Communities and Local Government

Modelling and forecasting UK mortgage arrears and possessions

Report

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This paper draws in part on our report *Mortgage Possessions Statistics and Outlook: an Independent Review for the Minister for Housing/Department for Communities and Local Government, UK, May 2009.* The *Mortgage Possessions Statistics and Outlook* report, commissioned by the CLG Housing Markets and Planning Analysis Expert Panel, has now been superseded by the publication of this paper. Copies of the Expert Panel report are available on request from:
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Contents

1. Introduction

The international financial crisis of 2008-09 has had costly implications for some home-owners through a surge in mortgage possessions and arrears, raising political concern. However, the rise in problem mortgages has been less severe than in the early 1990s crisis. New research presents more sophisticated models than previously for UK aggregate arrears and possessions. Forecasting with these models, under varying scenarios to 2013, highlights possible risks faced by policy makers.

There has been great uncertainty about the scale of the UK's new mortgage difficulties. The Council of Mortgage Lenders' (CML) adjusted their forecasts twice, from 75,000 mortgage possessions in 2009 (November, 2008), to 65,000 (June, 2009) and to 48,000 (November, 2009). The estimated number of possessions is 46,000 for the year[1]. The uncertainty concerned both the tightening of the credit market on house prices, interest rates, unemployment and income, and the effects of changing lending quality and policy interventions. Credible models for mortgage arrears and possessions, taking account of loan quality and policy, which can be used to forecast future trends on alternative scenarios, should be invaluable to policy-makers in assessing risks ahead. Understanding the past should also improve long-term policy making.

This paper presents new quarterly models for forecasting aggregate UK data on mortgage possessions (foreclosures) and mortgage arrears (payment delinquencies), revealing sensitivity to different economic conditions. The fundamental economic drivers of aggregate arrears and possessions are:

- the debt service ratio (the product of the mortgage interest rate and the level of debt divided by disposable income)
- an estimate of the incidence of negative equity (based on the ratio of average mortgage debt to average home prices) and
- the unemployment rate

[1] In May 2010, the CML revised their mortgage possession figures from Q1 2009 onwards to be representative of the entire first charge mortgage market. The revised figure for properties taken into possession in 2009 is 47,700. Earlier data relate to CML members only and so are not directly comparable.

Together with proxies for loan quality and government policy, this suggests just five variables are needed to explain the history of arrears and possessions over 1983-2009, and to assess future trends.

The paper contains several innovations:

1. To address variations in loan quality and shifts in forbearance policy by lenders, something which is difficult to observe, by using common latent variables estimated in a system of equations. This method is more satisfactory than the widely used loan-to-value measures for first mortgages, which are not comparable over time and omit further advances.
2. The theory-justified use of an *estimate of the proportion of mortgages in negative equity*, calibrated to micro data, and based on the ratio of average debt to average equity.
3. The systematic treatment of measurement bias in the available "months-in-arrears" measures that has been previously neglected.
4. The assumption in previous studies on UK aggregate data, Breedon and Joyce (1992), Brookes et al. (1994), Allen and Milne (1994) and Cooper and Meen (2001), of a proportional relationship between possessions and arrears is relaxed.

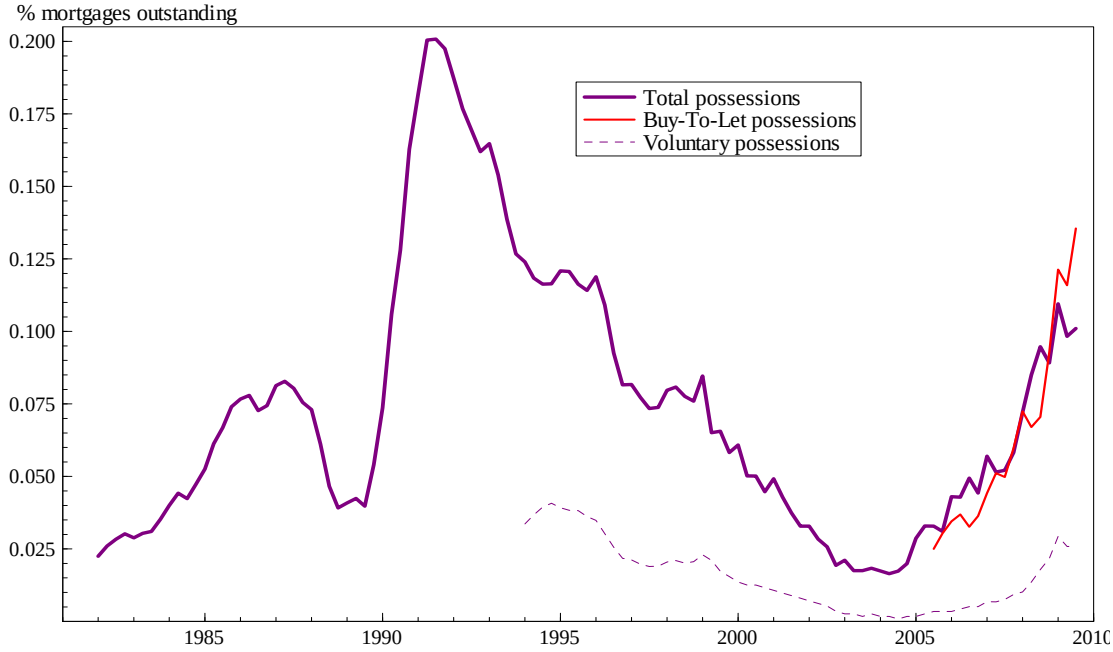
A careful study of the aggregate data is pertinent in the UK given the paucity of micro data on mortgage defaults (by contrast with the US). The only micro-candidate for a random sample is the British Household Panel Study (BHPS). These data are sparse and not timely, however, and there are major problems drawing aggregate implications from them[2].

Fluctuations in UK possessions and arrears rates are shown in Figures 1 and 2, using data from the CML[3]. The flow into possessions peaks in 1991, at a

[2] The BHPS sample under-represents some types of households; the possessions data are too sparse to make full use the panel structure (see Cooper and Meen, 2001); some variables are poorly measured; and the history is too short to identify complex time-varying influences, such as policy variations.
[3] Available data on UK mortgage possessions and arrears is documented in Annex 1.

quarterly rate of 0.2 per cent of the number of mortgages. From the subsequent trough in 2004 to 2008 the possessions rate has traced out just over half the previous rise from 1989 to 1991. The arrears rate peaked in 1993 (proportions of mortgages with greater than six months or greater than 12 months payment arrears), lagging significantly behind the 1991 possessions peak. The lag can partly be attributed to a shift in government policy and coordinated efforts by mortgage lenders from the end of 1991 (Muellbauer and Cameron, 1997)[4]. The policy shift reduced the possessions rate, but mortgages in arrears rose. There are strong parallels between these and later government interventions and discussions with lenders towards greater leniency, in 2008-9[5].

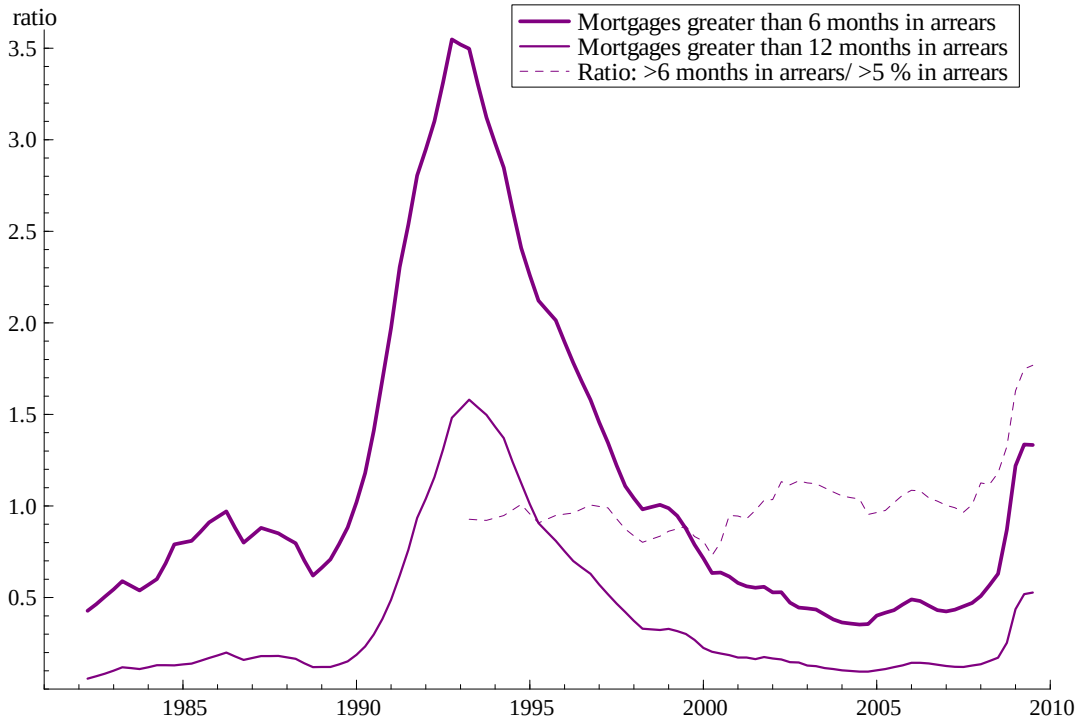
Figure 1: Aggregate possessions rates: total, voluntary and Buy-to-Let (percentage mortgages outstanding)



Source: CML, interpolations of quarterly CML data are used before 1999.

[4] Policies included the shift to direct payment of income support to mortgage lenders and a Stamp Duty holiday, in return for a collective agreement by lenders to be more lenient.
[5] The recent policy shifts include more generous Support for Mortgage Interest, the application of the Mortgage Pre-action Protocol from November 2008, the Mortgage Rescue Scheme, and Homeowners Mortgage Support (see Stephens (2009) for a summary of these measures). Indirect recent policy support includes another Stamp Duty holiday and mortgage loan targets for lenders owned by tax-payers (Northern Rock), or partly owned (Royal Bank of Scotland and Lloyds TSB), to underpin mortgage availability and house prices.

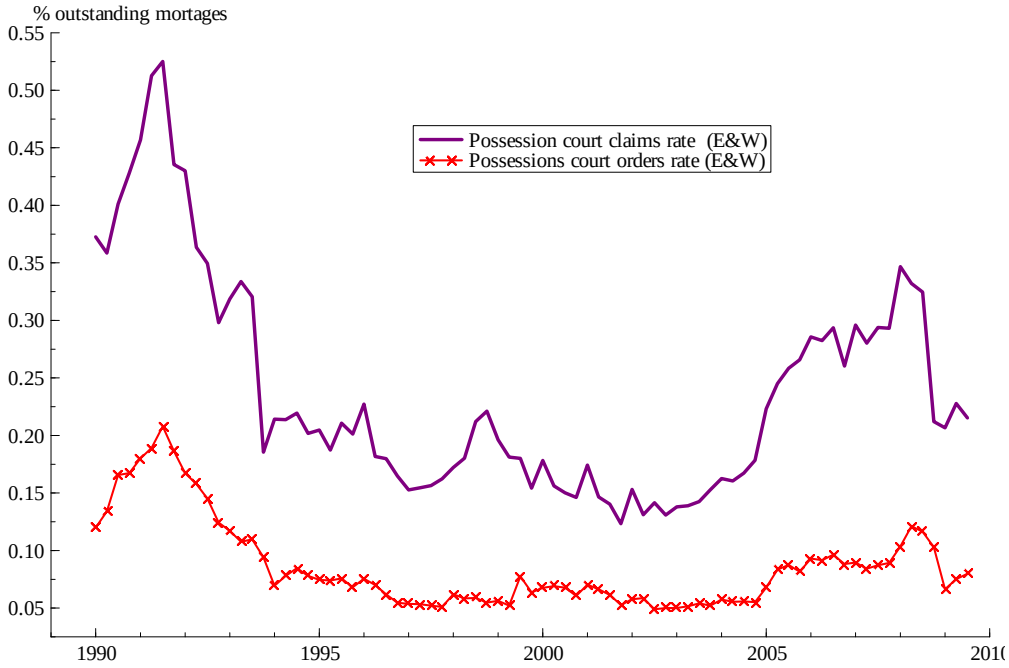
Figure 2: Arrears rates by months in arrears (percentage of mortgages outstanding) and ratio of months to percent in arrears



Source: CML, interpolations of quarterly CML data are used before 1999.

An alternative data source from the Ministry of Justice records the court possessions actions and orders made for England and Wales. In Figure 3 these are plotted as a fraction of the number of UK mortgages outstanding. The court actions data show a dramatic drop in the last quarter of 2008, confirming the forbearance policy shift by lenders. This was undoubtedly related to the Mortgage Pre-action Protocol. It is likely that part of the effect of the policy shift was to postpone possessions, though the magnitude of this effect is unknown. The court orders data experienced a larger proportionate rise from 2004 to 2008 (though with a drop in the last quarter of 2008) than the CML possessions rate data, which tend to lag behind. The court actions and orders data are consistent with the stabilisation in the possessions rate in 2009.

Figure 3: Ministry of Justice data on possessions: court orders and actions, expressed as a rate using count of CML mortgages outstanding

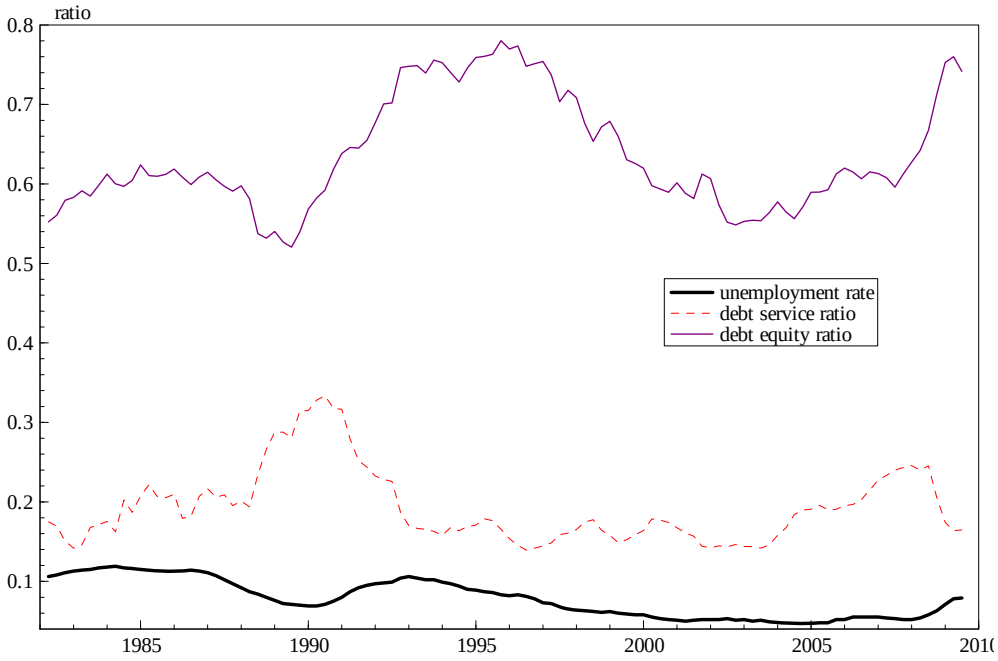


Source: Ministry of Justice quarterly date on court orders and actions[6].
CML, interpolations of quarterly CML data are used before 1999, see section 3.2.1.

There are, however, differences between the recent economic downturn and that of the early 1990s, the most radical being in the monetary policy response in rapidly bringing down interest rates. In 1990-92, monetary policy was constrained by the high rate of inflation, and sterling's membership of the European Exchange Rate Mechanism until the UK exited in September, 1992. The average cost of servicing mortgage debt as measured by the debt service ratio has thus fallen in 2009 to below early 1990s levels, despite far higher levels of mortgage debt relative to income. The rises in the unemployment rate and in the average debt equity ratio are more comparable to the previous downturn (see Figure 4).

[6] Figure 3 reflects the number of court claims issued and orders given as a rate of CML mortgages outstanding Ministry of Justice figures include possession cases regarding second charge lenders as well as first charge whereas the CML figures use first charge lender types of outstanding arrears, therefore the proportions may be slightly inflated and appear higher than they actually are.

Figure 4: The three key drivers: unemployment, the interest rate and debt equity



Source: See Table A4.1 (Annex 4) for sources of data and definitions.

2. The approach used

Theory and methodology

In this research, new models for aggregate UK data on mortgage possessions and arrears are motivated by a 'double trigger' framework for defaults and payment delinquencies. The double trigger approach rests on the idea that defaults occur not just because home equity is low relative to debt, but also because households have cash-flow problems. An early exposition of the theory behind the double trigger model is by Elmer and Seelig (1998), and it underlies much recent micro-econometric work on US mortgage defaults (Bajari et al. (2009); Gerardi et al. (2008)). Full technical details on the 'double trigger' framework are presented in Annex 2.

The empirical models for possessions and arrears have an 'equilibrium correction' form with three fundamental economic drivers:

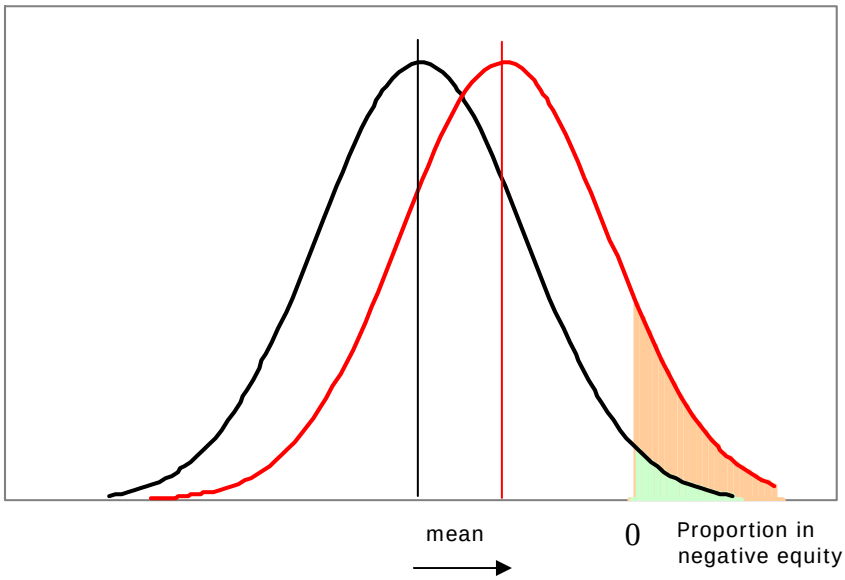
- the debt service ratio (the product of the mortgage interest rate and the level of debt divided by disposable income)
- an estimate of the incidence of negative equity (based on the ratio of average mortgage debt to average home prices) and
- the unemployment rate

These models have long-run or 'equilibrium' solutions in which the respective arrears and possessions rates depend on the level of these three economic drivers, loan quality and policy. However, in the short run, arrears and possessions rates typically diverge from these long-run or 'equilibrium' solutions and an adjustment process operates, to narrow the gap.

