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Consumption and credit constraints: A model and evidence for Ireland

Petra Gerlach-Kristen and Rossana Merola*

Abstract: Since the onset of the financial crisis, consumption has fallen in many economies. This paper presents a small-scale DSGE model with occasionally binding credit constraints. Indebted households start facing credit constraints when the value of their main asset, which we assume to be housing, declines. As a response, they stop smoothing consumption and deleverage. We show that even households that only expect to face a credit constraint in the future deleverage. In an Irish dataset collected during the crisis, we reject the permanent income hypothesis for highly leveraged households and thus find evidence for a disruption in consumption smoothing. This effect suggests the presence of credit constraints.

Key words: Occasionally binding credit constraint, housing collateral, DSGE, Ireland.

Corresponding authors: petra.gerlach@esri.ie and rossana.merola@esri.ie

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Consumption and credit constraints: A model and evidence for Ireland

1. Introduction

One indication of the severity of the financial crisis that began in 2007 is that consumption, which typically evolves smoothly over time, has fallen alongside income in many economies. For instance, real per capita consumption decreased from the pre-crisis peak by between 8.6% and 17.0% in the European periphery.[1] By contrast, there was a decrease in consumption by only 5.3% in the United Kingdom and by 2.5% in the United States. The fall in consumption in the European periphery is large also by historical standards. During the Great Depression, US real per capita consumption fell by 20.6%.[2]

There are two potential explanations for the size of the recent decline. First, permanent income has decreased, and consumption therefore has been adjusted downwards. Second, households have stopped smoothing consumption because they face credit constraints or expect to face them in the near future.

It seems likely that both effects explain the decline in consumption during the crisis. In the middle of a financial crisis, incomes are lower than potential, even if the latter has been adjusted downwards. If the permanent income hypothesis (Friedman, 1957) holds, consumption therefore should decline only in line with potential, but not by as much as actual income. Indeed, we find that real disposable per capita income has decreased by more than consumption in the European crisis countries (by between 15.6% and 26.5%). Nevertheless, the decrease in consumption in the crisis has been large, both in an international and a historical comparison, and this suggests that credit constraints may matter as well.

This paper examines the role of credit constraints for consumption decisions of indebted households using a small-scale DSGE model and Irish data. The literature on credit constraints goes back to Leland (1968) and Tobin and Dolde (1971). The main hypothesis in this literature is that households that are deemed to represent a large credit risk from the point of view of a bank are unable to smooth consumption because they cannot access credit in periods when actual income is below permanent income.

Earlier studies have shown that credit constraints tend to matter for young, unemployed households with little education or wealth. In the context of the financial crisis, highly leveraged households – those that bought a house with a large mortgage at the height of

[1] The most recent data are from 2013Q1. The declines are -8.6% for Greece (available data end in 2011Q1), -8.7% for Italy, -12.0% for Spain, -13.2% for Portugal and -17.0% for Ireland. The data are from Eurostat and, for population figures, the United Nations. The graph reported in the Appendix A presents consumption data since 2000.

[2] This number is derived from real personal consumption expenditure from the FRED database, which shows a decline by 18.6% between 1929 and 1933, and the 1940 United States Census, which indicates an average population growth in the 1930s of 0.7% a year.

the property boom and have seen the value of their housing asset decline – are likely to be deemed a large credit risk as well, and hence find access to credit difficult.[3]

Precautionary or buffer-stock savings have been explored as a related explanation for depressed consumption. This strand of the literature posits that even if credit constraints are not currently binding, risk averse households try to avoid a situation of binding credit constraints in the future by building up savings beforehand (see e.g. Japelli, 1990, Deaton, 1991, Carroll, 1992, Carroll and Kimball, 2001, and Carroll and Toche, 2011). In the context of the financial crisis, savings may be used more to deleverage, rather than to finance future consumption. Once a household lowered its leverage ratio and hence rebuilt its balance sheet, future consumption can again be financed by new credit. The incentive to deleverage is also present for mortgage households that expect house prices, and thus the value of the collateral they have to offer, to decline.

