characteristics are constant over time, ruling out estimation with fixed effects.

We present random effects OLS estimates, even though the dependent variable is either zero (not in arrears) or one (in arrears), which normally calls for estimation using a logit or probit transformation. However, our main interest is in interactions between the explanatory variables, and testing for the statistical significance of such interactions when using a non-linear estimator is difficult. We instead apply a linear probability model (which is estimated using random effects OLS). As robustness checks, reported in the Appendix, we estimate some of our models using conditional logit and fixed effects estimators. We cluster the standard errors at the country level, thus taking into account that residuals may be correlated at the national level. Because we do not have many countries in the data set, whether clustering is viable is unclear; as another robustness check, we also show unclustered results in the Appendix.

The two main questions that we would like to answer with the regressions below are as follows. First, how important are affordability problems? Finding that income, unemployment, mortgage payments and house price declines contribute to arrears would suggest that monetary policy has a side effect on mortgage defaults. Second, what potential is there for macroprudential policies? In particular, does the dual trigger matter? If so, the enforcement LTV limits could play a role. If, as expected, the dual trigger is a major factor in explaining longer-term arrears, which seriously disrupt banks' income streams and can threaten their financial stability, this finding would be a strong argument for macroprudential regulation.

To elucidate these questions, we first present the full sample estimates (Section 5.1) and then split the data into short- and longer-term arrears (Section 5.2) before assessing the impact of monetary and macroprudential policies (Section 5.3).

5.1 Full sample

Table 4 reports the full sample estimates, using *sincepeak* as the measure for the house price decline in the first column and *sincepurchase* in the second. The sample size in the first case is 179,777 observations; in the second case, there are only 51,562, due to missing observations in the national house price indices in the 1970s and 1980s, when many of the properties in the sample were purchased. Our baseline household has a reference person aged between 35 and 44 and with tertiary education. Given the large sample size, we treat coefficients at a confidence level of 5% or better as significant.

In Table 4, we find a clear impact of affordability, as measured by the share of unemployed household members, the logarithm of disposable income and the mortgage payment (only in the *sincepurchase* regression) on arrears. This finding suggests that a policy rate cut reduces arrears by lowering mortgage costs and unemployment and by increasing income and thus making mortgages more affordable.[12]

Neither the negative equity nor the dual trigger proxies are statistically significant. One reason for this finding may be that we combine temporary and longer-term arrears, where the dual trigger should only matter for the latter. We return to this issue in Section 5.3.

For the other controls, listed in the bottom panel of Table 4, we find a clear role for age; older households appear to go into arrears less frequently than the baseline household, aged 35 to 44. Arrears are also more frequent for large households and those with little education (for the latter, the reference category is tertiary education). The outstanding principal and its interaction with the share of unemployed in the household are insignificant in the *sincepeak* regression; in the *sincepurchase* regression, the interaction is significant.

Appendix 2 shows a series of robustness tests, which all use *sincepeak*. Table A1 includes a variable capturing investor protection; includes the annual house price change as an additional variable; and uses the ratio of mortgage payment to income instead of using the two variables separately. Table A2 runs the baseline regression using no clustering of standard errors, household fixed effects, country-year fixed effects, and a conditional logit. Table A3 presents a Heckman model that, in the first stage, models which households hold a mortgage and, in the second, reruns the arrears equation conditional on this selection.

In Table A1, where the estimation method is, as in Table 4, a random effects OLS with clustered standard errors, unemployment and income are significant in the robustness checks, and negative equity and the dual trigger never become significant. Investor protection, the annual house price change and the mortgage payment-to-income ratio are not significant. In Table A2, where the same sample and right-hand side variables are used as in Table 4, but the estimation methods differ, income is always significant, unemployment matters in two of the four equations, as do the mortgage payment, the house price decline and the dual trigger. Negative equity is significant once.

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[12] Ehrmann and Zettelmeyer (2014) analyse Eurosystem Household Finance and Consumption Network data and also show that a reduction in mortgage rates reduces the debt-burden of households.