A key innovation in this research is estimating the *joint effects of policy interventions and of lending quality*, broadly conceived, on possessions and arrears. The models utilise dummy-based equations capturing difficult to measure institutional changes in lending quality and policy.

A second important innovation in the new models is the theory-justified use of an *estimate of the proportion of mortgages in negative equity*, calibrated on micro data and based on the ratio of average debt to average equity. This takes into account a crucial 'non-linearity' not considered by previous researchers: in current circumstances of high debt and lower house prices, a rise in the average debt equity ratio results in negative equity rising at a faster rate than would normally be the case. This is illustrated in Figure 5, which shows the proportion of mortgages with negative equity as the area under the right tail of the distribution of log debt/equity. The figure makes it clear that, say, a five percent rise in average debt/equity, shifting the distribution to the right, would result in a much more than five percent increase in the area under the tail.

Figure 5: The impact of an increase in the average debt equity ratio on the proportion of mortgages in negative equity



Source: Authors own calculations, illustrative impact of a shift in the average debt equity ratio on the proportion of mortgages in negative equity

Another innovation is the systematic treatment of *measurement bias in the months in arrears count of mortgages* with payment difficulties[7]. When interest rates decline, the immediate effect is to *increase* the *months* in arrears count of mortgages; however, the *percentage* in arrears count of mortgages with arrears exceeding, say, 5 per cent of the mortgage, is unaffected, and should soon start to decline as lower rates reduce payments. Figure 2 illustrates the rise in the ratio of mortgages six months in arrears to mortgages 5 per cent in arrears with the fall in interest rates in 2009.

The fourth innovation is that the assumption in previous studies on UK aggregate data, Breedon and Joyce (1992), Brookes et al. (1994), Allen and Milne (1994) and Cooper and Meen (2001), of a proportional relationship between possessions and arrears is relaxed.

Measuring policy can have two aspects: capturing increased forbearance which lowers possessions but increases arrears; and increased income support for those with payment difficulties, which lowers both possessions and arrears. Increased forbearance has a direct effect on arrears, since every mortgage already in arrears which does not move into possession then swells the arrears count. There is also an incentive effect, since knowing that lenders are more lenient on possessions permits households to be less rigorous in reducing debt. Previous UK research on possessions and arrears has not considered these policy effects.

Lending quality is difficult to measure directly. Since 1968, micro data have been collected from mortgage lenders on loan-to-value and loan-to-income ratios. The UK literature on arrears and possessions has used these as indicators of lending quality or credit availability or both. These indicators cannot be pure measures of lending quality as they depend also on interest rates, house prices, incomes and other factors (Fernandez-Corugedo and Muellbauer, 2006). Moreover, the available data are not fully comparable over time. The original survey, based on a five percent sample of building society

[7] This has not been systematically treated by previous authors; though see the discussion in Brookes et al. (1994).

mortgages, became unrepresentative of the market as the banks entered the mortgage market from 1980, and as centralised mortgage lenders increased their share of the market from the mid-1980s. The latter suffered possessions rates around three times as large as those of high street banks and building societies, Ford et al. (1995). Coverage was extended to the banks from 1992 in the Survey of Mortgage Lenders (SML), but not to the centralised mortgage lenders. Sample coverage after 2002 included fuller electronic records from some lenders, see Tatch (2003); there may have been problems, however, in classifying borrowers into first-time and repeat buyers. The new Regulated Mortgage Survey (RMS) was introduced in 2005 with a larger coverage of types of lender. There was jump in the fraction of high loan-to-value loans recorded for first-time buyers, and other differences with the SML, Tatch (2006). These data capture only first mortgages, omitting second mortgages and the home equity loans that later added to mortgage debt (LaCour-Little et al. (2009) give US evidence on the relevance for defaults of such further loans). The data also do not fully capture the quality of the screening carried out by lenders. The shares of self-certification and of securitised mortgages rose sharply in 2005-07 (Turner (2009)), and such mortgages have shown higher default rates more recently.

These are the reasons why this paper prefers to use a latent variable, common to all three equations, based on dummies, to capture changes in loan quality. 'Loan quality' affects possessions and arrears rates in the same direction but must necessarily do so with a considerable lag: 'loan quality' does not measure the quality of loans at the time they were issued, but rather the later impact of quality change on possessions and arrears. Two other effects will be reflected by this loan quality indicator. The first of these is from altered access to credit. It is typical that a period of poor quality lending with high defaults will affect bank balance sheets and generate more cautious lenders. This will constrain the refinancing route out of payment difficulties. For instance, dummies reflecting earlier poor quality lending from 1989 and from 2007 will additionally capture reduced refinancing opportunities. The second effect, as noted above, derives from improvements in income support to those with payment difficulties that affect arrears and possessions in the same direction and comprise part of the 'loan quality' function. Examples are the policy shifts announced in 2008, offering more generous income support for the unemployed with mortgages and those already on Pension Credit and Income Support, and the Mortgage Rescue Scheme[8]. The definition and timing of loan quality dummies is described below.

Some data issues

The first issue is the interpolation of bi-annual data. CML publishes quarterly data for arrears, possessions and the outstanding mortgage stock, beginning in 2008. Half-yearly data for earlier years can be interpolated into quarterly data from the early 1980s, and linked to unpublished quarterly data from CML from 1999Q1. The interpolation for arrears, which are stock data, is

[8] The Mortgage Rescue Scheme was intended to help a small minority of vulnerable households and should reduce both arrears and possessions, and hence be part of the 'loan quality' function. However, Homeowners Mortgage Support, which became fully operational in April 2009, was intended to lower mortgage payments for up to two years for those with payment problems expected to be temporary. It should lower possessions and raise arrears and therefore be part of the forbearance policy function.

straightforward, as a smoothed step-function. For the flow of possessions, the interpolation is a bit more complex[9].

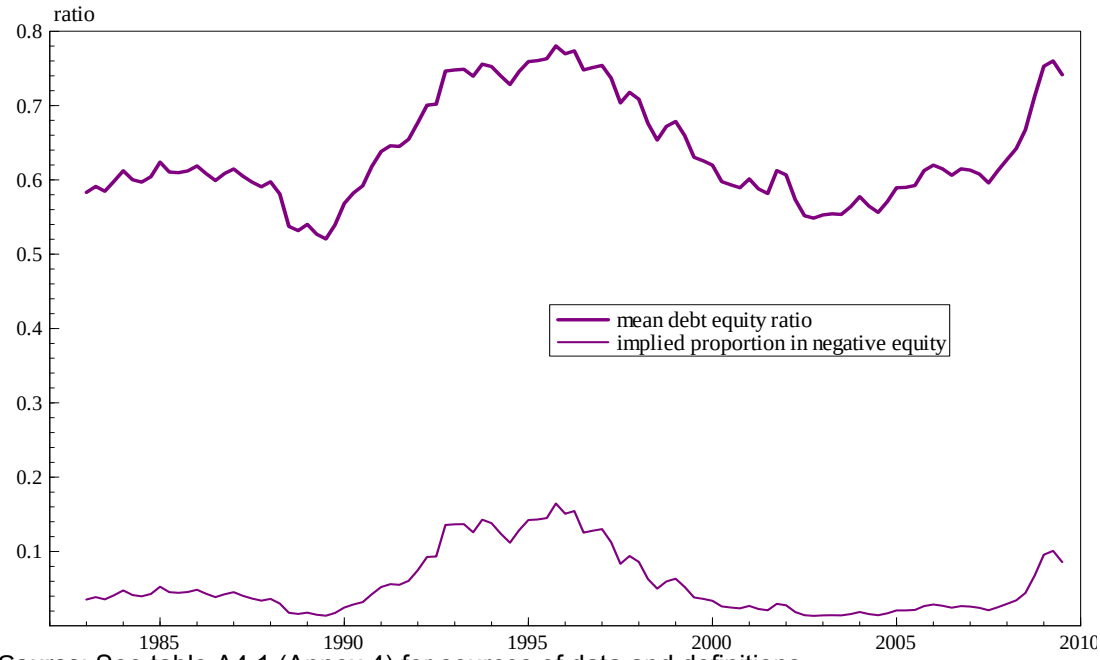
The second issue is the measurement of the debt-equity ratio and negative equity. One commonly used definition of the *ratio of mortgage debt to housing equity* measures equity by the estimated value of the residential housing stock owned by the household sector (as published in the National Income and Expenditure Blue Book, and interpolated to a quarterly frequency). A substantial proportion of owners of housing equity, however, have no mortgages. We prefer, therefore, to adopt a measure defined as the average mortgage for those with mortgages relative to the average house price. We take the mix-adjusted index of second-hand house prices, normalised to the average value of houses traded in some year, as a proxy for the average house price of mortgaged properties.

An estimate of the *proportion of mortgages in negative equity* has been derived from the average debt equity ratio. CML research (Tatch 2009) suggests that between 7.6 per cent and 10 per cent of UK mortgages were in negative equity in February 2009 (using Halifax and Nationwide house price indices, respectively, for the fall in UK house prices between December 2008 and February 2009). CML previously estimated a peak of 17 per cent of mortgages with negative equity in the early 1990s. We assume a figure of 9 per cent for 2009 Q1 and 15.5 per cent for 1995 Q4. The debt equity ratio and the implied proportion of mortgages in negative equity are plotted in Figure 6. Moves in the proportion in negative equity become more pronounced as the average debt equity ratio rises, due to the non-linearity of their relationship[10].

[9] See details in the fuller version of this paper in the Spatial Economics Research Centre discussion paper series.

[10] One further small adjustment is made. It seems likely that a high number of recent possessions would have temporarily depleted the count of mortgages in negative equity, below those implied by the average debt-equity ratio. To take account of this, we subtract the cumulated number of possessions cases over the previous two years, scaled by the number of mortgages outstanding, from the proportion of negative equity.

Figure 6: Average debt equity ratio and the implied proportion of mortgages in negative equity



Source: See table A4.1 (Annex 4) for sources of data and definitions.

Finally, we consider how to model the historical *policy shifts and lending standards*. Table 1 explains the dating of forbearance and other policy shifts, and the expected effects of loan quality and policy shifts on possessions and arrears.

Table 1: The impact of lending standards and policy shifts on arrears and possession

Date	*Shift*	*Arrears Impact*	*Possessions Impact*
1986-1989	Bad lending, reduced credit access at end	Arrears up	Possessions up
End 1991	Forbearance policy shift to reduce possessions	Arrears up	Possessions down
1994/5	Better lending quality	Arrears down	Possessions up
1997	Forbearance policy reversal (back to normal) and SMI lending quality	Arrears?	Possessions up
1999-2006	Good lending quality and/or easy credit access	Arrears down	Possessions down
2007-2009	Bad lending and reduced access to credit	Arrears up	Possessions up
2008q4	Forbearance policy shift to reduce possessions	Arrears up	Possessions down
2008-9	Income support made more generous	Arrears down	Possessions down

We first consider forbearance policy. *Dummy variables* have been used to reflect the policy shifts in December 1991 and the final quarter of 2008.

The December 1991 policy response to the mounting possessions crisis involved an agreement between mortgage lenders and the government. The government acceded to the lenders' request to pay income support for mortgage interest direct to the lenders and also announced a Stamp Duty holiday, while lenders agreed to greater leniency on possessions. After 1995, it seems likely that a gradual return began toward more standard behaviour since, in that year, the government substantially reduced the generosity of SMI, despite lender criticism. We use a smooth S-shaped step dummy (see

below) for 1997 to capture this return to normal, imposing the restriction that the 1991 shift is eventually cancelled out.

In 2008Q4, forbearance policy shifted again, following government discussion with lenders – some of whom the government saved from bankruptcy and so partially owned – to exercise generosity. The industry's mortgage code of practice was also tightened through the Mortgage Pre-action Protocol, and pressure exerted on lenders to conform. The latter shift would have introduced delay on possessions procedures, and implies a partial reversal after a few quarters of the initial impact of the policy shift.

The effects of these policy shifts are opposite in sign on possessions and arrears, as explained above. The impact on possessions is the same in the short-run and the long-run, while the impact on arrears lags behind since it is plausible that incentive effects do not operate instantaneously.

Lending standards evolve more slowly than policy and have gradual effects on mortgage defaults; heterogeneity of individual borrowers and of lender behaviour results in smoothness in aggregate default rates in responding to shocks. The dummy variables have been smoothed to reflect this gradual transition.

The late 1980s and early 1990s and 2007 onwards are obvious candidates for the impact on defaults of periods of lax lending standards. After a default crisis, lending quality always improves, as lenders' experience of bad loans creates caution, and the shortage of funds available for lending induces credit rationing (witness the decline in loan-to-value and loan-to-income ratios since mid-2007). Improved methods of credit scoring and arrears management probably raised lending quality in the later 1990s and early 2000s.

3. The estimation results

Models are simultaneously estimated for total possessions and two different arrears measures (greater than six months and greater than 12 months), together with the proxies of loan quality, broadly conceived, and forbearance policy changes[11]. Details of the equations and the variables are presented in Annex 4.

Possessions and arrears are driven, as noted above, by three economic fundamentals: the debt service ratio; the proxy for the proportion of mortgages in negative equity, calibrated from an average debt to equity ratio; and the unemployment rate. Modelling the three equations as a system with common lending quality and policy shifts helps greatly in the identifying these unobservables.

The research shows that possessions are more sensitive than arrears to negative equity but rather less sensitive to unemployment. Both possessions and arrears are highly sensitive to the debt service ratio.

A 10 per cent increase in the debt-service ratio, for example due to the mortgage interest rate rising from 4 per cent to 4.4 per cent, is estimated eventually to raise the possessions rate by around 19 per cent, and the six month arrears rate by 15 per cent. This calculation holds the proportion of mortgages in negative equity and the unemployment rate fixed. In practice, a higher interest rate would also raise both, so that the full effect is even larger than indicated.

However, to keep these figures in perspective, UK possessions rates in 2009 were running at less than one tenth of comparable US rates.

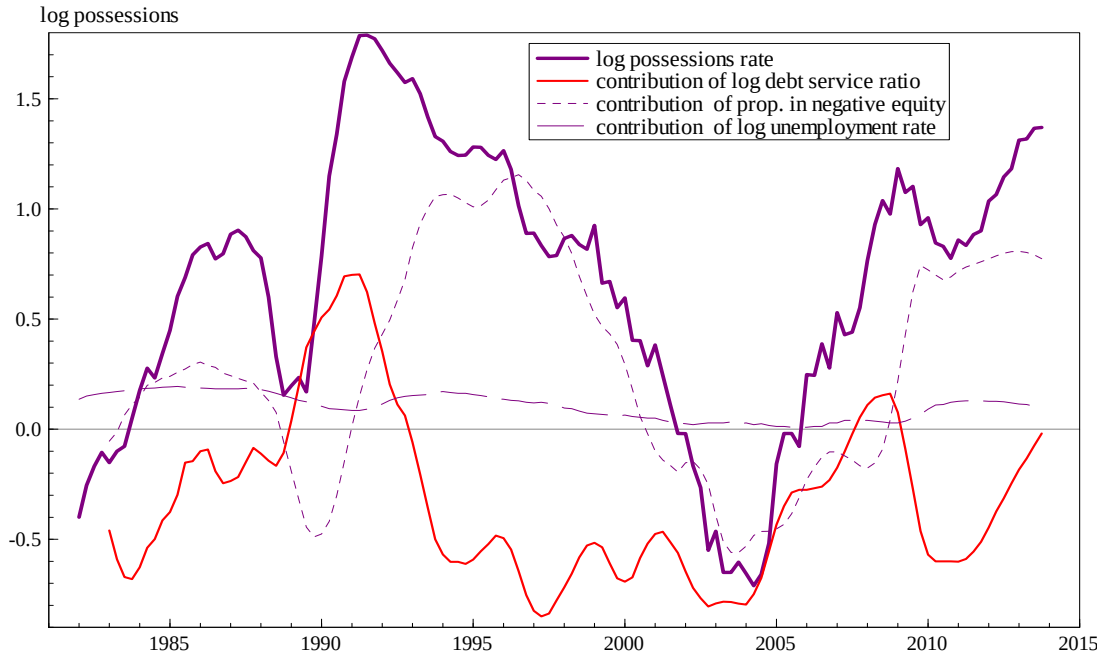
[11] The computations were performed in Hall, Cummins and Schnake's Time Series Processor (TSP 5) package, using TSP's SUR procedure to obtain seemingly unrelated regression estimates of a set of nonlinear equations (the maximum likelihood results were almost identical).

At 2009 Q3 house price and debt levels, a fall in house prices of 1.4 per cent would raise the proportion of mortgages with negative equity from an estimated 8.5 per cent to 9.35 per cent, a 10 per cent proportionate increase. An increase of this magnitude in the rate of negative equity is estimated eventually to increase the possessions rate by 7 per cent and the six month arrears rate by 3.5 per cent.

A 10 per cent increase in the unemployment rate from 8 per cent to 8.8 per cent is estimated to increase the possessions rate by 2 per cent[12] and the six month arrears rate by 10 per cent.

Figure 7 shows the long-run effects on the possessions rate attributable to: the debt service ratio; the estimated proportion in negative equity and the unemployment rate, while the long-run impact of loan quality and forbearance policy are shown in figure 8 (these figures assume a particular economic scenario for 2009-2013).

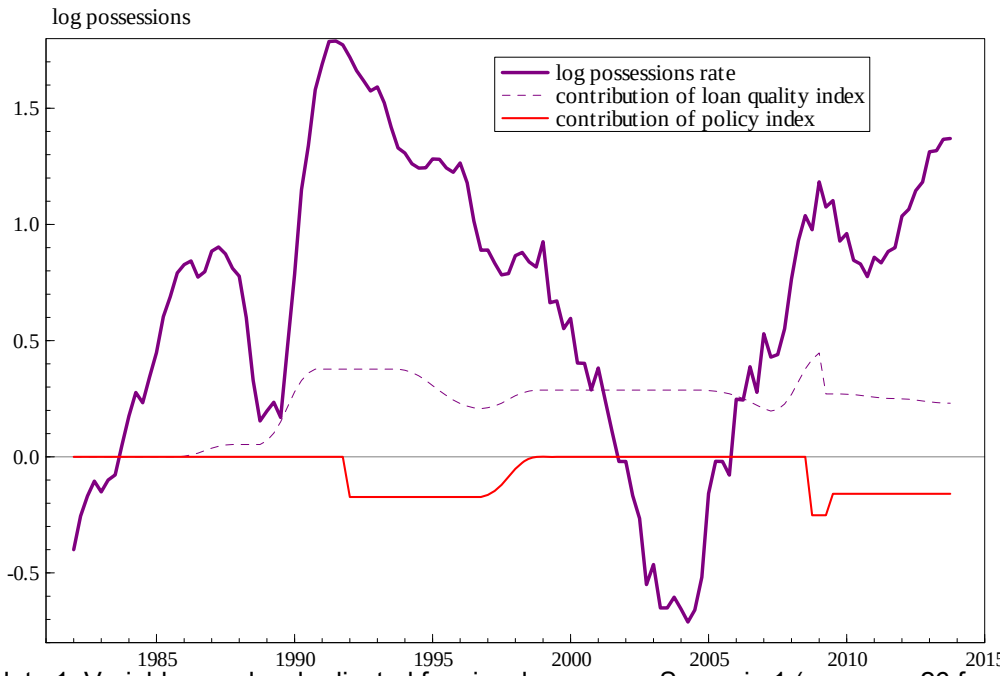
Figure 7: Estimated long-run contributions of key explanatory variables to the log possessions rate



Note 1: Variables are level-adjusted for visual purposes. Scenario 1 (see page 26 for details of this secenario) is assumed for 2009 q4 to 2013 q4.