Below, we present a small-scale DSGE model that assumes that households can finance part of their consumption expenditure by borrowing against their main asset, housing. If house prices decline, their leverage ratio increases such that banks refuse to finance further loans, and households have to reduce consumption. We show that they also deleverage; this is to improve their future access to credit. In terms of the literature on precautionary savings, we show that the mere expectation of a house price decline results in reduced consumption and deleveraging.

We then go on to assess whether the prediction made by the model – that consumption is not smoothed and the permanent income hypothesis is thus rejected for highly leveraged households – is compatible with Irish household data collected during the financial crisis.[4] This indeed is the case. It seems that the more leveraged a household, the less it smoothes consumption. We interpret this as evidence of credit constraints for highly leveraged households and as evidence of precautionary savings for less leveraged mortgage households that expect further house price declines.

The rest of the paper is structured as follows. Section 2 presents the model. Section 3 discusses the data and analyses which households are most likely to have high leverage ratios. Section 4 presents the consumption function estimates and tests the theory predictions. Section 5 concludes. Technical details about the data are presented in the Appendix.

3 It is also likely that credit standards have tightened in the crisis (see Guerrieri and Lorenzoni, 2011, for an analysis of the US situation), which would imply that credit constraints matter for more households.

4 See O'Connell et al. (2013) for a comparison of real per capita consumption before and during the financial crisis in the euro zone. Studies on Irish household consumption include Hogan and O'Sullivan (2007), Lydon and O'Hanlon (2012) and Gerlach-Kristen (2013 and forthcoming).

2. A small-scale model

This section presents a small-scale DSGE model to link households' consumption and savings decisions to the value of their mortgage and their real estate wealth. We assume that households try to smooth consumption and offer housing as collateral for the necessary credit. However, banks do not lend once households become too leveraged. This is equivalent to saying that households can borrow up to a specified fraction of their real estate wealth. A drop in the house price decreases the value of housing wealth and hence reduces the capacity of households to use debt to finance the purchase of consumption goods. Therefore, house price fluctuations matter for consumption decisions.

The model thus assumes that the credit constraint is only occasionally binding, depending on developments in the housing market.[5] It should be noted that occasionally binding constraints represent a large step forward compared to the literature on credit constraints.

There are two basic ways in the earlier literature to model credit constraints. First, it can be assumed that there are two types of households, one of which smoothes consumption, while the other always consumes all available income. The latter type of household has been interpreted as credit constrained (Erceg et al., 2005; Lalonde et al., 2007; Ratto et al., 2009; Kumhof et al., 2010; Cogan et al., 2010; Gomes et al., 2012).[6] Second, some authors have assumed that there is an ever-binding credit constraint (Iacoviello, 2005; Iacoviello and Neri, 2010; Guerrieri and Lorenzoni, 2011; Lambertini et al., 2013). In this situation, households always borrow as much as the constraint allows, thus increasing consumption when the value of their collateral rises and decreasing consumption when the collateral value falls.

Both these approaches have the disadvantage that they assume that there are households that never smooth consumption. This contradicts the permanent income hypothesis and seems implausible for most households but those in abject poverty.

The main impact of occasionally binding credit constraints is that households smooth consumption in good times (Jappelli and Pistaferri, 2010; Guerrieri and Iacoviello, 2013b). In bad times, they cut their consumption, since the credit constraint means they cannot smooth consumption any longer.[7] We show that they even reduce consumption before the constraint starts binding.

[5] To solve the model, we employ a piecewise linear solution technique developed by Guerrieri and Iacoviello (2013a) and available online under https://www2.bc.edu/matteo-iacoviello.

[6] This approach is also chosen by Mayer and Gareis (2013), who present a DSGE model for Ireland.

[7] The idea that occasionally binding collateral constraints deliver asymmetries and non-linearities in the responses of macroeconomic variables to shocks has been developed also in Brzoza-Brzezina et al. (2012) using a penalty function approach, as well as in Mendoza (2010) using a solution algorithm developed in Arellano and Mendoza (2002) and Mendoza and Smith (2006). Justiniano et al. (2013) model the borrowing constraint so to reproduce the asymmetry of mortgage contract and the downward stickiness of mortgage debt observed in 2006-2007 US data. Benigno et al. (2009) analyse optimal monetary policy rules for both crisis period when the borrowing constraints bind and for "normal" periods when the borrowing constraint is slack. They also conclude that optimal policy is non-linear. For more details on methodological aspects and a comparison of alternative parameterised expectations algorithms, we refer the reader to Christiano and Fisher (2000).