Table 4: Determinants of mortgage arrears

	House price decline = *sincepeak*		House price decline = *sincepurchase*	
	Coefficient	Robust SE	Coefficient	Robust SE
Affordability				
Share of unemployed household members	0.0565***	0.0178	0.0572***	0.0208
Ln(Household disposable income)	-0.0378***	0.0070	-0.0467***	0.0069
Ln(Mortgage payment)	0.00370	0.00237	0.00621**	0.00282
House price decline	0.0718	0.0641	0.000175	0.000255
Negative equity				
House price decline*principal outstanding	0.194	0.121	-0.00111	0.00070
Dual trigger				
House price decline*principal outstanding*share of unemployed	0.365*	0.217	-0.00134	0.00618
Other controls				
Aged 16-34	0.000552	0.002377	0.000448	0.003224
Aged 45-54	0.00140	0.00237	0.00588	0.00373
Aged 55-64	-0.0126***	0.0032	-0.00717**	0.00343
Aged 65+	-0.0245***	0.0059	-0.0209***	0.0059
Household size	0.0113***	0.0025	0.0150***	0.0031
Primary education	0.0316***	0.0088	0.0303***	0.0101
Secondary education	0.0123***	0.0041	0.0108**	0.0047
Principal outstanding	0.0123	0.0114	0.0160*	0.0097
Principal outstanding*share of unemployed	0.0502*	0.0297	0.0816***	0.0273
Constant	0.364***	0.066	0.432***	0.006
Number of observations	179,777		51,562	
Number of groups	80,985		38,653	

Note: *, ** and *** denote significance at the 10%, 5% and 1% levels, respectively. OLS random effects with standard errors clustered at the country level (18 countries). *House price decline* is the decline in the national house price index since its peak for the *sincepeak* regression and the decline in the same index since the time of the house purchase in the *sincepurchase* regression.

In Table A3, all affordability variables, negative equity and the dual trigger are significant in the arrears equation. We find that mortgage households are young and well educated and have few members and high incomes. The negative Mills ratio indicates that there is an additional unobserved variable that simultaneously increases a household's probability of having a mortgage and reduces the likelihood that it goes into arrears. Correcting for this selection bias results in a significant dual trigger in the arrears equation. However, the robustness of these findings depends on whether age, which we assume has a direct effect on the likelihood of holding a mortgage but exclude from the arrears equation, actually has a direct effect on arrears.

Overall, Table 4 and the robustness tests in the Appendix suggest the clear impact of affordability problems for arrears in Europe. The impact of the dual trigger is not clear if the full sample is used.

5.2 Split by the length of arrears
In theory, as explained in the model in Section 4 above, a household that expects its affordability problems to be temporary should go into arrears for a brief time (if the expectations prove correct); negative equity plays no role in this household's decision. A household that faces longer-term

affordability problems should downsize, though downsizing is not possible if it is in negative equity. Thus, for households that are in longer-term arrears, we expect the dual trigger to matter.

The EU-SILC data allow a split of delinquent mortgage households by the length of arrears. In particular, the survey asks if households have been in arrears either once or several times over the past year. Appendix 3 shows the data by country, where we count a household as in "longer-term" arrears if it missed at least two monthly mortgage payments over a full year, which is a rather strict definition.

Table 5: The determinants of temporary and longer-term arrears

	Temporary arrears		Longer-term arrears	
	Coefficient	Robust SE	Coefficient	Robust SE
Affordability				
Share of unemployed household members	0.00959*	0.00571	0.0324***	0.0119
Ln(Household disposable income)	-0.00907***	0.00236	-0.0189***	0.0039
Ln(Mortgage payment)	0.000616	0.000645	0.00260	0.00181
House price decline	0.0443	0.0413	0.0569	0.0467
Negative equity				
House price decline*principal outstanding	0.00993	0.01039	0.201**	0.093
Dual trigger				
House price decline*principal outstanding*share of unemployed	0.0940	0.0770	0.589***	0.213
Other controls				
Aged 16-34	-0.000506	0.000922	-0.000777	0.00107
Aged 45-54	0.000474	0.000780	0.00224	0.00150
Aged 55-64	-0.00302***	0.00081	-0.00330**	0.00162
Aged 65+	-0.00631***	0.00218	-0.0105***	0.0032
Household size	0.00271***	0.00086	0.00697***	0.00178
Primary education	0.00439**	0.00188	0.0189***	0.0071
Secondary education	0.00194*	0.00100	0.00584**	0.00240
Principal outstanding	0.000628	0.003158	0.00401	0.00655
Principal outstanding*share of unemployed	0.00993	0.01039	0.0304	0.0214
Constant	0.0894***	0.0234	0.168***	0.030
Number of observations	177,479		177,479	
Number of groups	80,243		80,243	

Note: *, ** and *** denote significance at the 10%, 5% and 1% levels, respectively. OLS random effects with standard errors clustered at the country level (18 countries). *Temporary arrears* households missed only one mortgage payment over the last year, while *longer-term arrears* households missed several payments. House price decline = $sincepeak$.

Table 5 presents the estimation output distinguishing temporary and longer-term arrears.[13] The left panel shows the analysis for only one-time arrears households. We find that only affordability matters in these households. The right panel shows the analysis for longer-term arrears households, and we find that the dual trigger is highly significant alongside affordability. These findings are fully in line with theory.