[12] This estimate is less accurate than the others and the figure could well be as high as 4 per cent.

Figure 8: Estimated long-run contribution of lending standards and policy shift proxies to the log possessions rate



Note 1: Variables are level-adjusted for visual purposes. Scenario 1 (see page 26 for details of this scenario) is assumed for 2009 q4 to 2013 q4.

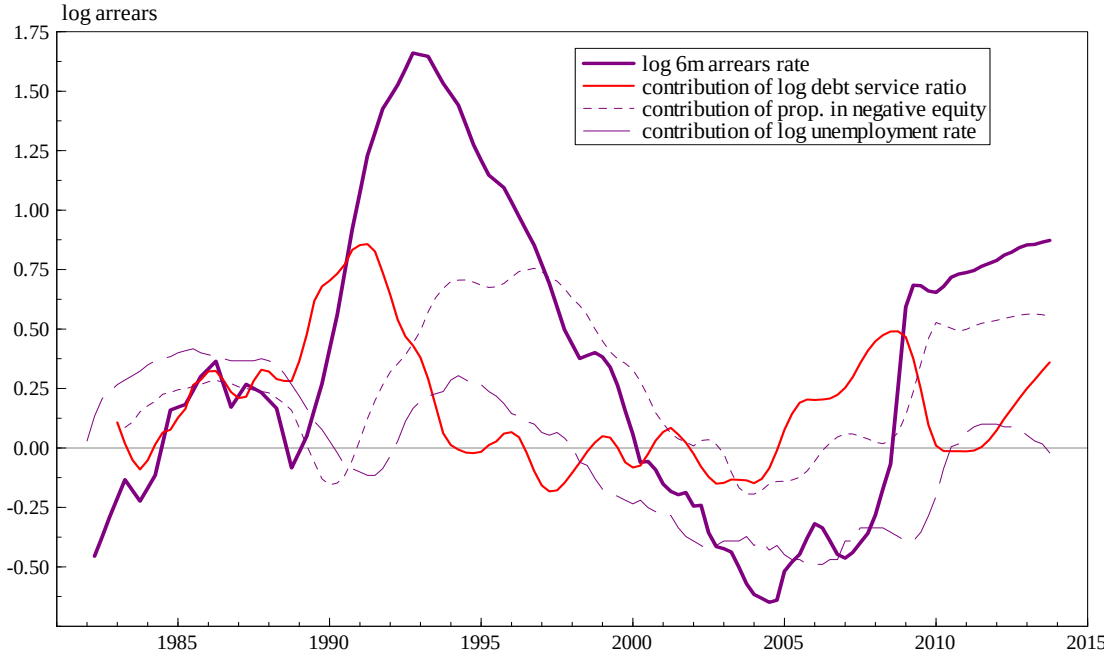
The figures suggest that in the downturn of 1989-93, the initial rise in possessions was driven mainly by the rise in the debt-service ratio, combined with lower loan quality, but later the rising incidence of negative equity emerged as an important driver. The persistence of negative equity prevented a faster decline in possessions, despite lower interest rates and the forbearance policy introduced at the end of 1991. In the more recent downturn, the rise in possessions from its low level in 2004 again was caused by a growing debt-service ratio, and later the increasing incidence of negative equity, which rose sharply in 2008-09[13].

Parallel analyses for the arrears rate, measured by the count of mortgages six or more months in arrears, are shown in Figures 9 and 10. As for possessions, the rise in arrears in 1989-93 was initially driven by the rise in the debt service ratio and lower loan quality. The impact of negative equity,

[13] The fitted long-run contributions shown in Figures 7 and 8 do not quite add up to the possessions rate outcome because they omit the adjustment process and short-run effects, such as the change in the proportion of households in negative equity.

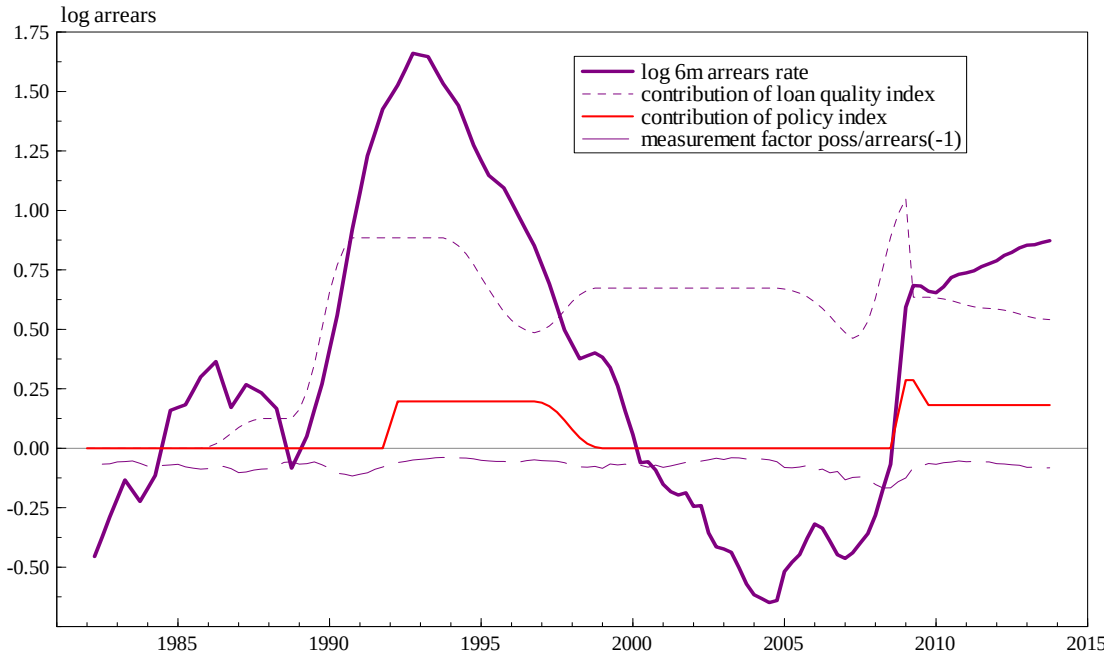
higher unemployment and forbearance policy came later. The contributions of the debt service ratio and of loan quality were larger than for possessions, while that of negative equity was smaller. The rise in arrears in 2008-09 is explained mainly by previous rises in the debt service ratio, the increased incidence of negative equity, the effect of forbearance policy, and, in 2009, by the rise in the unemployment rate.

Figure 9: Estimated long-run contributions of key explanatory variables to the log six month arrears rate



Note 1: Variables are level-adjusted for visual purposes. Scenario 1 (see page 26 for details of this scenario) is assumed for 2009 q4 to 2013 q4.

Figure 10: Estimated long-run contribution of lending standards and policy shift proxies to the log six month arrears rate



Note 1: Variables are level-adjusted for visual purposes. Scenario 1 (see page 26 for details of this scenario) is assumed for 2009 q4 to 2013 q4.

By sharp contrast with earlier UK literature, there is no significant effect on the rate of possessions from either measure of arrears. All published possessions models for UK macro data impose a one-for-one long-run effect of the arrears rate on the possessions rate. Our point estimate of the long-run effect is *negative,* though not significant, but strongly rejects the idea of a one-for-one effect. Since it seems plausible that most possessions cases would first have been in arrears, this rejection of the 'one-for-one' relationship is paradoxical. Most arrears cases do not end in possession, however, which reduces the paradox. The evidence of our preferred model implies that possessions are less sensitive to unemployment (and loan quality) than arrears. Forcing a one-for-one effect of arrears on possessions would then require a counter-intuitive *negative* impact of unemployment (and loan quality) on possessions to offset a too strong effect coming through arrears.

Effects of loan quality, income support, access to refinancing and forbearance policy

Previous research had limited success in addressing the important issue of quality of lending. In the late 1980s and in the mid-2000s there was a mini-version in the UK of the deterioration of loan quality seen in the US sub-prime lending problem. In the late 1980s, this occurred through the entry of centralised mortgage lenders without high street branches operating through intermediaries with little incentive for careful screening of mortgage applications. Analogously, the shares of self-certification and of securitised mortgages rose sharply in 2005-07, and such mortgages are now showing higher default rates. Available loan-to-value or loan-to-income data for first mortgages, used by earlier researchers to capture loan quality, unfortunately miss important parts of the story[14] and also omit second mortgages or re-mortgages. The models in this paper use an index, a weighted combination of dummy variables, guided by institutional knowledge, to capture the joint effect on arrears and possessions of loan quality, access to refinancing possibilities and of increased income support[15]. All shift arrears and possessions in the same direction and it is important to note that 'loan quality' has this broad interpretation. Another index based on dummy variables captures the effect of increased forbearance which lowers possessions but raises arrears.

The estimates suggest that the recent policy of increased forbearance will eventually reduce the possessions rate by around 16 per cent, similar to the early 1990s, see Figure 8, but will raise the fraction of mortgages six or more months in arrears by around 18 per cent, see Figure 10. These figures also show the estimated long run impacts of loan quality, access to refinance and income support. An increase in the loan quality index relative to the early 1980s, particularly in 1989-91, was eventually offset by better lending quality seen in lower defaults in the mid-1990s. The tightening of income support rules announced in 1995, partly cancelled this, with the impact apparent after

[14] Samples used to construct these measures are both not comparable over time and in the past excluded major segments of the market.
[15] In Annex 4, the functions for loan quality (LQ) and forbearance policy (PS) are presented.

1997. A decline during 2005-07 likely reflects the short-run effect of greater access to refinancing possibilities, while the rise in 2007-08 reflects poorer loan quality and the drying up of refinancing possibilities. The estimated net impact declines again in 2009, neutralised by more generous income support[16].

It is difficult to estimate the longer run consequences of large policy shifts that affect loan quality from this relatively short sample. A softening of the SMI rules announced in the second half of 2008 took effect from January 2009. The point estimate suggests the beneficial effect on defaults could offset as much as two-thirds of the damage attributable to lax loan standards and tighter credit. This seems too large and too immediate an effect to attribute entirely to the introduction of more generous income support rules. It probably also reflects strenuous efforts by the government to improve mortgage credit availability[17]. The estimate is based on only two observations; given the estimated standard error, the true effect could be smaller, which will become apparent with more data[18].

[16] An alternative formulation of the loan quality indicator, based on median loan-to-value ratios for first-time buyers (CML data), proved less successful in fitting the data. The estimates suggest a negative short-run affect (probably reflecting access to refinancing), but positive effects of loan-to-value ratios, expressed as four-quarter moving averages at lags of four or more quarters (probably reflecting more slowly evolving loan quality). The estimates of the key economic drivers on possessions and arrears are little affected by adopting the alternative specification of loan quality, however.

[17] This occurred through reversing the previous contraction of Northern Rock's loan book, and agreements of high mortgage lending targets with Royal Bank of Scotland and Lloyds TSB as a condition for allowing them to take part in the Asset Protection Scheme.

[18] Data published by CML on February 11, 2010 suggest that indeed the effect is smaller, as the model forecasts for the last quarter of 2009 proved a little too optimistic both for arrears and possessions.

4. The forecasting results

The results presented above are for a specific economic scenario. A range of other economic and policy scenarios are also considered, useful for policy makers and for risk assessment of the mortgage market and the potential bad loan books of lenders exposed to the UK mortgage market. Forecasts are given for 2009-2013 of total and voluntary mortgage possessions, arrears (six months or more and 12 months or more), based on eight different economic scenarios. These forecasts were generated using the model described above and explained in detail in Annex 4.

The different scenarios apply different assumptions for the exogenous variables: unemployment rates, interest rates (and hence debt service ratios), house prices (and hence debt to equity ratios), and per capita real income and prices. The varying scenarios illustrate possible risk factors in the outlook for arrears and possessions (full details of each scenario are set out in annex 5).

The first five scenarios are broadly based around November 2009 forecasts by Oxfordeconomics.com for underlying variables including interest rates, unemployment rates, inflation, house prices, disposable income, the mortgage stock and working age population.

Key features of the base scenario, *Scenario 1,* are:

- unemployment peaking at 8.6 per cent in 2010 then declining gently to 6.9 per cent by the end of 2013
- interest rates remaining moderate, so that even by mid-2012 mortgage rates are only 100 basis points higher than in mid-2009, rising another 90 basis points to the end of 2013
- house prices dipping a little in 2010, remaining subdued and recovering in nominal terms to end 2009 levels by mid-2012 then rising gently
- inflation is extremely subdued, under 0.5 per cent per annum in 2010, drifting up to around 1 per cent in 2011, under 2 per cent in 2012 and a little over 2 per cent in 2013

- real per-capita income growth is moderate at around 2 per cent per annum from the end of 2009 to the end of 2013
- the mortgage stock grows a little below the growth rate of aggregate nominal personal disposable income

Scenario 2 is a higher growth version of the base scenario, in which unemployment peaks at 8.4 per cent and falls to 6.4 per cent at the end of 2013. Income growth is a little faster and house prices do not fall in 2010, and start rising at first gently, but ultimately by over 4 per cent in 2011, over 5 per cent in 2012 and over 6 per cent in 2013. Interest rates rise earlier in this scenario and from the end of 2010 are around 70 basis points higher than in the base scenario. The mortgage stock grows somewhat faster than in the base scenario, so that by the end of 2013 it is 6 per cent higher than in the base.

Scenario 3 is a lower growth variant of the base scenario, with higher unemployment, lower growth but also even lower interest rates.

These scenarios all make the rather optimistic assumption that mortgage interest rates remain low for an extended period and that the unemployment rate will peak at moderate levels. Alternative scenarios with more volatile interest rates, unemployment and house prices were therefore considered.

Scenario 4 assumes a more rapid fall in unemployment from a higher peak in 2011, an earlier recovery in house price growth and hence earlier rises in interest rates. The mortgage stock assumption is the same as in the base scenario.

Scenario 5 is an optimistic variant of *scenario 4* in which, after rising further initially, unemployment falls rapidly from a peak in 2011 Q1, while interest rates remain remarkably subdued, rising only 150 basis points from 2009 Q2 to 2012 and remaining constant in 2013. House prices rise sharply, at over 6.5

per cent per annum between the end of 2010 and 2013 and the mortgage stock rises more strongly than in the base scenario.

Scenario 6 takes a far more pessimistic case. Unemployment peaks at 11.4 per cent in 2011 and is down only to 8.5 per cent at the end of 2013. Interest rates rise rapidly in 2010, perhaps because of a sovereign debt crisis in the UK, and remain high to the end of 2013. House prices fall in nominal terms in 2010, remain constant in 2011, then recover gradually, reaching nominal levels of end-2009 only by the end of 2013. The mortgage stock grows only in line with working age population and the price level in this scenario.

In each of these scenarios it is assumed that forbearance policy continues to the end of 2013 and modest improvements in loan quality are assumed beginning in 2010 and extended until 2012[19]. This is intended to reflect the improved loan quality on loans made after mid-2007, and an assumed return to more normal lending conditions, albeit under tighter financial regulation under terms still to be worked out under national and international agreements.

In addition to these scenarios, the impact of the forbearance policy and loan quality assumptions are tested in *scenarios 1A and 1B.* S*cenario 1A* makes the base economic assumptions, but assumes that forbearance on possessions comes to an end in 2009 Q4. *Scenario 1B* also takes the base economic scenario as given, leaves policy unchanged from 2009 Q3, but makes a more negative assumption on loan quality that cancels out most of the benefits of more generous income support policies.

Graphical forecasts of the logs of possessions, voluntary possessions, arrears (six months or more) and arrears (12 months or more), for each of eight scenarios, for 2009 Q4 to 2013 Q4, are shown in Annex 6. The underlying assumptions are traced out from 2000 Q1 to 2013 Q4 in the graphs beneath these figures. Detailed forecasts of the numbers of properties taken into

[19] By assuming that parameters 10 and I12 in equation (16), Annex 4 are both equal to -0.02.

possession, and of the numbers of household with loans in arrears (≥12 months and ≥6 months) are given for scenarios 1, 2 and 6 in Table A6.1, at the end of Annex 6.

Despite the assumptions of the continuation of forbearance policy and mild improvements in loan quality in *scenario 1*, the forecast rate of possessions rises to new heights by the end of 2013 after declining in 2010 and 2011. This is mainly due to the assumed rise in the average mortgage size and the relatively weak recovery in house prices. The same factors imply a more gradual upward drift in both measures of mortgage arrears. The gradual fall in the unemployment rate, to which arrears are more sensitive, moderates the rise in the arrears rates after 2010.

Scenario 1A assumes that forbearance on possessions ceases from 2009 Q4 which, by the end of 2013, raises possessions flows by 19 per cent, but lowers six-month arrears by 46 per cent and 12-month arrears by 40 per cent compared to *scenario 1*. It is unlikely that such a policy shift would occur. The model suggests that forbearance policy is having a large effect on outcomes from 2009.

Scenario 1B assumes that just over half the improvement seen in 2009 Q2 and Q3 (e.g. due to improved income support for those with payment difficulties) is switched off from 2009 Q4, thus lowering loan quality. In addition, small improvements in loan quality due to tighter lending criteria from mid-2007 are now assumed away – or offset by lack of access to refinancing possibilities. Not surprisingly, both possessions and arrears deteriorate relative to *scenario 1* by the end of 2013, by 15 per cent for possessions, 43 per cent for six-month arrears, and 65 per cent for 12-month arrears.

The larger falls in unemployment and rises in house prices in *scenario 2* are partially offset by higher interest rates and the growth in mortgage debt. The net effect is that possessions dip in 2010 and 2011, as in *scenario 1*, but they rise again in 2012 and 2013, not quite to the 2009 Q1 peak and substantially below *scenario 1*. Arrears rates peak at the end of 2010 for six-month arrears

and the end of 2011 for 12-month arrears, but are lower almost throughout than in *scenario* 1 (by 23 per cent for six months and 11 per cent for 12 months by 2013).

In *scenario 3,* higher unemployment, weaker house prices, but lower mortgage interest rates induce lower possessions rates than in *scenario 1*, but arrears rates are higher. By the end of 2013, possessions are 6 per cent lower, six-month arrears 5 per cent higher and 12-month arrears 4 per cent higher. The fact that *scenario 3* is only a little worse than *scenario 1* is a symptom of the sensitivity to mortgage interest rates.