2.1 The model

Households provide housing as collateral good in order to have access to credit. Households gain utility from consumption c_t and housing h_t and therefore they maximise their utility function:

$$U_t = E_0 \sum_{t=0}^{\infty} \beta^t \left[(1-\chi)\log(c_t - \chi c_{t-1}) + \vartheta \log h_t\right] \tag{1}$$

where χ is a parameter which measures habit in consumption, $(1-\chi)$ is a scale factor which guarantees that the marginal utility of consumption in the steady-state is independent from the habit parameter, and the parameter ϑ measures preference on housing.

Households maximise their utility subject to a budget constraint and a credit constraint:

$$c_t + p_t^h h_t - p_t^h h_{t-1}(1-\delta_h) = y_t + d_t - R d_{t-1} \tag{2}$$

$$\frac{d_t}{p_t^h h_t} = lev_t \leq LTV \tag{3}$$

Equation (2) describes the budget constraint, where y_t denotes income and d_t denotes the mortgage debt, on which households pay the gross interest rate R. The term p_t^h denotes the house price, which depreciates at rate δ_h. The budget constraint requires that households' consumption and purchase of additional housing must be covered by resources, i.e. current income and the change in debt.

Equation (3) describes the borrowing constraint, which imposes that households are allowed to borrow only up to a certain level. In particular, the leverage ratio at time t, lev_t, may not exceed the maximum loan-to-value ratio, LTV, beyond which banks reject loan applications. We assume that this maximum LTV is constant over time. However, if it were to vary, this would impact on households' consumption decisions.

When house prices fall such that the current lev_t exceeds LTV, the credit constraint becomes binding and the parameter capturing this cost, λ_t, becomes positive.[8] If the borrowing constraint is not binding, equation (3) is replaced with equation (3a):

$$\lambda_t = 0 \tag{3a}$$

Households choose consumption, housing and debt, so that the following first order conditions hold:

[8] In models assuming an ever-binding constraint, equation (3) holds with equality and equation (3a) is never invoked. We present an impulse response based on an ever-binding constraint model in Figure 3.

$$\lambda_t = U_{ct} - \beta R U_{ct+1} \tag{4}$$

$$p_t^h U_{ct} = \vartheta U_{ht} + \beta(1-\delta_h)\, p_{t+1}^h U_{ct+1} + \lambda_t LTV p_t^h \tag{5}$$

where U_{ct} and U_{ht} denote respectively the marginal utility of consumption and housing and are defined as:

$$U_{ct} = \frac{1-\chi}{(c_t - \chi c_{t-1})} \tag{6}$$

and

$$U_{ht} = \frac{1}{h_t} \tag{7}$$

Finally, total output is assumed to be fixed and normalised to one:

$$y_t = 1 \tag{8}$$

and the house price is assumed to be exogenous, following an autoregressive process with an IID-normal error term ε_t^h:

$$\log(p_t^h) = \rho_h \log(p_{t-1}^h) + \varepsilon_t^h \tag{9}$$

It should be noted that we choose equations (8) and (9) to keep the model simple and our analysis tractable. A more elaborate model, which would also allow labour to respond to wealth shocks, would be desirable to analyse the implications of higher risk of unemployment for consumption and credit constraints, as well as the contribution of labour supply to the deleveraging process. Also, the question how house prices respond to other variables could be explored. For the purpose of the present paper, the simple model chosen here is sufficient to assess the main effect of credit constraints.

One central feature of the Irish data we use to examine the predictions of the model is that property prices were in free fall when the household interviews underlying the data were conducted. Prices had declined by a third between the end of 2006 and 2009/10, and households had begun expecting further declines. Indeed, the house price index bottomed out at half its original level only in 2013.