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[13] The sample is by 2,289 smaller than in Table 4 because of observations that are coded as "in arrears" in the EU-SILC database but have a missing value both in the temporary and the longer-term arrears question.

It can be argued that, in terms of financial stability, longer-term arrears pose a greater risk to banks and thus to financial stability than temporary arrears. Macroprudential policies that help reduce the incidence of negative equity are therefore desirable. The next subsection attempts to shed more light on the role of monetary and macroprudential policies.

5.3 The role of monetary and macroprudential policies

Tables 4 and 5 showed that affordability is a clear driver of arrears. Income, unemployment and asset prices all depend on monetary policy. A change in the policy rate thus has a clear impact on arrears.

The most direct link between affordability and monetary policy runs through mortgage payments. This effect should be particularly strong in countries where variable-rate mortgages are most prevalent. In countries where fixed rates are standard, the transmission of monetary policy should be slower because only new or renewed mortgages would benefit from an interest rate cut.

To assess whether the reaction indeed is stronger in variable-rate counties, we report in the left panel of Table 6 the baseline regression shown in Table 4, but we include the interaction between the mortgage payment and a variable-rate country dummy an as additional variable. This dummy is taken from the ECB data reported in Table 2. At first glance, surprisingly, we do not identify a stronger impact of mortgage payments in variable-rate countries. That said, the coefficient for mortgage payment itself is now clearly significant, whereas it was insignificant in Table 4. This finding suggests that mortgage payments in fixed-rate countries are drivers of arrears.

One explanation for this finding is that monetary policy responds to other drivers of arrears, particularly unemployment and income because of their impact on inflation. During a recession, when arrears rise because of unemployment and falling incomes, monetary policy is loosened. In variable-rate countries, this policy loosening translates into lower mortgage payments, so that affordability actually improves. In fixed-rate countries, mortgage payments remain unchanged, and the higher their level, the more likely a household that faces other affordability problems goes into arrears.

If this interpretation is correct, the regression in the left panel of Table 6 shows that monetary policy also directly affects arrears though the size of the mortgage payment. While arrears, of course, are not an objective variable of monetary policy, knowing that policy rate changes have a direct impact on financial stability through arrears is useful.

In terms of macroprudential policies, much recent discussion has focussed on LTV limits. The lower the LTV ratio, the more house prices have to decline before mortgage holders fall into negative equity. If negative equity, in combination with affordability problems, is a driver of long-term arrears, as shown in Table 6, low LTV limits contribute to financial stability by avoiding a drop in the income stream of banks when house prices decline.

In the right panel of Table 6 we assess whether there is a separate role for LTV limits. The table shows the arrears regression output that we obtain if we include the typical LTV ratio per country from Table 1. However, this variable turns out to be insignificant and have the wrong sign. One possible explanation for the negative sign is that, in practice, the typical LTV ratio is not a policy variable set by the regulator; it instead may reflect the risk-taking in mortgage supply and demand in the country in question. If risk-taking increases in countries where arrears are rare, the reverse causality would explain negative sign identified for the typical LTV ratio.

Table 6: Controlling for variable-rate mortgages and typical LTV ratios

	Controlling for variable-rate mortgages		Controlling for typical LTV ratios	
	Coefficient	Robust SE	Coefficient	Robust SE
Affordability				
Share of unemployed household members	0.0537***	0.0174	0.0552***	0.0175
Ln(Household disposable income)	-0.0377***	0.0066	-0.0382***	0.0068
Ln(Mortgage payment)	0.00383***	0.00074	0.00401*	0.00228
Ln(Mortgage payment)* variable-rate dummy	**0.00259**	**0.00356**	-	-
House price decline	0.0348	0.0590	0.0457	0.0559
Negative equity				
House price decline*principal outstanding	0.174	0.124	0.222*	0.114
Dual trigger				
House price decline*principal outstanding*share of unemployed	0.377*	0.201	0.367*	0.216
Other controls				
Typical LTV ratio	-	-	**-0.000320**	**0.000365**
Aged 16-34	0.000682	0.002249	0.000766	0.002321
Aged 45-54	0.00136	0.00199	0.00108	0.00245
Aged 55-64	-0.0118***	0.00237	-0.132***	0.0032
Aged 65+	-0.0233***	0.0053	-0.0251***	0.0059
Household size	0.0106***	0.0023	0.0110***	0.0025
Primary education	0.0284***	0.0084	0.0310***	0.0087
Secondary education	0.0112***	0.0042	0.0119***	0.0042
Principal outstanding	0.00890	0.00729	0.00864	0.01041
Principal outstanding*share of unemployed	0.0518*	0.0294	0.0517*	0.0293
Constant	0.352***	0.064	0.392***	0.069
Number of observations	177,923		179,777	
Number of groups	79,936		80,985	

Note: *, ** and *** denote significance at the 10%, 5% and 1% levels, respectively. OLS random effects with standard errors clustered at the country level (17 countries in the left panel, 18 countries in the right panel). House price decline = *sincepeak*.