In *scenario 4*, possessions decline a little in 2010 but then climb more sharply than in *scenario 1*, as interest rates rise more, and peak in early 2013. Arrears rates peak in 2012 above those in *scenario 1* given a higher unemployment peak, but then decline strongly under the impact of rapidly declining unemployment and rising house prices.

Scenario 5 considers a positive, high volatility economic environment. Possessions decline in 2010, climb a little in 2012 and 2013, but remain well below 2009 peaks, given strong house price growth despite some rise in interest rates and in average mortgage debt. Sharper rises in unemployment and the lagged response of arrears to the shift in forbearance policy causes arrears to exceed 2009 levels in 2010 before falling substantially below 2009 levels thereafter, with sharply falling unemployment and rising house prices.

Finally, *scenario 6* assumes a negative, high volatility economic environment. In this 'disaster' scenario, possessions in 2012 are almost four times higher than in 2009, though still far below US rates experienced in 2009, and both types of arrears are almost three times above 2009 levels. The combination of higher interest rates and weak house prices is bad for possessions. Unemployment peaking at 11.4 per cent is a further factor raising arrears. The combination of assumptions for the underlying variables is unlikely to happen in practice; this scenario is extremely pessimistic and included mainly to highlight the sensitivity of forecasts to the path of the economy.

Figure 11: Forecast aggregate possessions and arrears numbers, under four scenarios.

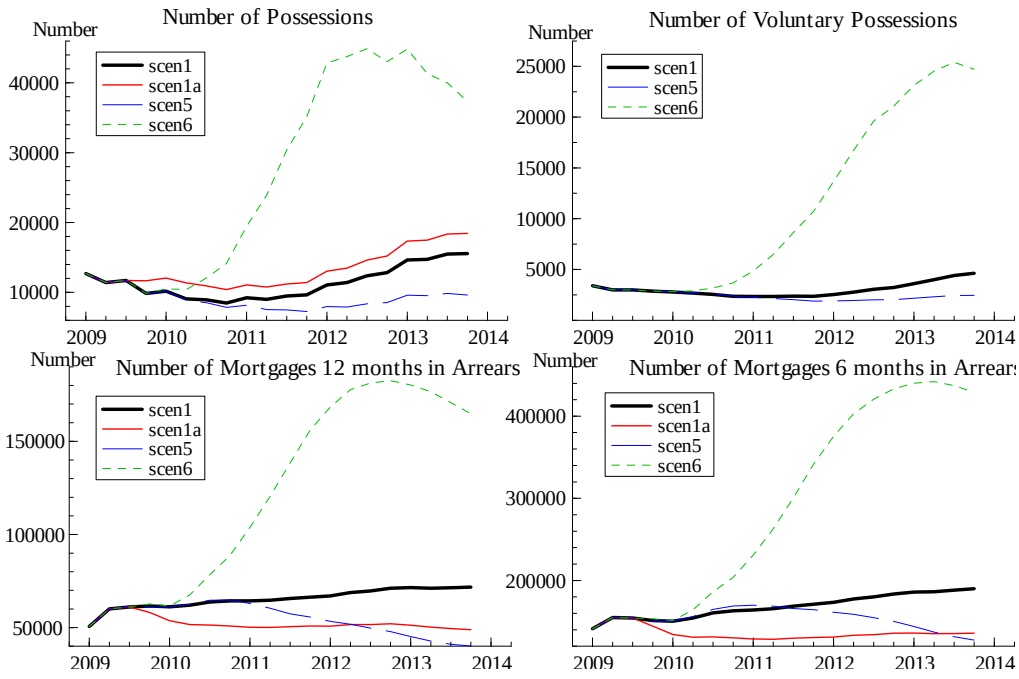


Figure 11a to d shows the total and voluntary possessions rate and the two arrears rates under four of the scenarios[20]. These are the base scenario and its variant scenario 1a, which switches off forbearance policy, and respectively the most positive and the most negative of the economic scenarios considered. It is striking how the most negative scenario stands out. It is driven by an assumed rise in interest rates which pushes down house prices and so raises negative equity and the unemployment rate. In the other scenarios, interest rates are mainly determined by economic success or otherwise, so that weaker growth is compensated by lower interest rates, while stronger growth is partly offset by higher rates. This means that the effect on arrears and possessions is also moderate under these scenarios.

These scenarios dramatise the sensitivity of mortgage possessions and arrears to interest rates. The length of horizon considered is three years since

[20] Forecasts for the other scenarios will lie between the extremely pessimistic scenario 6 and the optimistic scenario 5, but closer to the latter. These have been not been included in figure 11 to avoid over complicating the graphs, full details of these forecasts can be found in annex 6.

over such a relatively short horizon the average size of mortgage is unlikely to change very much. For a longer term outlook, it would be necessary to model the average mortgage stock and house prices, bringing in assumptions on the availability of mortgage finance, as well as on rates of house-building, interest rates, income and unemployment. Possible feedbacks from possessions, and perhaps arrears, on to house prices and the mortgage stock can then be checked[21].

[21] Evidence from annual regional data in Cameron et al. (2006) is that a downside risk measure, based on recent negative investment returns, outperforms the aggregate possessions rate in explaining house prices. The direct feedback from possessions to house prices may not be so important, therefore.

5. Conclusions

Models for aggregate arrears and possessions rates have been developed in this paper, with sound economic foundations. These incorporate policy shifts and proxies for loan quality that affect arrears and possessions rates in predictable directions at particular times. Jointly estimating a three-equation system for the arrears and possessions rates, with cross equation restrictions, results in plausible magnitudes for the effects of policy shifts and lending quality. Parsimonious arrears and possessions models were tested successfully against more general specifications. The long-run impact of four major drivers, house prices, interest rates, debt levels, and income, is captured by just two coefficients: on the debt equity ratio, transformed into a proxy for the fraction of mortgages with negative equity; and on the debt service ratio. Tests for interaction effects, e.g. whether the effect of unemployment was higher in years where negative equity was more prevalent, found no supporting evidence.

The measurement distortion in the months-in-arrears measure was handled systematically, with the help of parameter restrictions. The analysis of different forecast scenarios allows an assessment of risks for different views on the UK and global economies. There are inevitable uncertainties around the evaluation of temporary and permanent effects of recent policy shifts, however, and of the decline in lending quality in recent years. With further data these estimates should become more accurate.

A notable conclusion of this research is to demonstrate the striking sensitivity of arrears and possessions to higher interest rates. If UK short-term interest rates were to increase mortgage rates would also increase, though probably by a smaller amount[22]. The bad loans resulting from significantly higher mortgage rates could further impair the financial system, reducing economic

[22] In late 2009 the spread between mortgage rates on new loans and base rate was close to 350 basis points, with base rates at 0.5%. It seems likely that the spread would narrow with base rates at 1.5 or 2 %. Also with slightly higher base rates and hence higher deposit rates, retail saving flows into banks are likely to improve, perhaps easing credit constraints on lending.

growth. However, as noted above, mortgage possessions rates in 2009 in the UK were under one-tenth of US rates so that the magnitude of the risks should not be overstated.

A second conclusion is that lenders' forbearance policy and the more generous government income support for those with mortgage payment difficulties at present appears to have had a notable effect in lowering possessions. As noted in the introduction, conditions in mortgage and housing markets in the UK have been far more benign in 2009 than feared in the autumn of 2008. This has been achieved through policy interventions on an unprecedented scale, including the drastic reduction in base rates, and large-scale quantitative easing by the Bank of England, which brought down gilt yields and reduced rates on fixed rate mortgages. The bank rescues, and the direction given to expand mortgage lending, not only to Northern Rock (now wholly owned by the public sector), but also to Royal Bank of Scotland and Lloyds-TSB as a condition of rescue, have compensated significantly for the evaporation of lending from other sources, especially those financed by securitisation. In addition, there has been a Stamp Duty holiday, and a raft of further support measures already discussed. The sustainability of these relatively benign conditions is questionable, however, given the funding gap between retail deposits in UK banks and their loan book[23], and concern over the UK's sovereign debt.

Two UK government objectives are to improve housing affordability and to restore financial stability. Housing has become unaffordable for many younger people, perpetuating the inequality from the redistribution of housing wealth of the late 1990s to 2007, from potential first-time buyers to older and wealthier households. However, substantial falls in house prices, triggered by the removal of income support, higher interest rates and potentially by supply and demand side reforms, could increase negative equity and exacerbate the problem of bad banking loans. It would, however, be a mistake to take the risk of substantial falls in house prices as an excuse for not expanding residential

[23] See CML (2010) for an analysis of the funding gap.

land supply. For if reforms of the planning system and of incentives for local governments to expand the supply of residential building land were to increase the rate of future building, CLG's housing affordability model and research done for the Barker reviews both suggest that the effects on house prices would be felt only gradually. A further advantage in the short-run would be employment gains in the building industry at a time when the public sector will be shedding jobs. In the long-run, a more sustainable level of house prices relative to the financial capabilities of households should reduce the risk of new crises.

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Annex 1: Typology of Published Estimates on Mortgage Arrears and Possession

Table A1.1: Typology of Published Estimates on Mortgage Arrears and Possessions

Source	***Category***	***Frequency and historical samples***			***Units and seasonal adjustment***	***Definition of coverage***
		Annual	***Quarterly***	***Bi-annual***		
LOANS DATA						
CML	Mortgages outstanding	1969-2008	*Published:* 2008q1 onward *Unpublished:* 1999q1-2007q4	1981:h2 onward	Reported as number at end period	For BTL only, CML estimates lending figures where these are not reported, see below.
CML	BTL properties: mortgages outstanding	1998-2008	2008q1 onward	2005:h2 onward		
FSA	Number of loan accounts	2008q1 onward	2007q1 onward	2008q1 onward	Reported as number at end period	
ARREARS DATA						
CML data: no. of households more than x months in arrears and no. of households whose arrears total x% or more of the total outstanding balance on their mortgage						
CML	Arrears ≥6-12 months	1969-2008	*Published:* 2008q1-2009q2 *Unpublished:* 1999q1-2007q4	1981:h2 onward	Reported as number at end period *and* as % of all loans end period. Arrears figures are rounded to the nearest 100. Figures are not seasonally adjusted.	*Definition*: All first charge loans held by CML members, both regulated and unregulated, are included. This includes Buy-to-Let (BTL). Non-CML members are excluded Other secured lending is also excluded. Properties in possession are not counted as arrears. BTL mortgages when a receiver or rent has been appointed are not counted as arrears. *Sample*: Estimates from a sample of CML members, "grossed up" to represent the membership as a whole. Not clear how representative this sample is or how it changes over time. For BTL only, CML estimates lending figures where these are not reported.
CML	Arrears ≥12 months	1982-2008		1982:h1 onward		
CML	Arrears ≥3-6 months	1994-2008		1994:h2 onward		
CML	Arrears ≥3 months	1994-2008		1994:h2 onward		
CML	Arrears 2.5%<5%	1994-2008		1994:h2 onward		
CML	Arrears 5%<7.5%	1993-2008		1993:h1 onward		
CML	Arrears 7.5%<10%	1993-2008		1993:h1 onward		
CML	Arrears ≥10%	1993-2008		1993:h1 onward		
CML	BTL properties: arrears ≥3months	1998-2008	2006q3 onward	1998:h2 onward		
CML	BTL properties in arrears with ROR newly appointed, in period	2006-2008	2006q3 onward	2005:h2 onward		
CML	BTL properties in arrears with ROR acting on lender's behalf, end period	2005-2008	2006q3 onward	2005:h2 onward		

Source	***Category***	***Frequency and historical samples***			***Units and seasonal adjustment***	***Definition of coverage***
						Members: Drawn from Scotland, Wales and England (see App 1). Note clear on whether the coverage is equally good in each region and over time.
FSA data: number of individual loan accounts in arrears						
FSA	New cases in quarter		2007q1 onward	-	Reported as number of loan accounts, amount in £m, balance outstanding in £m, or new cases as % total stock Figures are not seasonally adjusted.	*Disaggregation*: all FSA data for residential loans to individuals in the column 2 are separately presented in six different categories: A. Securitised loans 1. Regulated + Non-regulated 2. Non-regulated 3. Regulated B. Unsecuritised and securitised loans 4. Regulated + Non-regulated 5. Non-regulated 6. Regulated *Definition*: All first charge loans, both regulated and unregulated, held by firms regulated by the FSA, are included. Firms not regulated by the FSA, are excluded. Second and subsequent charge loans are also included (i.e. any loan secured on a property for which a separate first charge loan already exists). Hence, Buy-to-Let mortgages (BTL) are covered, but not if extended by unregulated firms (many second charge lenders are not regulated). Some further advance loans are also included from first charge lenders. Properties in possession are counted as arrears, see previous column. Note ♪ lower threshold than for CML. Note: contrasts with the CML data which refers
FSA	1.5<2% in arrears ♪		2007q1 onward	-	Reported as number in arrears, % all loans, balance in arrears, or % total loan balance Figures are not seasonally adjusted. Total includes cases in possession	
FSA	2.5<5% in arrears		2007q1 onward	-		
FSA	5<7.5% in arrears		2007q1 onward	-		
FSA	7.5<10% in arrears		2007q1 onward	-		
FSA	≥10% in arrears		2007q1 onward	-		
FSA	Total in arrears		2007q1 onward	-		

Source	***Category***	***Frequency and historical samples***			***Units and seasonal adjustment***	***Definition of coverage***
						to no. of borrowers in arrears: here it is no. of loan accounts in arrears. *Sample*: 100% of regulated firms. *Regulated firms*: UK-wide.
POSSESSIONS DATA						
CML data: number of possessions						
CML	Properties taken into possession in period	1970-2008	*Published:* 2008q1 onward *Unpublished:* 1999q1-2007q4	1982:h1 onward	Reported as number at end period *and* as % all loans end period. Rounded possessions figures to the nearest 100. Figures are not seasonally adjusted.	*Definition*: All first charge loans held by CML members, both regulated and unregulated, are included. This includes Buy-to-Let (BTL). Non-CML members are excluded Other secured lending is also excluded. Voluntary repossessions are included. *Sample*: Estimates from a sample of CML members, "grossed up" to represent the membership as a whole. Not clear how representative this sample is or how it changes over time. For BTL only, CML estimates lending figures where these are not reported. *Members*: Drawn from Scotland, Wales and England (see App 1). Not clear on whether the coverage is equally good in each region and over time.
CML	Properties in possession at end period	1990-2008		1990:h2 onward		
CML	Voluntary possessions	1994-2008		1994h1 onward		
CML	Possessed properties sold in period	1997-2008		1997:h1 onward	Number	
CML	BTL Properties taken into possession in period	2006-2008	2006q3 onward	2005:h2 onward	Reported as number at end period or % all loans	
CML	BTL Properties in possession at end period	2005-2008	2006q3 onward	2005:h2 onward		
MoJ data: possession claims issued or orders made in the county courts						
Possession actions England and Wales						
MoJ	Actions entered (number of possession claim issued in the county courts) There are also data on:	1987-2008	1989q2 onward	-	Both seasonally adjusted and non-seasonally adjusted figures are given (adjustment using X12	Mortgage data include all types of lenders whether local authority or private (e.g. banks and building societies). Landlord data include all types of landlord whether social or private sector, and cover actions made using both the

Source	***Category***	***Frequency and historical samples***			***Units and seasonal adjustment***	***Definition of coverage***
	No. of Landlord possession claims				ARIMA).	standard and accelerated possession procedures. parties to a hearing. Voluntary repossessions are not included.
MoJ	Number of possession orders made (incl. suspended orders) There are also data on: No. of Landlord possession orders made (incl. suspended orders)	1987-2008	1990q1 onward	-	Data are disaggregated into court regions back to 1987.	Note: The mortgage possession figures do not indicate how many houses have actually been repossessed through the courts. Repossessions can occur without a court order being made while not all court orders result in repossession.
MoJ	Orders suspended	1990-2008	1990q1 onward	-	Comparability over time is affected by new court jurisdictions being incorporated.	
MoJ	Charging orders applications made	2001-2008		-		
MoJ	Charging orders granted	2001-2008		-		
Possession actions Northern Ireland						
NI Court Service	Writs and summonses	1991-2007	1991q1-2007q4			
FSA: number of individual loan accounts in possession						
FSA	New possessions in quarter		2007q1 onward	-	Number. Figures are not seasonally adjusted.	*Definition*: All first charge loans, both regulated and unregulated, held by firms regulated by the FSA, are included. Firms not regulated by the FSA, are excluded. Second and subsequent charge loans are also included. Hence, Buy-to-Let mortgages (BTL) are covered, but not if extended by unregulated firms (many second charge lenders are not regulated). Voluntary repossessions are included. *Sample*: 100% of regulated firms. *Regulated firms*: UK-wide. Note: contrasts with the CML data which refers to no. of borrowers subject to possession: here it is no. of loan accounts in possession
FSA	Possessions cases sold in quarter		2007q1 onward	-		
FSA	Stock at end- quarter		2007q1 onward	-		

ANNEX 2: Conceptual framework: the double trigger model for defaults.

There is general agreement that mortgage defaults or possessions result from some mix of excessive debt relative to home equity and cash flow problems. This is consistent with the 'double trigger' approach, a more general view of mortgage possession than the option pricing approach popular in some of the US literature, see Kau et al. (1992) and Deng et al. (2000), and applied to UK data by Ncube and Satchell (1994). In the option pricing model, default is chosen by the household once housing equity falls below the mortgage debt level by a given percentage, which depends mainly on house price uncertainty. Even in the US, where mortgages in many states are non-recourse loans (i.e. where the lender's rights are restricted to the equity in the home, excluding recourse to the borrower's income or other assets), doubt has been cast on this 'ruthless default' literature (Vandell, 1995). Recent empirical literature adopts a more general approach that encompasses cash flow problems, for example, Gerrardi et al. (2008) and Foote et al. (2008).

A thorough early exposition of the double trigger model is by Elmer and Seelig (1998). A recent exposition and application to US micro data on sub-prime mortgages is by Bajari et al. (2009). They argue that, abstracting from variations in interest rates, default for household i at time t, due to a weak net equity position, occurs when

$$\log\left(\text{mortgagedebt}_{it} / \text{equity}_{it}\right) > c_{it} \qquad (1)$$

where the threshold c_{it} depends positively on the expected growth rate of house prices, given transactions delays, and also on house price volatility (Bajari et al. (2009), equation (4), p.10). They argue that when interest rates can change, c_{it} depends additionally on an interest rate term (equation (10), p. 13). Default due to a weak net equity position can occur even if the household does not have cash flow problems. This is particularly relevant in the US where, in states such as California, borrowers have a 'walk away' option so that their liability is confined to the value of the home.