To capture the expectation of falling future house prices, we consider an alternative formulation for house prices, which assumes that households correctly anticipate the house price decline. In this case, equation (9) changes to

$$\log(p_t^h) = \rho_h \log(p_{t-1}^h) + \eta_{t-1}^h \quad \text{(9a)}$$

where η_{t-1}^h denotes a shock which is known with certainty to private agents in period $t-1$, but that will materialise only one period ahead.

2.2 Calibration and impulse response functions

For most of the parameters, the calibration is standard and close to Iacoviello and Guerrieri (2013b). We set $R < 1/\beta$, so that the constraint binds in normal times and the leverage is at its upper bound. This means that in equilibrium, households maximise consumption by maximising borrowing. The consumption habit parameter χ is set equal to 0.6 and falls in the range of standard values. We set the housing utility weight ϑ equal to 0.12, as in Iacoviello and Neri (2010) and Lambertini et al. (2013). We assume that the logarithm of the house price follows an AR(1) process, with high persistence ($\rho_h = 0.975$). Finally, in the baseline calibration, we set the maximum loan-to-value ratio LTV, beyond which banks reject loan applications, equal to 0.9. This value is consistent with the increasing proportion of loan-to-value ratios on mortgage loans between 2004 and 2008 (see Honohan, 2009; Kennedy and Calder, 2011). We also consider, as alternative, an LTV of 0.8. The calibration is summarised in Table 1.

Table 1: Calibrated parameters

Parameters	Values
Discount factor β	0.965
Housing depreciation δ_h	0.010
Consumption habit χ	0.600
Housing utility weight ϑ	0.120
House price AR parameter ρ_h	0.975
Loan-to-value ratio LTV	0.900

We compute impulse response functions of consumption, debt and the leverage ratio to a 2% shock in the house price. We first consider an unexpected house price decline (Figure 1), then an anticipated decline (Figure 2) and finally an unanticipated house price increase (Figure 3). This analysis allows us to assess the importance of precautionary savings, credit constraints and asymmetries in the response of consumption.[9]

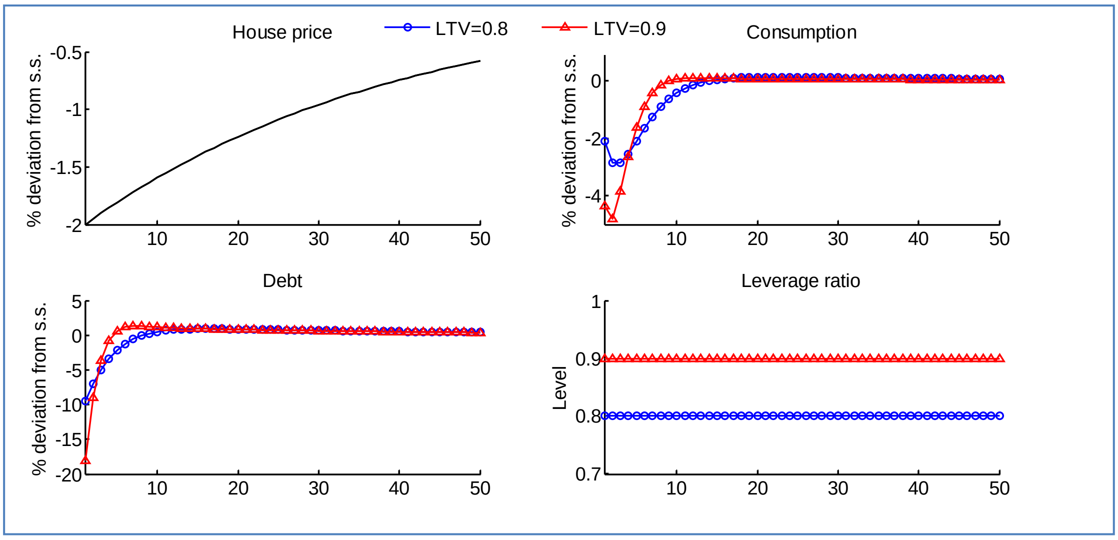
Figure 1 considers the effect of a 2% drop in house price. The line marked with triangles shows the responses for the baseline calibration ($LTV = 0.9$). The line marked with circles shows the response assuming that the regulatory authority sets a more prudent regulatory loan-to-value ratio ($LTV = 0.8$). The responses are reported as the percentage deviation from the steady state, except for the leverage ratio, which is reported in level.