6 Caveat and conclusions

The main caveat in this analysis is that we rely on a proxy for negative equity. It would be desirable to have an actual household measure for this variable, but we are not aware of a large European data set that would include these and the other relevant data.

As predicted by theory, arrears in Europe are driven by affordability problems, such as unemployment, low disposable income, mortgage payments and house price declines. We find no clear evidence that negative equity *per se* is associated with higher arrears, which is in line with expectations because of European recourse legislation. However, the combination of affordability problems and negative equity, which makes it impossible for financially strained households to move to cheaper places and which the literature refers to as a dual trigger situation, seems to matter for longer-term arrears. As predicted by our model, the dual trigger does not explain temporary arrears.

The analysis shows that monetary policy influences arrears by affecting mortgage rates, income, employment and asset prices. However, it is important to emphasise that the fact that monetary policy influences mortgages arrears does not necessarily mean that it should be used for this purpose. Monetary policy should respond to arrears only inasmuch as they affect consumption, output and inflation, and if they threaten financial stability.

Macroprudential policy, which has emerged as an additional tool for central banks, also appears useful, as negative equity seems to drive longer-term arrears when it coincides with affordability problems. Low LTV limits, by reducing the number of households in negative arrears for any given house price decline, may help stabilise banks' income streams and ultimately their financial stability. At the same time, it may help avoid the negative consequences of arrears for households in terms of reduced future access to credit, more volatile and lower consumption, reduced labour mobility and social stigma.

Appendix 1: Optimisation

Stay & pay strategy

Here, we derive optimal consumption under the stay & pay strategy. We first solve the budget constraints for period 1 and 2 for b_1 and equate

$$\frac{1}{1+r}(c_2 + m_2 - y_2 - p_2 h_0 + d_0) = y_1 - c_1 - m_1$$

or

$$c_1 + \frac{1}{1+r}c_2 = y_1 - m_1 + \frac{1}{1+r}(y_2 - m_2 + p_2 h_0 - d_0). \tag{A1}$$

Overall utility is given by

$$U = U_1 + \beta U_2,$$

where β is the discount factor. The Lagrangian is

$$\mathcal{L} = U_1 + \beta U_2 - \lambda \left[c_1 + \frac{1}{1+r}c_2 - y_1 + m_1 - \frac{1}{1+r}(y_2 - m_2 + p_2 h_0 - d_0) \right].$$

Taking the derivative with respect to c_1 and c_2, setting it equal to zero and solving yields

$$\frac{1}{c_1} = \lambda$$

and

$$\frac{\beta}{c_2} = \frac{\lambda}{1+r}$$

or

$$c_1 = \frac{1}{\beta(1+r)}c_2.$$

Assuming $\beta(1+r) = 1$ implies that consumption is the same in both periods. Finally, inserting in equation (A1) yields

$$c_{stay \,\&\, pay} = \frac{1}{2+r}[(1+r)(y_1 - m_1) + y_2 - m_2 + p_2 h_0 - d_0].$$

Temporary arrears

If the household goes into temporary arrears, the optimisation problem changes. The budget constraint (A1) becomes

$$c_1 + \frac{1}{1+r}c_2 = y_1 + \frac{1}{1+r}(y_2 - m_1 - m_2 + p_2 h_0 - d_0 - \phi),$$

and optimal consumption equals

$$c_{temporary} = \frac{1}{2+r}[(1+r)y_1 + y_2 - m_1 - m_2 + p_2 h_0 - d_0 - \phi].$$

If $\phi > r m_1$, then the stay & pay strategy is preferable.

Nevertheless, even if $\phi > r m_1$, there may be situations in which the household goes into temporary arrears. If a decrease in income, an increase in mortgage payments or an expected drop in house prices pushes $c_{stay \,\&\, pay}$ below an acceptable consumption level, c_{min}, if $y_2 > y_1$ and if the household faces a borrowing constraint, i.e., b_1 has to be non-negative, the household may be able

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to raise consumption in period 1 by postponing the mortgage payment by one period. In this case, the utility from the temporary arrears strategy exceeds that from the stay & pay strategy.