Default can also occur because of cash flow problems induced by credit constraints, when a function of the debt service ratio exceeds a threshold. Bajari et al. argue that this function depends also on the credit worthiness of the household, its employment status and its expected income growth (their equation (13), p.15). This can be expressed by a trigger function being positive:

$$f(\text{debt service ratio}_{it},\ ur_{it},\ cs_{it},\ \Delta y_{it}^{e}) > 0 \qquad (2)$$

where ur is the household's unemployment rate, cs its credit score and Δy^e represents its expected income growth. Bajari et al. embed condition (1) in a stochastic utility model, so that if the utility associated with this type of default is positive, the household will default. Condition (2) is treated as an aspect of the budget constraint, outside the control of the household. Default then occurs if either or both conditions are fulfilled. This is modelled as a bivariate probit, given some unobserved stochastic components reflecting tastes and household characteristics.

There is a problem with this formulation. It makes little sense for a household with positive net housing equity to default, even when there are cash flow problems. With positive equity, such households may have refinancing possibilities or could sell the home rather than lose it through possession. It seems more plausible that default condition (2) should be replaced by:

$$\begin{aligned} &f(\text{debtservice ratio}_{it},\ ur_{it},\ cs_{it},\ \Delta y_{it}^{e}) > 0 \\ &\textit{and} \quad \log\left(\text{mortgage debt}_{it} / \text{equity}_{it}\right) > c_{0t} \end{aligned} \qquad (3)$$

The parameter c_{0t} is likely to be negative since significant positive equity is likely to be needed for refinancing, while transactions costs need to be covered when selling. Then default occurs if *either* condition (1) *and/or* condition (3) are fulfilled. This differs from the either/and or condition specified by Bajari et al. since it suggests that problems with debt relative to equity are present in all defaults.

Given individual heterogeneity and knowledge of (or assumptions on) the distributions of the observables (such as the debt/equity ratio) and of the unobservables (such as tastes) at the micro level, one could obtain the aggregate proportion of defaults as a function of the means of the observables and of the parameters of the distributions. Without knowledge of the distributions of observables and unobservables, the functional form of the relationship between the aggregate proportion of defaults and the means of the observables is unknown, but in general will be non-linear. Specifically, there is an important common element in conditions (1) and (3) involving a threshold for log (mortgage debt/equity). Although c_{0t} is expected to be a little below zero (e.g. from transactions costs), while option pricing theory implies c_{it} would be a little above zero, the proportions of households satisfying each

condition should be highly correlated with the proportion in negative equity (the proportion for whom log (mortgage debt/equity) exceeds zero).

On specific assumptions, it is possible to derive a simple relationship between the proportion of households with negative equity, and mean debt and mean equity. Suppose, for example, that debt and equity have log-normal distributions, so that the log (mortgage debt/equity) is also normally distributed. The proportion of mortgages with negative equity, i.e. log (mortgage debt/equity) greater than zero, is then given by the normal distribution function $F(\mu, \sigma; 0)$, with the mean of log (mortgage debt/equity) denoted by μ and its standard deviation by σ. As the mean of the distribution shifts to the right, the area under the tail increases proportionately *more* than does the mean. For the log-normal distribution, there is a simple relationship between the mean of log debt, which we do not observe, and the log of mean debt, which we do observe; and, correspondingly for the mean of log equity.[1] The logistic function is a good approximation to the normal, with a distribution function implying:

$$\begin{aligned} &\text{proportion of negative equity} \\ &\quad = 1 / (1 + \exp(-\lambda\ (\text{mean logdebt/equity})) \\ &\quad = 1 / (1 + \exp(-\lambda\ (\log(\text{mean debt/mean equity}) - \lambda_0)) \end{aligned} \tag{4}$$

where λ_0 is half the difference in the variances of log debt and log equity. Given data on the ratio of mean debt to mean equity, and estimates based on micro data of the proportion of households with negative equity, the coefficients λ and λ_0 can be calibrated to match the estimated proportion of negative equity to the micro data. This equation should yield a good time-series approximation to the most important non-linearity in the relationship between the aggregate rate of possessions and the means of its fundamental drivers. A further advantage is that if later estimates of negative equity based on micro data become available, the relationship could be recalibrated for improved accuracy.

In the UK, unlike the US, it is probable that relatively few possessions cases arise through condition (1) since the consequences of possession are more painful. Mortgage borrowers can be pursued for up to six years for negative equity remaining after the lender has sold off a home in possession (by contrast with non-recourse mortgage loans and 'walk away' options in the US).

The probability associated with condition (3) can be written as the product of the probability of 'bad (debt/equity)' and the probability of a 'bad trigger' given 'bad (debt/equity)'. Modelling the log of the probability, i.e. the log possessions rate, results in an additive model. If the two events

[1] It is well-known that if X is log normally distributed, then $\log EX = E \log X + 0.5 \text{Var} \log X = \mu + 0.5\sigma^2$.

in condition (3) were independent, the log possessions rate would be given by a function of (debt/equity) plus a function of the means of the variables appearing in the trigger function, i.e. the debt service ratio, unemployment etc.. A log-linear formulation can thus be used in which the log possessions rate is driven by the log of the unemployment rate, the log of the debt service ratio and the log of the imputed proportion with negative equity. In addition, without data on the aggregate credit score, an aggregate loan quality indicator is needed (section 3.3.2).

The reasoning just set out for modelling the possessions rate can be adapted for modelling mortgage arrears or 'payment delinquencies'. As noted in section 2.2, the US literature is here sparser than that on possessions. The count of mortgages exceeding a threshold level of arrears (such as 6 months of regular payments, or 5 percent of mortgage debt.) measured relative to the total number of mortgages, should be governed by a less stringent version of condition (2). The debt equity ratio is also important for determining the arrears count. The outflow from an arrears count above a given threshold enters one of four states: possession; partial (or full) repayment in order for arrears levels to fall below the threshold; the sale of the property; or refinancing. The last two options may be blocked by low net equity. Thus, the proportion of mortgages in negative equity is likely to have a significant effect on the arrears count. The relative importance of the cash flow drivers, however, the debt service ratio and unemployment, is likely to dominate the proportion in negative equity in the arrears equation, particularly for lower arrears thresholds. While a poor debt equity ratio is a necessary condition for possession for rational households, arrears can arise without the household necessarily being close to negative equity.

ANNEX 3: Estimation methodology.

The models for possessions and arrears are formulated in an equilibrium correction form, illustrated as follows for the log possessions rate:

$$\Delta \log poss_t = a_4(a_0 + \sum_{l=1}^{n} a_l X_{l,t} + LQ_t + PS_{t-1} - \log poss_{t-1}) + \sum_{l=1}^{n}\sum_{j=0}^{k} \beta_{l,j} \Delta X_{l,t-j} + \sum_{j=1}^{k} c_j \Delta \log poss_{t-j} + \Delta PS_t + \varepsilon_t \quad (5)$$

The dependent variable is the quarterly change in the log possessions rate.[1] The equilibrium correction term is defined in terms of levels of the key drivers in a vector X of variables, and the loan quality and policy functions, LQ and PS . The speed of adjustment to long run equilibrium is a_4. The long-run relationship between the log possessions rate and the long-run X variables, loan quality and policy function is thus:

$$\log poss = (a_0 + \sum_{l=1}^{n} a_l X_l + LQ + PS) \quad (6)$$

The set of X variables includes an estimate for the proportion of mortgages in negative equity (see equation (4), Annex 2), the log mean debt service ratio, the log unemployment rate and potentially a measure of mortgage arrears. Note that among the short-run effects, ΔPS_t appears with a unit coefficient. This imposes the testable restriction that the short and long-run effects of policy are identical.

It is important to distinguish between two types of policy shifts. First, forbearance exercised by lenders and the courts lowers possessions, other things being equal, but raises arrears. The second type of policy shift relaxes the economic constraints faced by households, for example by making income support more generous, hence shifting possessions and arrears in the same direction.

[1] The log formulation, used in our models, has the advantage of plausible multiplicative effects, but may exaggerate movements at low levels of possessions, e.g. in 2004, unless the explanatory variables similarly reflect these extremes. We find, however, that the log of the estimated proportion of mortgages with negative equity, together with the log of the debt service ratio, does an excellent job in capturing these low levels.

The arrears models have a broadly similar structure to the possessions equation (5), and are applied to data on the proportion of mortgages that are more than 6 months and more than 12 months in arrears. There are two key differences from the possessions equation: the first concerns the role of policy, which has the opposite-signed effect on arrears from that on possessions; the second arises from the correction of a bias from the commonly used "months-in-arrears" measure.

Beginning with forbearance policy, two channels affecting arrears must be distinguished. One arises from a stock-flow relationship with possessions. If all possession cases were previously at least 6 months in arrears, then a reduction in the number of possessions cases should raise the arrears count by a similar number, other things being equal. To be more precise, the change in the count of any measure of arrears equals the inflow minus the outflow of arrears. The total outflow consists of the 'good' outflow into repayment or refinancing, and the 'bad' outflow into possessions. Suppose that (inflow into arrears – 'good' outflow from arrears)/(stock of arrears_{t-1}) is a function of a vector *Z, F(Z)*. Hence

$$\text{total change in arrears}_t/\text{arrears}_{t-1} = F(Z_t) - \text{flow into possession}_t \,/\, \text{arrears}_{t-1} \qquad (7)$$

Hence approximately,

$$\Delta \log \text{arrears}_t \approx F(Z_t) - \text{flow into possession}_t \,/\, \text{arrears}_{t-1} \qquad (8)$$

As a result, the ratio of negative possessions to lagged arrears was included in each arrears equation to account for this link between possessions and arrears.[2]

The second channel where policy on possessions affects arrears is via a demonstration or incentive effect. The knowledge that lenders and courts are exercising forbearance makes borrowers less concerned about the risk that a rise in their arrears levels will induce possession. For example, borrowers with this belief may pay off credit card debt before mortgage debt, or may cut back less on other household expenditure. The parameter $-b_6$ (note the negative sign) where b_6 is positive, captures the incentive effect of increased

[2] Since it is likely that some possessions arise before arrears reach the 12-month level, the 12-month arrears equation uses 0.8 of the ratio of possessions to lagged arrears.

forbearance on arrears. The formulation in the equation below also allows a lag in the operation of this effect when κ takes a value below 1.

The two policy effects are shown in an arrears equation corresponding to equation (5), for a percentage of arrears measure, *arr** (e.g. a count of arrears cases where ratio of arrears to mortgage debt exceeds say 5 percent):

$$\begin{aligned}\Delta \log arr^*_t \;=\; & b_4(b_0 + \sum_{l=1}^{n} a_l X_{l,t} + b_5 LQ_t - b_6(\kappa PS_t + (1-\kappa)PS_{t-1}) - \log arr^*_{t-1}) \\ & + \sum_{l=1}^{n}\sum_{j=0}^{k} \beta_{l,j}\Delta X_{l,t-j} - poss_t / arr^*_{t-1} + \sum_{j=1}^{k} c_j \Delta \log arr^*_{t-j} + \varepsilon_t\end{aligned} \tag{9}$$

Correcting the bias from the "months-in-arrears" measure is discussed next. It is unfortunate that a long history of arrears data is available only for a count of arrears measured as "months in arrears" (those with an accumulated level of arrears in excess of an equivalent number of months of normal payments). When mortgage rates fall, normal payments fall and the "months-in-arrears" count *rises*[3].

A bias correction based on the log debt service ratio is used to convert a relationship formulated for *arr** (a count of arrears by the ratio of arrears to mortgage debt) into one for arrm (a count by months).[4] We approximate the relationship between the two measures in equation (10):

$$\log arr^*_t = a \; + \log arrm_t + \theta \log dsr_t \tag{10}$$

where *arrm* is the month in arrears count which best matches the percentage in arrears count represented by *arr**, and θ log dsr proxies the measurement bias. The parameter θ will differ for 6-month and 12-month arrears rates. By substituting equation (10) into equation (9), we obtain an equilibrium correction model for the proportion of mortgages measure by "months-in-arrears":

---

[3] With a 25 year conventional repayment mortgage, at a 7.5 percent mortgage rate, being 2.5 percent in arrears (e.g. arrears of £2500 on a £100,000 loan) translates into being 3.3 months in arrears (see CML information notes on release of arrears data, e.g. February 20, 2009). For a similar interest-only mortgage, the number of months in arrears is higher at 4 months, as monthly payments do not incorporate a repayment element. If the current interest rate falls and so the regular monthly payments, the accumulated arrears translate into a higher monthly payment equivalent at the new lower interest rate, and months in arrears *rises*. With a lower 4.5 percent interest rate, being 2.5 percent in arrears translates into 4.4 months for a conventional mortgage, and 6.7 months for an interest only mortgage. This pushes more existing cases into the 3-6 months and the 6-12 months in arrears categories.

[4] Basing the bias correction on log of the tax-adjusted mortgage rate instead of the log debt service ratio gives closely similar results for the arrears equations and jointly estimated possessions equation.

$$\begin{aligned}\Delta \log arrm_t &= b_4(b_0 + \sum_{l=1}^{n} b_l X_{l,t} + b_5 LQ_t - b_6(\kappa PS_t + (1-\kappa)PS_{t-1}) \\ &-(\log arrm_{t-1} - \theta \log dsr_{t-1})) + \sum_{l=1}^{n}\sum_{j=0}^{k} \beta_{l,j} \Delta X_{l,t-j} + \theta \Delta \log dsr_t \\ &- poss_t / arrm_{t-1} + \sum_{j=1}^{k} c_j (\Delta \log arrm_{t-j} - \theta \Delta \log dsr_{t-j}) + \varepsilon_t\end{aligned} \tag{11}$$

The equation specifications (5) and (11) have a general lag structure in the dynamic terms. With two arrears measures, there are three equations in all, jointly estimated imposing cross-equation constraints through the common *LQ* and *PS* functions. There is much heterogeneity in individual circumstances, including the timing of the initial mortgage, and in behaviour by lenders and the courts. This suggests that fluctuations in debt service ratios and in the proportion of mortgages in negative equity have long, drawn-out effects in aggregate that could be well-represented by moving averages of these variables. The evidence pointed to the relevance of four-quarter moving averages of the log debt service ratio and of the negative equity indicator in parsimonious models, for both possessions and arrears. These formulations were incorporated in the three-equation system, and tested against more general lag structures.

ANNEX 4: Parsimonious equations, variable definitions and tables of results.

The selected possessions equation:

$$\begin{aligned}\Delta \log poss_t = a_4 \times (a_0 + LQ_t + PS_t + a_1 \log dsrma_{t-1} + a_2 \log negeqma_{t-1} \\ + a_3 \log ur_{t-4} - \log poss_{t-1}) + (PS_t - PS_{t-1}) + a_7 \Delta \log negeq_t + \\ a_8 \Delta \log negeq_{t-1} + a_9 \Delta \log poss_{t-2} \\ + a_{11} q1_t + a_{12} d89q3_t + a_{13} d03q1_t\end{aligned} \tag{12}$$

The selected voluntary possessions equation:

$$\begin{aligned}\Delta \log vposs_t = v_4 \times (v_0 + v_1 \log dsrma_{t-1} + v_2 \log negeqma_{t-1} \\ + v_5 LQ_t - \log vposs_{t-1}) + v_7 q4_t\end{aligned} \tag{13}$$

The selected arrears equations:

Arrears ≥ 12 months

$$\begin{aligned}\Delta \log arr12_t = b_4 \times (b_0 + b_1 \log dsrma_{t-1} + b_2 \log negeqma_{t-1} + b_3 \log ur_{t-5} \\ + b_5 LQ_t \text{-} b_6 (\kappa \mathrm{PS}_t + (1\text{-}\kappa)\mathrm{PS}_{t-1}) - (\log arr12_{t-1} - \theta_{12} \log dsr_{t-1})) \\ + \theta_{12} \Delta \log dsr_t - 0.8 poss_t / arr12_{t-1} \\ + b_7 \Delta \log negeq_t + b_8 \Delta \log negeq_{t-1} \\ + b_9 (1 - sd99_t)(\Delta \log arr12_{t-1} - \theta_{12} \log \Delta dsr_{t-1}) + b_{10} \Delta_4 \log ur_t\end{aligned} \tag{14}$$

Arrears ≥ 6 months

$$\begin{aligned}\Delta \log arr6_t = c_4 \times (c_0 + c_1 \log dsrma_{t-1} + c_2 \log negeqma_{t-1} + c_3 \log ur_{t-5} \\ + c_5 LQ_t \text{-} c_6 (\kappa \mathrm{PS}_t + (1\text{-}\kappa)\mathrm{PS}_{t-1}) - (\log arr6_{t-1} - \theta_6 \log dsr_{t-1})) \\ + \theta_6 \Delta \log dsr_t - poss_t / arr6_{t-1} \\ + c_7 \Delta \log negeq_t + c_8 \Delta \log negeq_{t-1} \\ + c_9 (1 - sd99_t)(\Delta \log arr6_{t-1} - \theta_6 \log \Delta dsr_{t-1}) \\ + c_{10} \Delta_4 \log ur_t + c_{11} d84q3_t\end{aligned} \tag{15}$$

The selected loan quality equation

$$\begin{aligned}LQ_t = l86 \times sdmm86_t + l89 \times sdmm89_t + l94 \times sdmm94_t \\ + l95 \times sdmm95 + l97 \times sdmm97_t + l05 \times sdmm05_t \\ + l06 \times sdmm06_t + l07a \times sdmm07_{t-2} + l09a \times \mathrm{sd2008q4}_{t-2} \\ + l09b \times \mathrm{sd2008q4}_{t-4} + l10 \times sdmm10_t + l12 \times sdmm12_t\end{aligned} \tag{16}$$

The selected forbearance policy equation

$$\begin{aligned}PS_t = p91 \times (sd91_{t-4} - sdmm97_t) + p08 \times sd2008q4_t \\ + p09a \times sd2008q4_{t-3} + p09b \times sd2008q4_{t-4}\end{aligned} \tag{17}$$

Table A4.1: Definitions of variables used in the regressions

Symbol	*Definition*	*Means*	*Source*
$\log poss_t$	Log of the ratio of possessions to number of mortgages outstanding	-7.361	CML
$\log vposs_t$	Log of the ratio of voluntary possessions to number of mortgages outstanding	-9.209	CML
$\log arr6_t$	Log of the ratio of arrears (greater than or equal to months) to number of mortgages outstanding	-4.690	CML
$\log arr12_t$	Log of the ratio of arrears (greater than or equal to 12 months) to number of mortgages outstanding	-5.942	CML
$\log ur_t$	Unemployment rate (ILO measure)	1.993	ONS
$\log dsr_t$	Cost of loan to income, measured as: $((arbm/100)(avmort(-1))/(avpdi)$ arbm=average mortgage interest rate, rbm[1], adjusted for tax before 2000; avmort=amwt/mortno; amwt=mortgage lending, stock, personal sector (£mn), from Financial Statistics; mortno=mortgages outstanding from CML; avpdi=4 x quarterly personal disposable income[2], current prices (£mn)/popw; popw=population of working age, 15 to 59 for women, 15 to 64 for men ('000s), quarterly interpolation.	-7.164	mortno: CML popw: ONS amwt: ONS rbm: ONS pdi: ONS
$\log negeq_t$	Log of the debt equity ratio, measured to proxy average mortgage to house prices. Implied proportion of negative equity (*normalised*) (see equation (4), section 2.1): $negeq = ([1/(1+\exp(-\lambda * (\log(avdebt/equity) - \lambda_{0t}))]$ Then adjust $negeq$ by subtracting the cumulated number of possessions cases over the previous 2 years, scaled by no. of mortgages outstanding. (average debt)/(average equity)=avmort(-1)/(ph); ph=2nd-hand mix-adjusted house prices[3] (2002Q1=100), *normalized.* λ=7, λ_0 = - 0.001*(t - 40) + 0.04.	-3.150	ph: ONS
$sd2008q4_t$	step dummy =1 from 2008Q4, and 0 otherwise	-	Constructed
$sdmmxx_t$	Double moving average of step dummies, with a smooth increasing transition from zero to one over 8 quarters, from zero in the last quarter of year xx-1, to one in the last quarter of year xx+1	-	Constructed
$d84q3_t$	Impulse dummy for 1984Q3 for an outlier in 12month+arrears.	-	Constructed
$d89q3_t$	Impulse dummy for 1989Q3 for an outlier in possessions.	-	Constructed
$d2003q4_t$	Impulse dummy for 2003Q4 for an outlier in possessions.	-	Constructed

Notes: The sample is the longest available for both arrears and repossessions, 1983Q2 to 2009Q3. Interpolated quarterly CML data are used before 1999, see section 3.2.1.