Downsizing

If the decline in income is permanent, moving to a cheaper place and thus adjusting both housing and non-housing consumption may be optimal. Under this strategy, the budget constraint yields

$$c_1 + \frac{1}{1+r}c_2 = y_1 + p_1h_0 - d_0 - \rho p_1 h_1 - \mu + \frac{1}{1+r}(y_2 - \rho p_2 h_1).$$

Setting the first order condition with respect to h_1 equal to zero and solving yields

$$\frac{\alpha(1+\beta)}{h_1} = \lambda\rho\left(p_1 + \frac{1}{1+r}p_2\right).$$

Using $\lambda = 1/c_1$ in equation (A5) and solving gives

$$c_{downsize} = \frac{1}{(2+r)(1+\alpha)}[(1+r)(y_1 + p_1h_0 - d_0 - \mu) + y_2].$$

In theory, adjusting both consumption and housing consumption, rather than only consumption, is optimal when faced with a drop in income or expected house prices or an increase in mortgage payments. However, the larger the moving costs, the lower $c_{downsize}$ and $h_{downsize}$.

Longer-term arrears

A long-lasting drop in income may push $c_{stay\,\&\,pay}$ permanently below an acceptable consumption level, c_{min}, so that being in temporary arrears, i.e., postponing the payment of m_1 until period 2, is not an option. Downsizing is not viable either, if $p_1h_0 < d_0$ because realising the loss on the house further reduces consumption. Thus, in a situation of reduced affordability and negative equity, going into long-term arrears is optimal to prevent consumption from falling to c_{min}.

Proceeding as before, we obtain

$$c_1 + \frac{1}{1+r}c_2 = y_1 + \frac{1}{1+r}(y_2 - \Phi)$$

and

$$c_{long-term} = \frac{1}{2+r}[(1+r)y_1 + y_2 - \Phi].$$

Appendix 2: Robustness checks

As a check of the robustness of our full model using *sincepeak* in Table 4, Table A1 reports regression that includes the World Bank Doing Business Report data on investor protection (first panel), the house price change (second panel) and the ratio of the mortgage payment to disposable income rather than using the two variables separately (third panel). Not reported here, but available on request, are regressions that drop Ireland and Hungary and Poland, respectively, which both yield estimates very close to the baseline regression. Appendix 3 shows the investor protection variable for the different countries.

Table A2 re-estimates the *sincepeak* regression from Table 4 using random effects without clustered standard errors (first panel), fixed household effects (second panel), fixed country-time effects and random household effects (third panel), and a conditional logit (fourth panel). The sample size in the fourth panel is much smaller than in the others because the estimation concentrates on households that change status from not-in-arrears to in-arrears.

Finally, Table A3 reports a two-stage model, where the first stage captures which households have a mortgage and the second stage corrects for the resulting selection bias and re-estimates the baseline arrears equation.

The main results reported in Table 4 appear robust. In some instances, additional variables become significant. Concentrating again on significances of 5% and better, we mark these cases in blue in the tables. Where previously significant variables have become insignificant, we mark those in red.

Table A1: Robustness checks

	Including investor protection		Including house price change		Mortgage payment/income	
	Coefficient	Robust SE	Coefficient	Robust SE	Coefficient	Robust SE
Affordability						
Share of unemployed household members	0.0648***	0.0183	0.0566***	0.0178	0.0693***	0.0218
Ln(Household disposable income)	-0.0375***	0.0062***	-0.0378***	0.0070	-	-
Ln(Mortgage payment)	0.00390	0.00292	0.00370	0.00236	-	-
Mortgage payment/income	0.0176	0.0128	-	-	**0.0000415**	**0.0000530**
House price decline	0.0773	0.0636	0.0656	0.0729	0.0579	0.0843
Negative equity						
House price decline*principal outstanding	0.180	0.128	0.193	0.123	0.303*	0.163
Dual trigger						
House price decline*principal outstanding*share of unemployed	0.339	0.219	0.368*	0.214	0.338	0.212
Other controls						
Aged 16-34	-0.000238	0.002413	0.000573	0.002339	0.00644***	0.00242
Aged 45-54	0.00230	0.00259	0.00139	0.00237	-0.0000451	0.0021642
Aged 55-64	-0.0116***	0.0032	-0.0126***	0.0032	-0.0115***	0.0030
Aged 65+	-0.0251***	0.0060	-0.0245***	0.0059	-0.0185***	0.0054
Household size	0.0118***	0.0024	0.0112***	0.0025	0.00531***	0.00175
Primary education	0.0322***	0.0091	0.0315***	0.0087	0.0508***	0.0108
Secondary education	0.0131***	0.0043	0.0123***	0.0041	0.0225***	0.0062
Investor protection	**-0.00531**	**0.00439**	-	-	-	-
Principal outstanding	0.0176	0.0128	0.0123	0.0114	0.0172	0.0106
Principal outstanding*share of unemployed	0.0414	0.0320	0.0500*	0.0296	0.0539	0.0328
House price change	-	-	**-0.0000777**	**0.0002712**	-	-
Constant	0.385***	0.071	0.364***	0.066	-0.00206	0.00643
Number of observations	158,660		179,777		179,777	
Number of groups	73,718		80,985		80,985	

Note: *, ** and *** denote significance at the 10%, 5% and 1% levels, respectively. Standard errors are clustered at the country level (17 countries in the first panel, 18 countries in the second and third). House price decline = *sincepeak*.