1. Mortgage rate: from 2007Q1 FSA MLAR, Table 1.22 - Residential loans to individuals: Interest rate analysis. Overall weighted average interest rate on balances outstanding, all loans. From 2000 to 2006, linked to average of mortgage rate on balances outstanding for banks and building societies, previously reported in Financial Statistics. Before 2000, linked to average mortgage rate on balances outstanding for building societies, previously reported in Financial Statistics, code AJNL.
2. Nominal household disposable income = real household disposable income x consumer expenditure deflator, where the latter = current price measure of consumer expenditure/chained volume index of consumer expenditure from Consumer Trends, both seasonally adjusted. Real household disposable income SA Table 38 from UK Economic accounts, code NRJR.
3. Mix-adjusted index for UK for old dwellings from DCLG website Table 594.

Table A4.2a: Estimation results for arrears and possessions equations, 1983Q2-2009Q3

Variable	*Symbol*	*Possessions equation:* Δlog poss	*Robust std. errors*	*Symbol*	*Arrears equation:* Δlog ass12	*Robust std. errors*	*Symbol*	*Arrears equation:* Δlog arr6	*Robust std. errors*
Constant	a0	7.60**	0.96	b0	3.39**	1.35	c0	3.06**	1.11
log dsrma(-1)	a1	1.86**	0.10	b1	1.59**	0.15	c1	1.47**	0.12
log negeqma(-1)	a2	0.718**	0.046						
log negeqma(-2)				b2	0.598**	0.065	c2	0.397**	0.053
log ur(-4)	a3	0.199	0.146				c3	0.976**	0.267
log ur(-5)				b3	0.782*	0.331			
Speed of adjustment	a4	0.434**	0.047	b4	0.474**	0.038	c4	0.345**	0.034
LQ (loan quality)	a5	1	-	b5	2.90**	0.65	c5	2.35**	0.54
PS (policy shift)	a6	-1	-	b6	0.815*	0.435	c6	1.14**	0.42
Correction factor	-	-	-	θ12	-0.303**	0.074	θ6	-0.239**	0.052
Δlog negeq	a7	0.172**	0.046	b7	0.0798*	0.0323	c7	0.0508*	0.0218
Δlog negeq (-1)	a8	0.158**	0.047	b8	0.0947**	0.0323	c8	0.0632**	0.0223
$\Delta_4$log ur	a9	0	-	b9	0.313**	0.113	c9	0.246**	0.069
Δlog POSS(-2)	a10	0.323**	0.056						
dynamic shift adjustment				b10	0.322**	0.096	c10	0.493**	0.078
d89q3	a11	0.0709**	0.0165	-	-	-	-	-	-
d2003q4(-1)	a12	-0.182**	0.064	-	-	-	-	-	-
q1	a13	-0.159*	0.063	-	-	-	-	-	-
d84q3	-	-	-	-	-	-	c11	0.133**	0.028
Diagnostics									
Eq. standard error		0.062			0.043			0.028	
R squared		0.990			0.997			0.998	
LM Het test P-val		0.050			0.343			0.471	
Durbin-Watson		1.55			1.65			2.09	

Notes:

1. Estimates are reported to three significant figures. See the equations that generated these results in section 4.1; variables are defined in Table 3.
2. ** indicates significant at the 1 percent level; * indicates significant at the 5 percent level.
3. The policy function enters as (kappa*PS+(1-kappa)*PS(-1)), with kappa fixed at 0.5.
4. The dynamic shift adjustment is for the 12-month and 6-month arrears, respectively,
   $(1-sd99_t)*(\Delta\log arr12_{t-1} - \theta_{12}\Delta\log dsr_{t-1})$ and $(1-sd99_t)*(\Delta\log arr6_{t-1} - \theta_{6}\Delta\log dsr_{t-1})$
   where sd99 is a step dummy beginning in 1999 when data frequency shifted to quarterly.

Table A4.2b: Estimation results for policy and lending quality equations, 1983q2-2009q3

Variable	*Symbol*	*Estimate*	*Robust std. errors*	*Robust t-statistic*
Policy function				
(*sd*91(-4) - *sdmm*97)	*p*91	-0.173**	0.047	-3.66
*sd*2008q4	*p*08	-0.252**	0.057	-4.42
*sd*2008q4(-3)	*p*09	0.093	0.061	1.52
Lending quality function				
*sdmm*86	*l*86	0.053*	0.026	2.04
*sdmm*89	*l*89	0.324**	0.078	4.14
*sdmm*94	*l*94	-0.095**	0.036	-2.66
*sdmm*95	*l*95	-0.074	0.040	-1.86
*sdmm*97	*l*97	0.080*	0.034	2.37
*sdmm*05	*l*05	-0.031	0.033	-0.94
*sdmm*06	*l*06	-0.070	0.042	-1.66
*sdmm*07(-2)	*l*07a	0.274**	0.083	3.32
*sd*2008q4(-2)	*l*09a	-0.190**	0.058	-3.28

Notes:

1. Estimates are reported to three significant figures. See the equations that generated these results in section 4.1; variables are defined in Table 3.

****** indicates significant at the 1 percent level; * indicates significant at the 5 percent level.

ANNEX 5: Forecast scenarios: underlying assumptions 2009q4-2013q4

	SCEN1	SCEN2	SCEN3	SCEN4	SCEN5	SCEN6
	Unemployment rate					
Date	UPBASE	UPHG	UPLG	UPBASEALT	UPXPOS	UPXNEG
Dec-09	8.3	8.3	8.4	8.6	8.4	9.2
Mar-10	8.5	8.4	8.6	9.0	8.7	9.9
Jun-10	8.6	8.4	8.7	9.3	9.0	10.6
Sep-10	8.6	8.4	8.8	9.5	9.3	11.1
Dec-10	8.6	8.3	9.0	9.5	9.3	11.4
Mar-11	8.5	8.2	9.0	9.5	9.3	11.4
Jun-11	8.5	8.2	9.0	9.5	9.0	11.4
Sep-11	8.4	8.1	8.9	9.5	8.6	11.4
Dec-11	8.2	7.9	8.7	9.5	8.2	11.4
Mar-12	8.0	7.7	8.6	9.3	7.6	11.0
Jun-12	7.9	7.4	8.5	9.0	7.0	10.7
Sep-12	7.6	7.1	8.3	8.3	6.4	10.3
Dec-12	7.5	7.0	8.2	7.6	5.8	9.9
Mar-13	7.3	6.8	8.0	6.9	5.2	9.6
Jun-13	7.1	6.6	7.8	6.4	4.8	9.2
Sep-13	7.0	6.5	7.7	6.0	4.75	8.9
Dec-13	6.9	6.4	7.6	5.6	4.75	8.5

	SCEN1	SCEN2	SCEN3	SCEN4	SCEN5	SCEN6
	House price					
Date	PHBASE	PHHG	PHLG	PHBASEALT	PHXPOS	PHXNEG
Dec-09	166.1	166.1	166.0	166.0	166.0	166.0
Mar-10	164.4	166.1	164.4	166.0	166.0	161.6
Jun-10	163.2	166.1	162.7	166.0	169.0	157.2
Sep-10	163.2	167.8	161.9	166.0	172.0	152.8
Dec-10	163.3	169.5	161.9	168.1	175.0	152.8
Mar-11	163.4	171.1	161.9	170.2	177.9	152.8
Jun-11	163.7	172.9	162.1	172.3	180.9	152.8
Sep-11	164.0	174.8	162.3	174.3	183.9	152.8
Dec-11	164.5	176.9	162.6	176.4	186.8	152.8
Mar-12	165.1	179.0	163.1	178.5	189.8	152.8
Jun-12	166.1	181.3	163.7	180.5	192.8	154.7
Sep-12	167.4	183.8	164.7	182.6	195.7	156.6
Dec-12	169.1	186.6	166.0	184.7	198.7	158.5
Mar-13	171.1	189.6	167.3	186.8	201.7	160.3
Jun-13	173.3	192.6	168.9	188.8	204.7	162.2
Sep-13	175.8	195.7	170.4	190.9	207.6	164.1
Dec-13	178.2	198.8	171.9	193.0	210.6	166.0

	SCEN1	SCEN2	SCEN3	SCEN4	SCEN5	SCEN6
	Real income					
Date	PEDYBASE	PEDYHG	PEDYLG	PEDYBASEALT	PEDYXPOS	PEDYXNEG
Dec-09	213862	213862	213648	213969	214290	213456
Mar-10	214076	214290	213434	214375	215683	213050
Jun-10	214504	214933	213434	214783	217085	212645
Sep-10	215148	215792	213648	215191	218496	212645
Dec-10	216008	216871	214075	215600	219916	212645
Mar-11	216980	218064	214610	216893	221895	212645
Jun-11	218065	219372	215254	218195	223892	212858
Sep-11	219373	220908	216115	219504	225907	213071
Dec-11	220799	222454	217196	220821	227940	213284
Mar-12	222345	224012	218390	222146	229992	213817
Jun-12	223901	225692	219592	223479	232062	214352
Sep-12	225524	227497	220909	224820	234150	214888
Dec-12	227553	229545	222235	226168	236258	215425
Mar-13	229602	231611	223568	227525	238384	215963
Jun-13	231668	233695	224909	228891	240529	216503
Sep-13	233753	235915	226259	230264	242694	217044
Dec-13	235915	238156	227616	231646	244878	217587

	SCEN1	SCEN2	SCEN3	SCEN4	SCEN5	SCEN6
	Mortgage interest rate					
Date	ARBMBASE	ARBMHG	ARBMLG	ARBMBASEALT	ARBMXPOS	ARBMXNEG
Dec-09	3.81	3.81	3.81	4.00	4.00	4.00
Mar-10	3.81	4.00	3.81	4.40	4.00	4.86
Jun-10	3.81	4.10	3.81	4.60	4.00	5.20
Sep-10	3.81	4.20	3.81	4.80	4.00	5.55
Dec-10	3.81	4.50	3.81	5.00	4.00	5.90
Mar-11	3.91	4.60	3.81	5.20	4.19	6.25
Jun-11	4.11	4.80	3.90	5.40	4.37	6.60
Sep-11	4.21	4.90	4.00	5.60	4.56	6.66
Dec-11	4.41	5.10	4.10	5.80	4.74	6.72
Mar-12	4.61	5.30	4.30	6.00	4.93	6.78
Jun-12	4.71	5.40	4.40	6.20	5.11	6.84
Sep-12	4.91	5.60	4.60	6.25	5.30	6.90
Dec-12	5.11	5.70	4.80	6.30	5.30	6.96
Mar-13	5.21	5.80	4.90	6.35	5.30	7.02
Jun-13	5.41	6.00	5.10	6.40	5.30	7.08
Sep-13	5.61	6.10	5.30	6.45	5.30	7.14
Dec-13	5.71	6.20	5.40	6.50	5.30	7.20

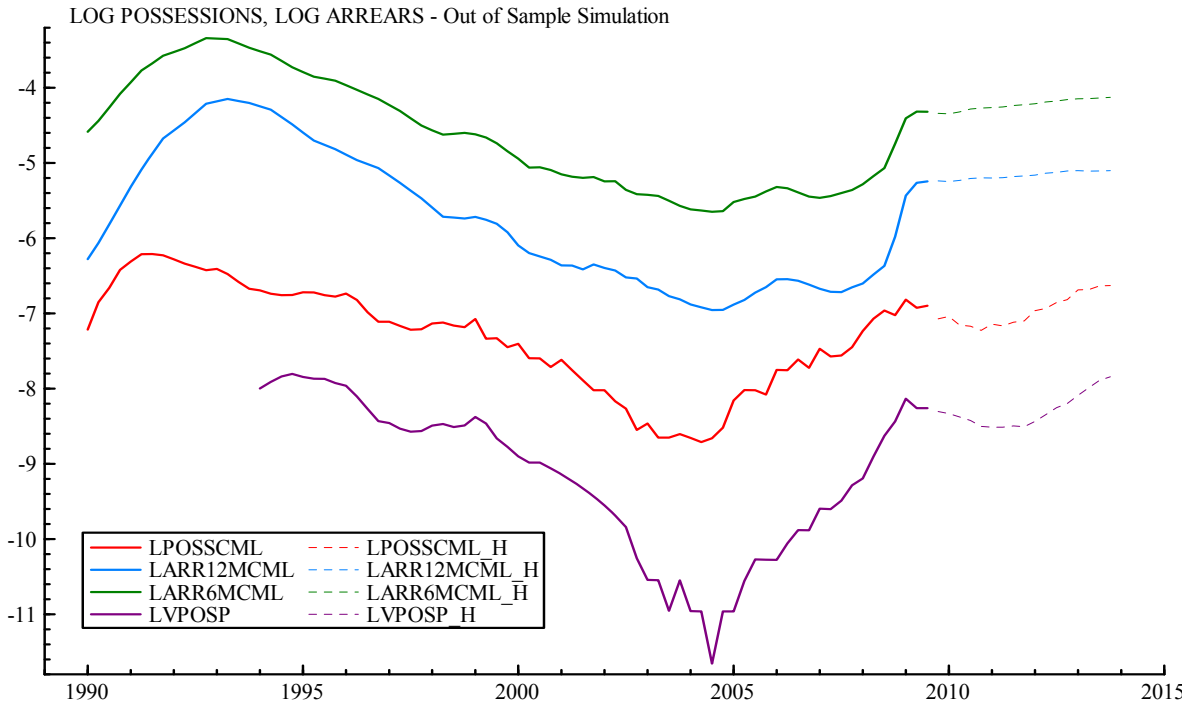
	SCEN1	SCEN2	SCEN3	SCEN4/5/6
	Price level			
Date	PCBASE	PCHG	PCLG	PCALT
Dec-09	1.095	1.097	1.095	1.099
Mar-10	1.101	1.103	1.097	1.104
Jun-10	1.099	1.107	1.097	1.110
Sep-10	1.101	1.111	1.099	1.115
Dec-10	1.103	1.116	1.101	1.121
Mar-11	1.105	1.121	1.103	1.127
Jun-11	1.108	1.127	1.106	1.132
Sep-11	1.111	1.133	1.109	1.138
Dec-11	1.114	1.140	1.112	1.144
Mar-12	1.118	1.147	1.116	1.149
Jun-12	1.124	1.154	1.121	1.155
Sep-12	1.130	1.161	1.126	1.161
Dec-12	1.137	1.168	1.131	1.167
Mar-13	1.144	1.175	1.137	1.173
Jun-13	1.151	1.182	1.143	1.178
Sep-13	1.158	1.189	1.148	1.184
Dec-13	1.165	1.196	1.154	1.190

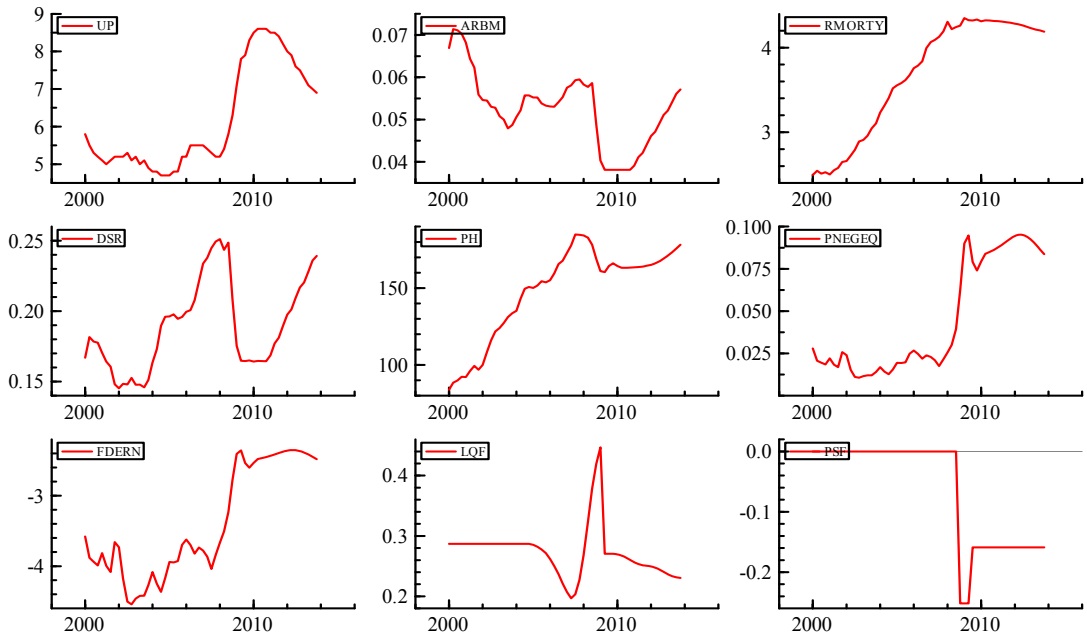
	SCEN1	SCEN2	SCEN3	SCEN4	SCEN5	SCEN6
	Mortgage lending stock					
Date	AMWTBASE	AMWTHG	AMWTLG	AMWTALT	AMWTPOS	AMWTNEG
Dec-09	1228872	1228872	1228872	1228872	1229994	1233993
Mar-10	1232437	1233664	1229978	1232437	1237190	1241403
Jun-10	1237133	1239586	1232192	1237133	1246097	1248858
Sep-10	1242578	1246280	1235149	1242578	1256191	1256357
Dec-10	1248814	1253757	1238854	1248814	1267497	1263902
Mar-11	1255972	1262158	1243438	1255972	1280235	1271491
Jun-11	1264304	1271750	1249158	1264304	1294830	1279127
Sep-11	1273797	1282560	1256028	1273797	1311339	1286808
Dec-11	1284469	1294103	1264821	1284469	1329042	1294535
Mar-12	1296263	1307044	1274307	1296263	1348977	1302309
Jun-12	1309160	1321421	1284501	1309160	1371235	1310129
Sep-12	1323128	1336618	1296062	1323128	1394889	1317996
Dec-12	1338123	1352657	1310318	1338123	1419997	1325911
Mar-13	1353772	1369565	1324732	1353772	1446622	1333873
Jun-13	1369788	1387370	1339304	1369788	1474831	1341883
Sep-13	1386022	1405406	1354706	1386022	1503591	1349941
Dec-13	1402473	1423676	1370285	1402473	1532911	1358047

ANNEX 6: Forecasts for repossessions and arrears

The different scenarios use underlying data in Annex 5.