Table A2: Robustness checks

	Random effects, unclustered standard errors		Fixed household effects, clustered standard errors		Country-time fixed effects, clustered standard errors		Conditional FE logit, clustered standard errors	
	Coefficient	Robust SE	Coefficient	Robust SE	Coefficient	Robust SE	Coefficient	Robust SE
Affordability								
Share of unemployed household members	0.0565***	0.0081	0.00782	0.00800	0.0446***	0.0164	0.104	0.224
Ln(Household disposable income)	-0.0378***	0.0013	-0.0115***	0.0039	-0.0317***	0.0054	-0.305**	0.146
Ln(Mortgage payment)	0.00370***	0.00040	0.00314	0.00261	0.00939***	0.00209	0.124*	0.074
House price decline	0.0718***	0.0113	0.0798	0.0670	0.0727***	0.0037	6.262*	3.743
Negative equity								
House price decline*principal outstanding	0.194***	0.033	0.0920	0.0914	-0.147	0.133	-2.901	3.240
Dual trigger								
House price decline*principal outstanding*share of unemployed	0.366**	0.185	0.252	0.240	0.507**	0.211	-2.554	2.371
Other controls								
Aged 16-34	0.000552	0.001422	0.00216	0.00258	0.00343**	0.00172	0.0866	0.1059
Aged 45-54	0.00140	0.00139	0.00168	0.00284	-0.000108	0.00184	0.0665	0.1448
Aged 55-64	-0.0126***	0.0015	0.00166	0.00351	-0.00973***	0.00256	0.0709	0.1620
Aged 65+	-0.0245***	0.0019	-0.00182	0.00558	-0.0174***	0.0047	0.0151	0.3443
Household size	0.0113***	0.0007	0.00155	0.00116	0.00766***	0.00193	0.0464	0.0451
Primary education	0.0316***	0.0024	0.00812	0.00795	0.0328***	0.0088	0.107	0.237
Secondary education	0.0123***	0.0011	-0.00121	0.00354	0.0128***	0.0042	-0.0893	0.1736
Principal outstanding	0.0123***	0.0016	-0.0268	0.0191	-0.0208***	0.067	-0.429	0.320
Principal outstanding*share of unemployed	0.0502***	0.0159	0.0470*	0.0223	0.0638**	0.0268	0.984**	0.435
Additional controls	-		Household fixed effects		Country-time fixed effects		-	
Constant	0.364***	0.013	0.133**	0.051	0.295***	0.046	-	-
Number of observations	179,777		179,777		179,777		8,604	
Number of groups	80,985		80,985		80,985		-	

Note: *, ** and *** denote significance at the 10%, 5% and 1% levels, respectively. Standard errors, if clustered, are clustered at the country level (18 countries). House price decline = *sincepeak*.

	Mortgage equation		Arrears equation	
	Coefficient	Robust SE	Coefficient	Robust SE
Affordability				
Share of unemployed household members	-0.217***	0.011	0.0850***	0.0055
Ln(Household disposable income)	0.688***	0.002	-0.0559***	0.0015
Ln(Mortgage payment)	-	-	0.00482***	0.00036
House price decline	1.006***	0.025	0.0387***	0.0122
Negative equity				
House price decline*principal outstanding	-	-	0.212***	0.026
Dual trigger				
House price decline*principal outstanding*share of unemployed	-	-	0.645***	0.096
Other controls				
Aged 16-34	-0.0359***	0.0046	-	-
Aged 45-54	-0.293***	0.005	-	-
Aged 55-64	-0.457***	0.005	-	-
Aged 65+	-0.955***	0.006	-	-
Household size	-0.197***	0.002	0.0176***	0.0005
Primary education	-0.182***	0.005	0.0304***	0.0016
Secondary education	-0.113***	0.004	0.0123***	0.0096
Principal outstanding	-	-	0.0137***	0.0014
Principal outstanding*share of unemployed	-	-	0.0512***	0.0099
Mills ratio	-	-	-0.0246***	0.0024
Constant	-7.064***	0.026	0.554***	0.018
Number of observations	973,084			

Note: *, ** and *** denote significance at the 10%, 5% and 1% levels, respectively. Heckman model, house price decline = $sincepeak$.