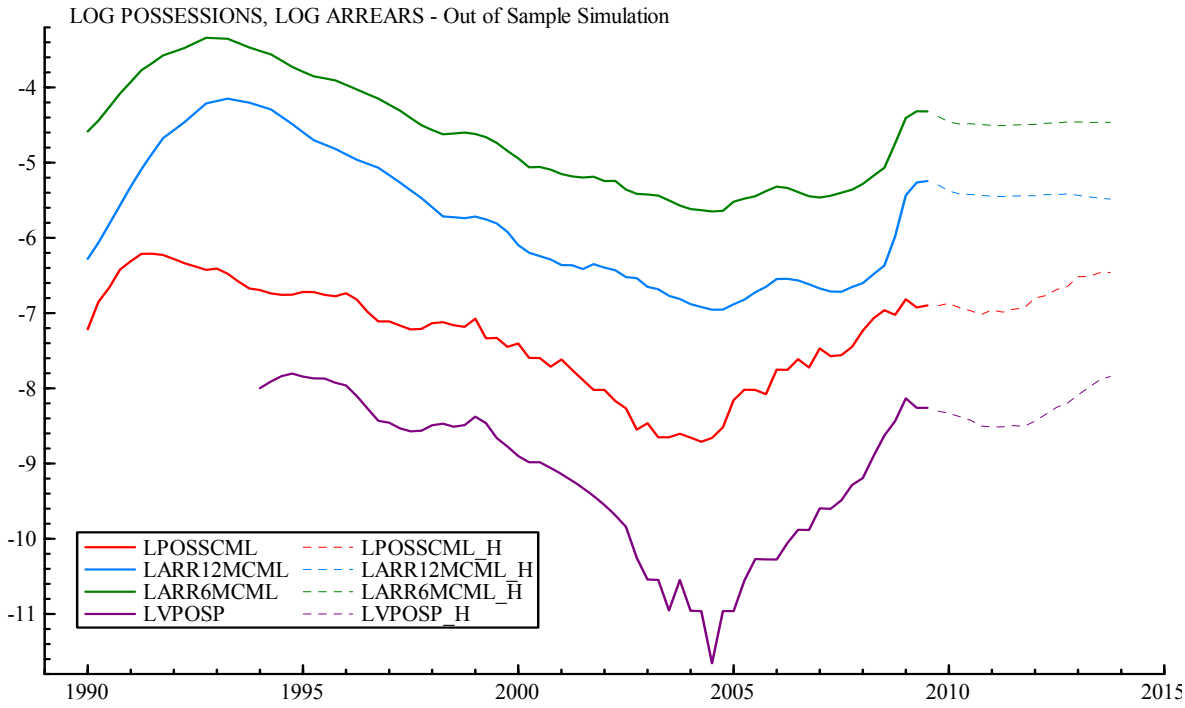
SCENARIO 1: Base scenario

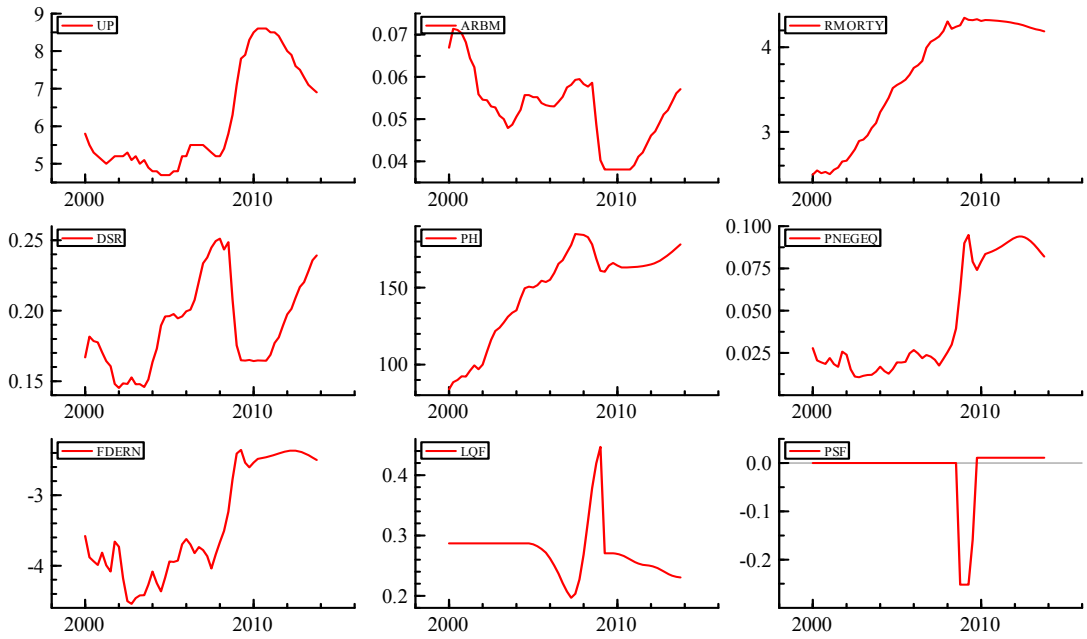




UP=unemployment, ARBM=mortgage rate; RMORTY=average mortgage over average income; DSR= debt service ratio; PH=house prices; PNEGEQ=proportion in negative equity; FDERN=log (pnegeq); LQF=lending conditions; PS=policy function.

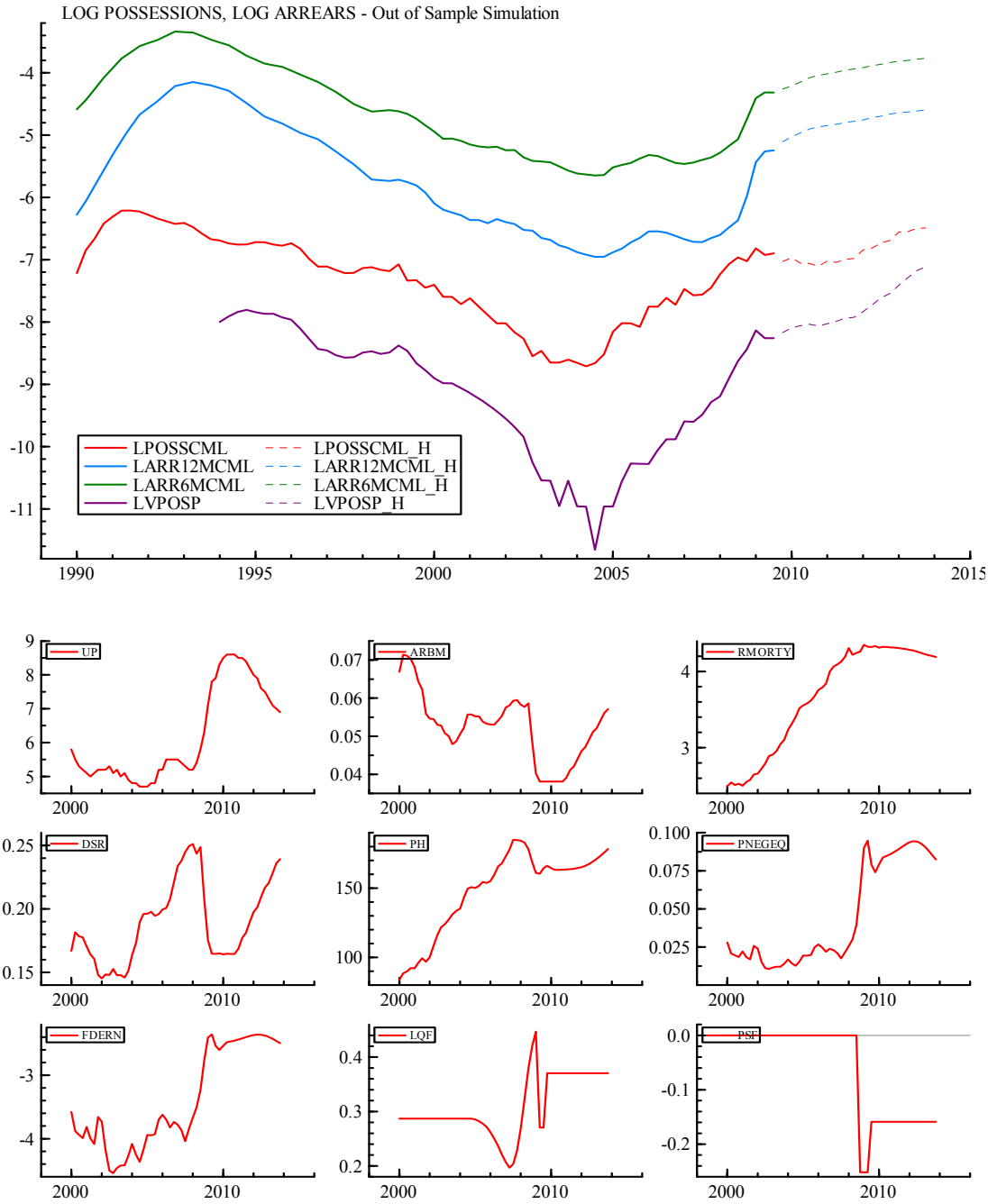
SCENARIO 1A: Base scenario with policy switched off





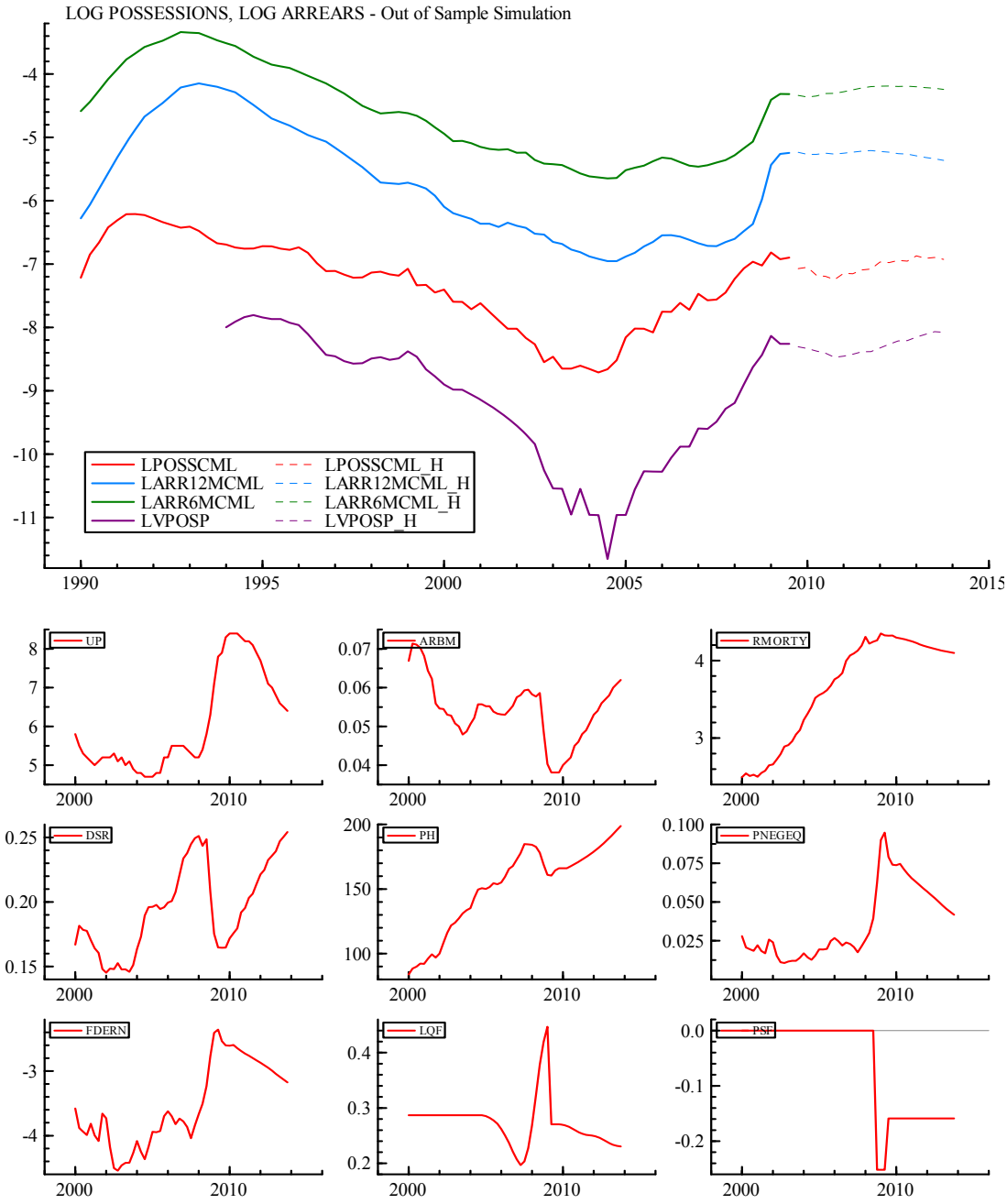
UP=unemployment, ARBM=mortgage rate; RMORTY=average mortgage over average income; DSR= debt service ratio; PH=house prices; PNEGEQ=proportion in negative equity; FDERN=log(pnegeq); LQF=lending conditions; PS=policy function.

SCENARIO 1B: Base scenario with sensitivity testing of the lending quality function



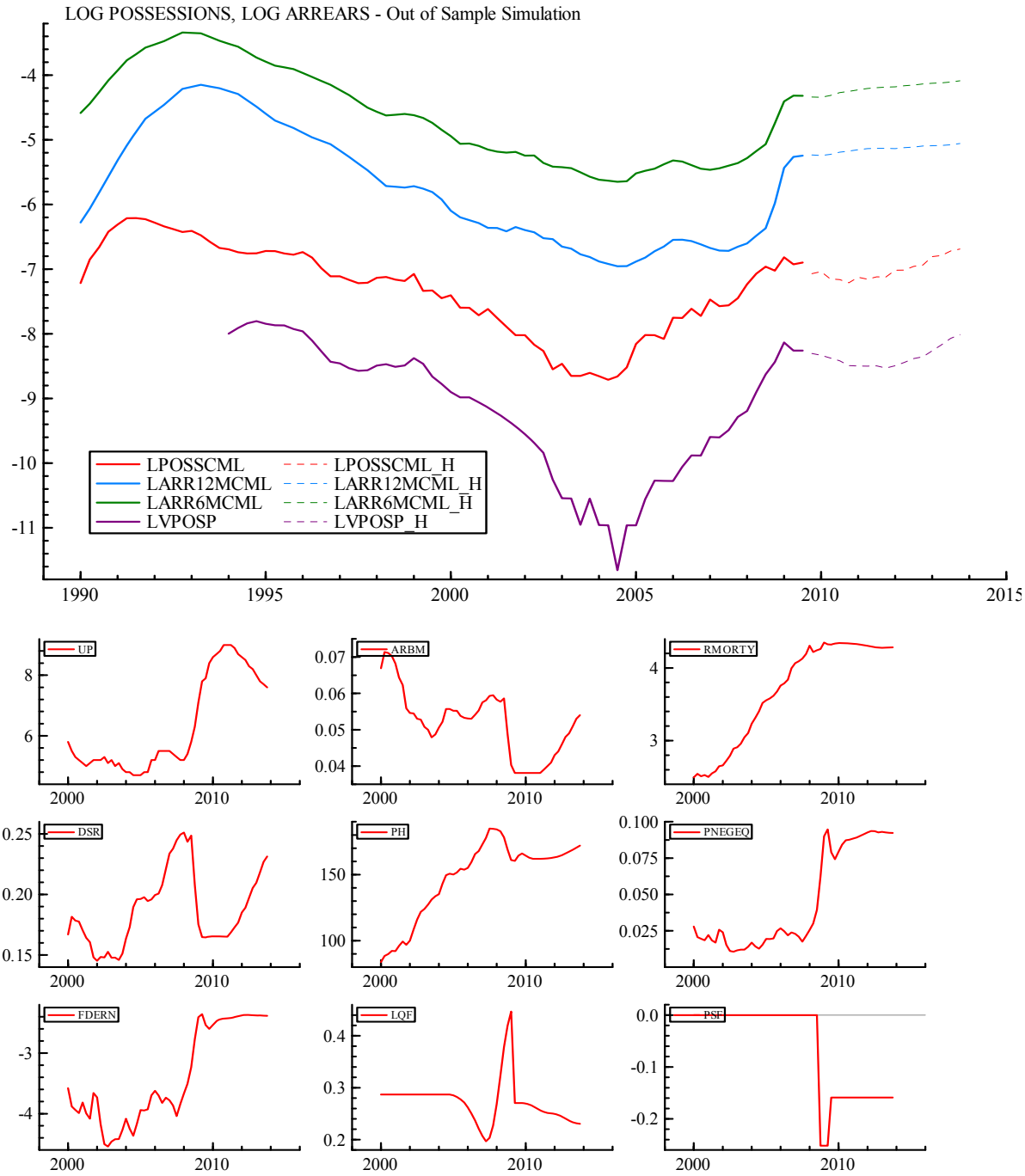
UP=unemployment, ARBM=mortgage rate; RMORTY=average mortgage over average income; DSR= debt service ratio; PH=house prices; PNEGEQ=proportion in negative equity; FDERN=log(pnegeq); LQF=lending conditions; PS=policy function.

SCENARIO 2: High growth scenario



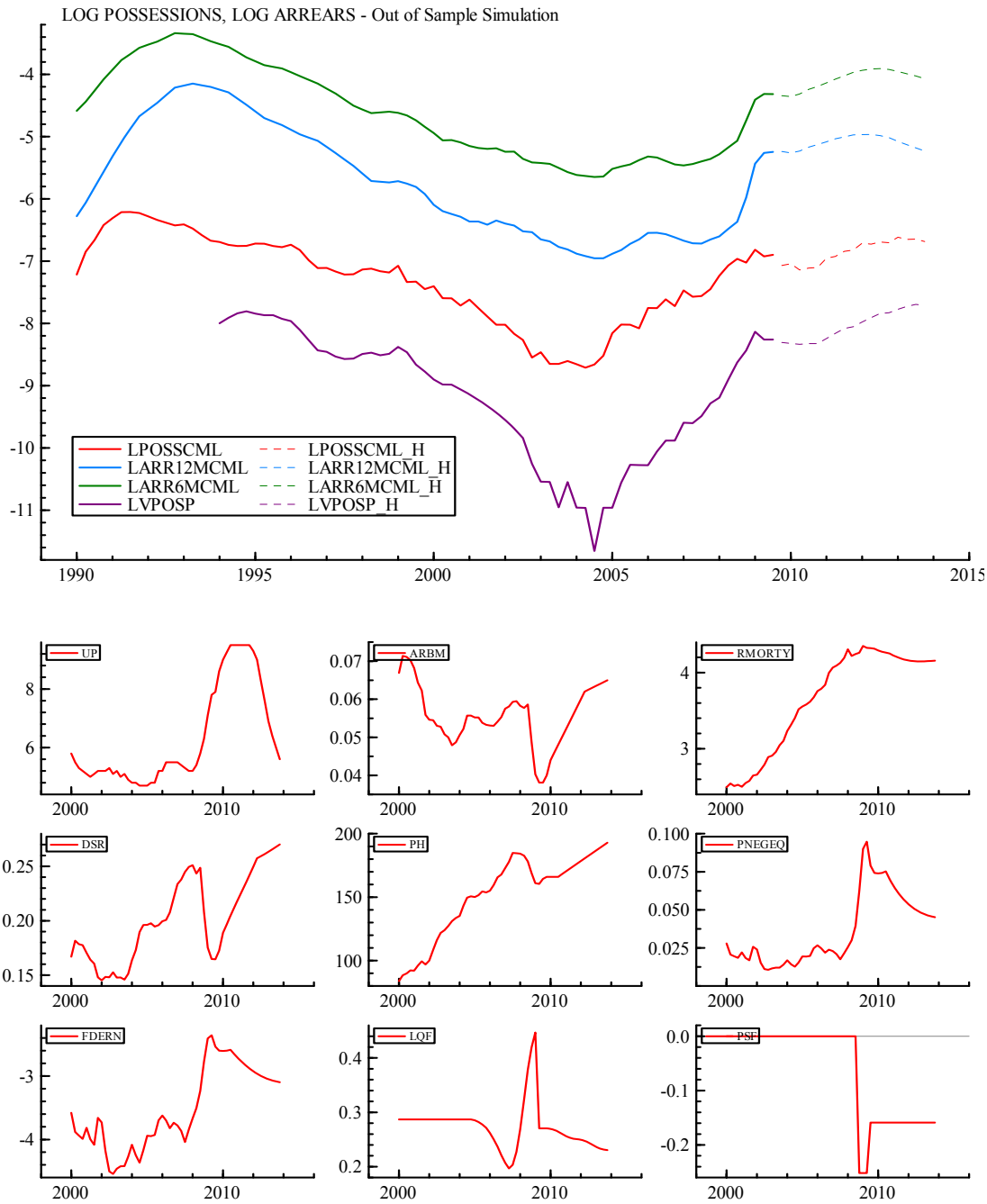
UP=unemployment, ARBM=mortgage rate; RMORTY=average mortgage over average income; DSR= debt service ratio; PH=house prices; PNEGEQ=proportion in negative equity; FDERN=log(pnegeq); LQF=lending conditions; PS=policy function.

SCENARIO 3: Low growth scenario



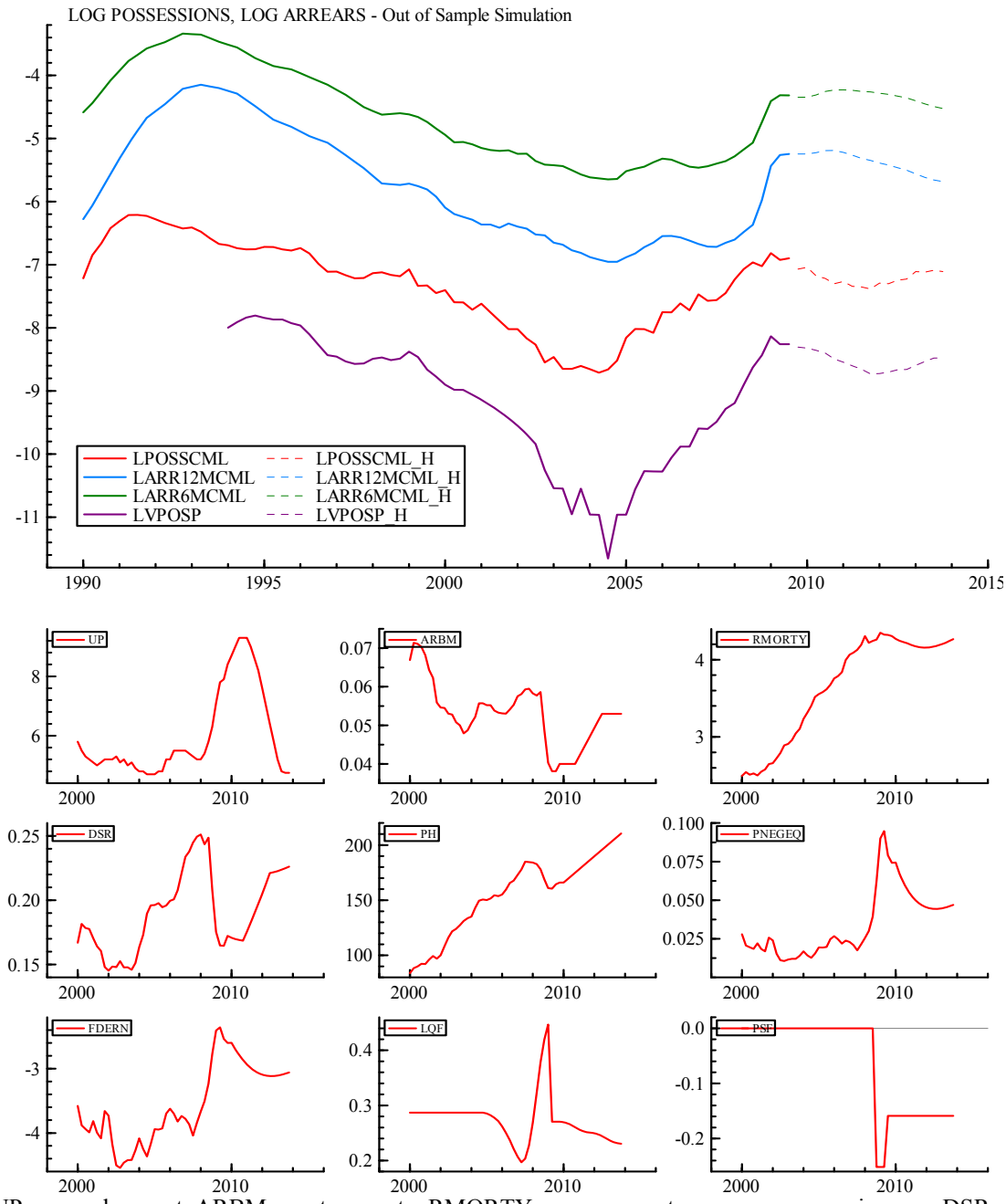
UP=unemployment, ARBM=mortgage rate; RMORTY=average mortgage over average income; DSR= debt service ratio; PH=house prices; PNEGEQ=proportion in negative equity; FDERN=log(pnegeq); LQF=lending conditions; PS=policy function.

SCENARIO 4: Base with alternative assumption on interest rates



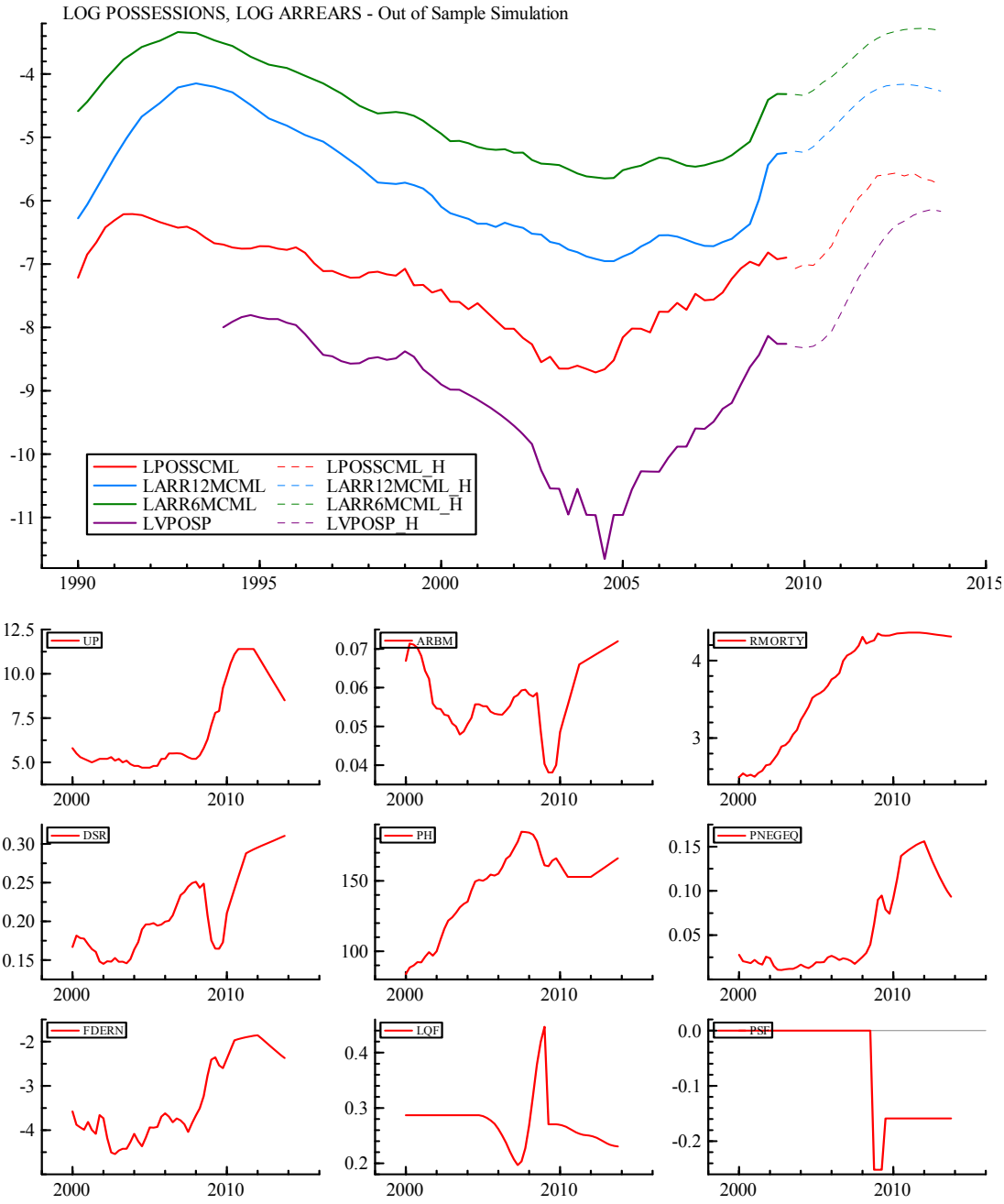
UP=unemployment, ARBM=mortgage rate; RMORTY=average mortgage over average income; DSR= debt service ratio; PH=house prices; PNEGEQ=proportion in negative equity; FDERN=log(pnegeq); LQF=lending conditions; PS=policy function.

SCENARIO 5: Extreme positive



UP=unemployment, ARBM=mortgage rate; RMORTY=average mortgage over average income; DSR= debt service ratio; PH=house prices; PNEGEQ=proportion in negative equity; FDERN=log(pnegeq); LQF=lending conditions; PS=policy function.

SCENARIO 6: Extreme negative



UP=unemployment, ARBM=mortgage rate; RMORTY=average mortgage over average income; DSR= debt service ratio; PH=house prices; PNEGEQ=proportion in negative equity; FDERN=log(pnegeq); LQF=lending conditions; PS=policy function.

Table A6.1: A selection of forecast results 2009q4-2013q4

SCENARIO 1 Forecast quarter	*Properties taken into possession in period/no.*	*Loans in arrears ≥12 months/no.*	*Loans in arrears ≥6 months/no.*
2009q1	12700	50600	141400
2009q2	11400	60100	154900
2009q3	11700	61100	154400
2009q4	9843	61612	151210
2010q1	10171	61134	150421
2010q2	9076	62041	154343
2010q3	8944	63759	160628
2010q4	8478	64346	162999
2011q1	9225	64377	164139
2011q2	9014	64709	165761
2011q3	9477	65635	168873
2011q4	9645	66356	171036
2012q1	11056	67035	173423
2012q2	11398	68828	177519
2012q3	12365	69663	179981
2012q4	12842	71119	183635
2013q1	14640	71467	185942
2013q2	14729	71131	186425
2013q3	15480	71392	188352
2013q4	15549	71702	189992

SCENARIO 2 Forecast quarter	*Properties taken into possession in period/no.*	*Loans in arrears ≥12 months/no.*	*Loans in arrears ≥6 months/no.*
2009q1	12700	50600	141400
2009q2	11400	60100	154900
2009q3	11700	61100	154400
2009q4	9843	61650	151283
2010q1	10052	59832	147951
2010q2	8891	59766	150444
2010q3	8737	60955	156300
2010q4	8300	60175	156980
2011q1	9188	61066	161434
2011q2	9123	62234	166333
2011q3	9709	63256	171480
2011q4	9856	63935	175472
2012q1	11022	63197	176865
2012q2	10929	62515	177558
2012q3	11312	61084	176484
2012q4	11202	60685	177195
2013q1	12183	59104	175687
2013q2	11738	57658	173598
2013q3	11904	56552	172070
2013q4	11573	55256	169411

SCENARIO 3 Forecast quarter	*Properties taken into possession in period/no.*	*Loans in arrears ≥12 months/no.*	*Loans in arrears ≥6 months/no.*
2009q1	12700	50600	141400
2009q2	11400	60100	154900
2009q3	11700	61100	154400
2009q4	9847	61834	151635
2010q1	10179	61411	150963
2010q2	9101	62520	155324
2010q3	9023	64743	162599
2010q4	8599	65949	166113
2011q1	9371	67368	170212
2011q2	9118	68587	173925
2011q3	9457	68987	176414
2011q4	9433	69025	177874
2012q1	10493	68790	178976
2012q2	10514	69940	182188
2012q3	11148	70620	184422
2012q4	11401	71873	187649
2013q1	13012	72303	189876
2013q2	13236	72688	191503
2013q3	14205	73482	194159
2013q4	14645	74933	197770

SCENARIO 4 Forecast quarter	*Properties taken into possession in period/no.*	*Loans in arrears ≥12 months/no.*	*Loans in arrears ≥6 months/no.*
2009q1	12700	50600	141400
2009q2	11400	60100	154900
2009q3	11700	61100	154400
2009q4	9847	61478	150941
2010q1	10155	60218	148755
2010q2	9194	62059	155188
2010q3	9484	66242	167423
2010q4	9584	69050	175643
2011q1	11120	72303	186243
2011q2	11480	75853	198177
2011q3	12468	78319	209056
2011q4	12731	80989	220935
2012q1	14231	81492	228534
2012q2	14027	81623	233903
2012q3	14536	80310	235347
2012q4	14396	77748	232519
2013q1	15714	73422	225524
2013q2	15190	69494	217445
2013q3	15298	66227	210082
2013q4	14705	63005	201085

SCENARIO 5 Forecast quarter	*Properties taken into possession in period/no.*	*Loans in arrears ≥12 months/no.*	*Loans in arrears ≥6 months/no.*
2009q1	12700	50600	141400
2009q2	11400	60100	154900
2009q3	11700	61100	154400
2009q4	9847	61054	150125
2010q1	10162	61138	150491
2010q2	8877	62555	156057
2010q3	8522	64678	165012
2010q4	7854	64775	169037
2011q1	8147	62962	169848
2011q2	7542	60345	168726
2011q3	7492	57418	165908
2011q4	7253	55696	164567
2012q1	7969	53371	161409
2012q2	7905	51754	158833
2012q3	8363	49710	154708
2012q4	8534	47865	150254
2013q1	9592	45205	143962
2013q2	9526	42800	137143
2013q3	9839	41061	131636
2013q4	9620	40140	127491

SCENARIO 6 Forecast quarter	*Properties taken into possession in period/no.*	*Loans in arrears ≥12 months/no.*	*Loans in arrears ≥6 months/no.*
2009q1	12700	50600	141400
2009q2	11400	60100	154900
2009q3	11700	61100	154400
2009q4	9847	62745	153375
2010q1	10512	61576	151354
2010q2	10385	67596	164427
2010q3	12044	78314	186219
2010q4	14140	88686	203941
2011q1	19456	103761	230903
2011q2	23885	120422	262737
2011q3	30372	138457	300661
2011q4	35134	156115	341472
2012q1	42840	168437	375412
2012q2	43761	177746	402844
2012q3	44879	181265	420551
2012q4	43041	182622	433208
2013q1	44845	180250	440029
2013q2	41313	176672	442059
2013q3	40017	170814	437238
2013q4	37324	164811	429003

SCENARIO 1a Forecast quarter	*Properties taken into possession in period/no.*	*Loans in arrears ≥12 months/no.*	*Loans in arrears ≥6 months/no.*
2009q1	12700	50600	141400
2009q2	11400	60100	154900
2009q3	11700	61100	154400
2009q4	11667	58217	144520
2010q1	12056	53734	134393
2010q2	11366	51617	130884
2010q3	10936	51345	131458
2010q4	10411	50850	130225
2011q1	11070	50190	128830
2011q2	10774	50078	128562
2011q3	11202	50494	129796
2011q4	11400	50825	130584
2012q1	13036	50774	131240
2012q2	13470	51605	133336
2012q3	14620	51604	134108
2012q4	15212	52067	135834
2013q1	17349	51300	136076
2013q2	17466	50249	135322
2013q3	18357	49482	135524
2013q4	18439	48920	135798

SCENARIO 1b Forecast quarter	*Properties taken into possession in period/no.*	*Loans in arrears ≥12 months/no.*	*Loans in arrears ≥6 months/no.*
2009q1	12700	50600	141400
2009q2	11400	60100	154900
2009q3	11700	61100	154400
2009q4	10280	70286	163521
2010q1	10892	75891	171956
2010q2	10006	81162	183541
2010q3	9977	86417	196773
2010q4	9550	89430	204392
2011q1	10408	91493	209969
2011q2	10186	93564	215511
2011q3	10699	96294	222509
2011q4	10888	98375	227671
2012q1	12476	100540	232971
2012q2	12874	104332	240446
2012q3	13990	106932	245941
2012q4	14575	110717	253366
2013q1	16679	113351	259479
2013q2	16845	114611	262837
2013q3	17763	116789	268091
2013q4	17884	118591	272439

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