Appendix 3: Temporary and longer-term arrears and investor protection

Figure A1 shows what fraction of mortgage households indicated to have been once or several times) in arrears over the course of the previous year. As in Figure 1 in the text, the data are presented by year and country. It should be noted that the EU-SILC questionnaire has included a general question on arrears since 2003; the distinction between one-time and repeated arrears yielded positive answers only from 2008 onwards.

Generally, temporary and longer-term arrears tend to simultaneously increase, which makes sense given that they both depend on affordability. Longer-term arrears were more prevalent than temporary arrears in all countries but Greece. Theory suggests that this prevalence is driven by the dual trigger of affordability problems and negative equity.

Figure A1: Fraction of mortgage households in arrears once (= temporary arrears) or several times (= longer-term arrears) over the previous year (in %)
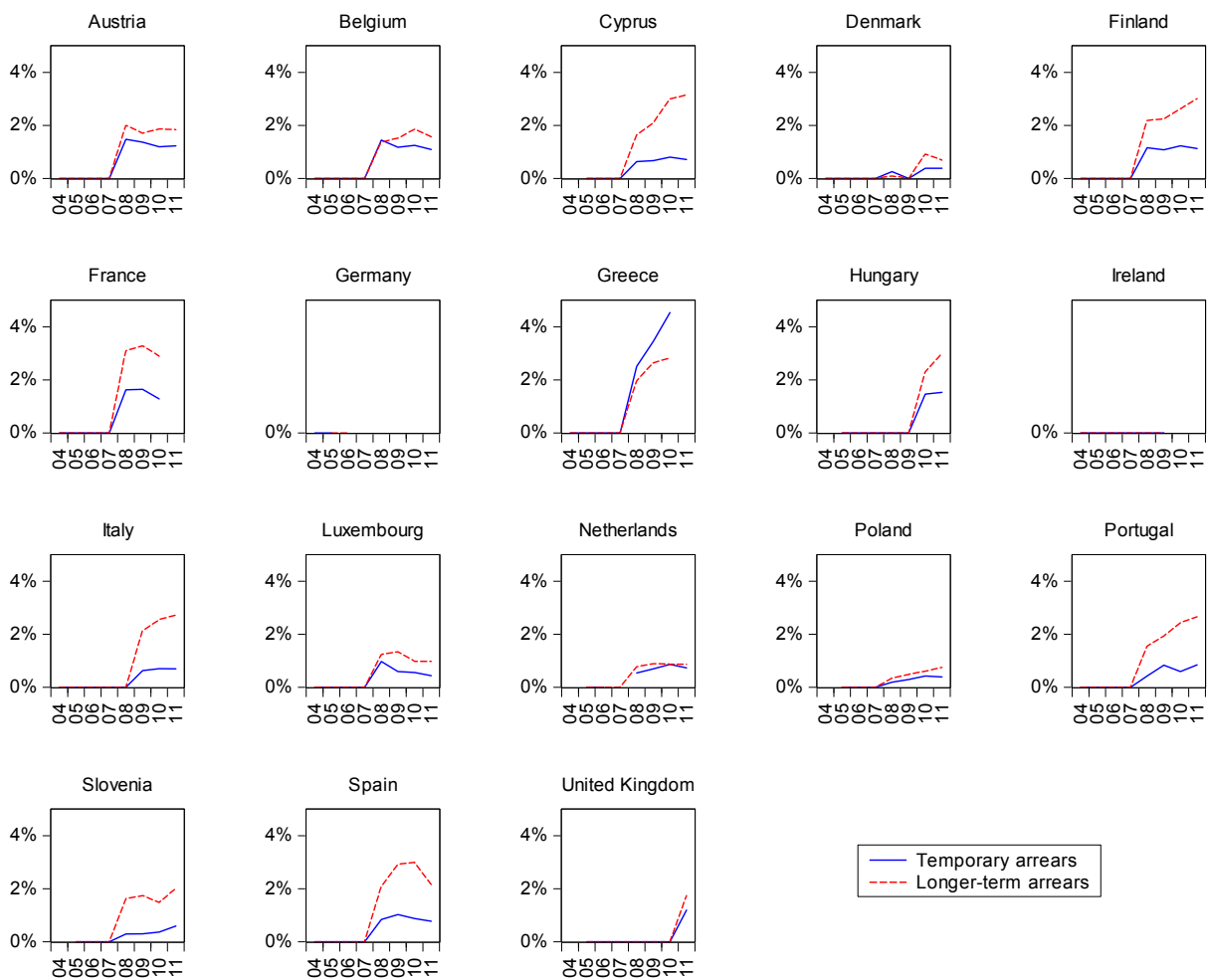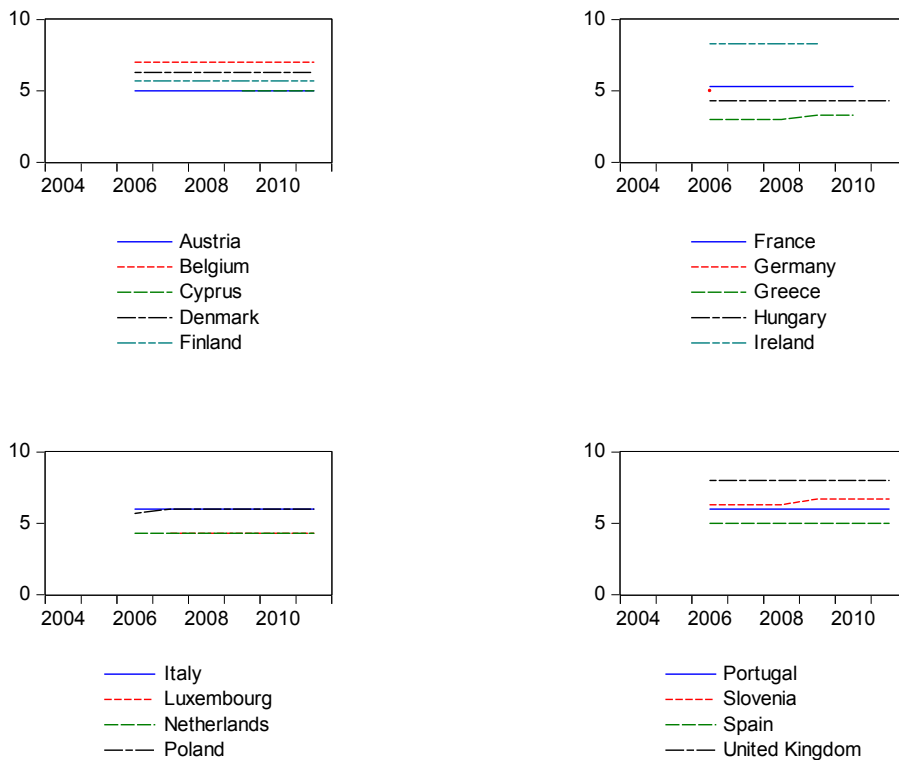
Figure A2 shows the strength of investor protection from the World Bank Doing Business Report, which we use in the estimation in the first panel of Table A1. Values range from 0 to 10, with higher values indicating stronger protection.

Figure 2A: Investor protection index, from the World Bank Doing Business report

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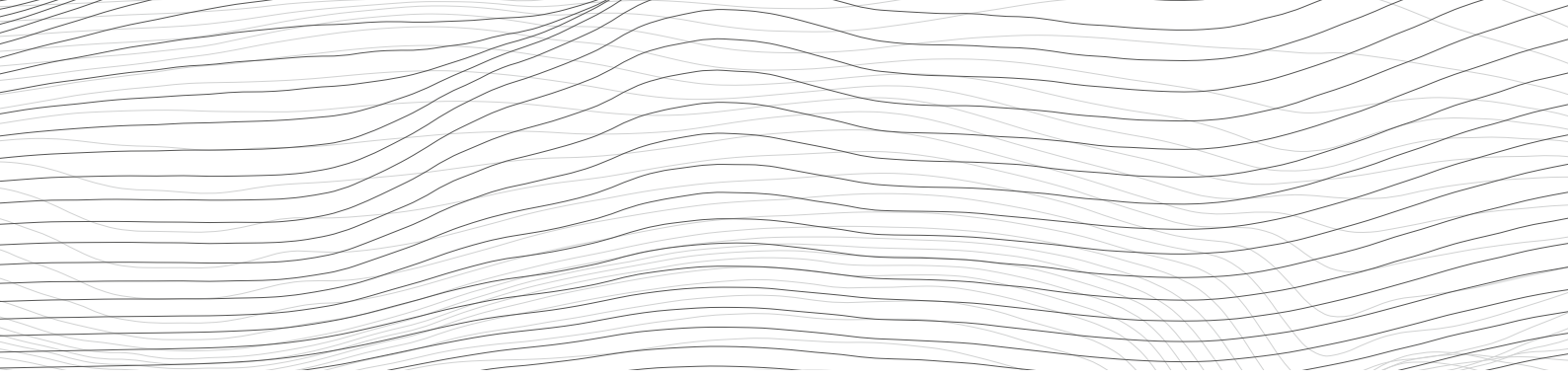
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