[9] All simulations are run in Dynare 4.3.3, using the OccBin Toolkit developed by Guerrieri and Iacoviello (2013a).

If house prices fall, households start consuming less and use their savings to deleverage. Generally, households use as much credit as they can get to achieve the highest possible consumption level. However, with house prices falling, the credit constraint starts binding, and households attempt to return to a situation in which they can access credit. To do so, they pay back part of their debt and consume less. Once house prices return to the steady state, households start increasing their debt and consumption levels again.[10]

Figure 1 also shows that the deleveraging and consumption responses are weaker when more prudent credit conditions are in place (i.e. $LTV = 0.8$ instead of 0.9). This result is due to the fact that consumption is less dependent on credit if the maximum loan-to-value ratio is low. In terms of macroprudential policies, this finding supports the notion that a reduction of the regulatory loan-to-value ratio mitigates the consequences of financial disruptions, such as credit constraints, and hence protects households.[11] This finding is also in line with empirical evidence suggesting that countries with high maximum loan-to-value ratios are those in which the demand for new borrowing is more sensitive to shocks (Almeida et al., 2006).

Figure 1: Negative house price shock



Note: Simulations in Figure 1 refer to the model with the occasionally-binding constraint and show the response of macroeconomic variables to a 2% drop in house price. Variables are reported as deviations from the steady-state, except for the leverage which is reported in level. The line marked with triangles shows the responses for the baseline calibration of the loan-to-value ratio (LTV= 0.9). The line marked with circles shows the response for an alternative calibration (LTV=0.8).

In the recent financial crisis, house prices have fallen in many economies over an extended period of time, and households came to expect further declines. Figure 2 therefore reports the response of macroeconomic variables to an anticipated 2% drop in the house price. It

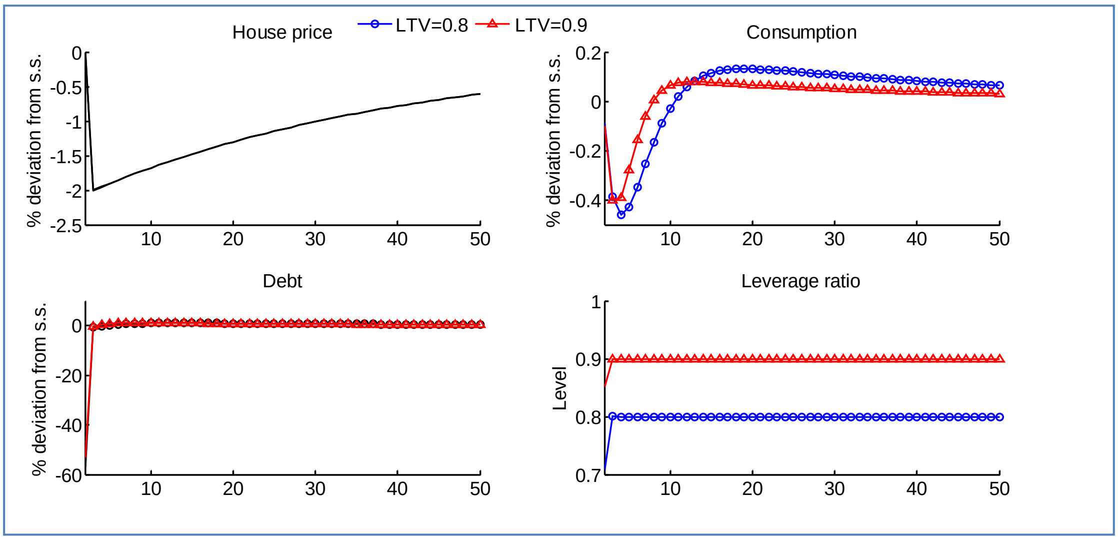
[10] It should be noted that the degree of deleveraging in our model is sizeable. This is due to the simple framework we choose, which does not include labour and therefore neglects that households can deleverage by working more and keeping consumption constant.

[11] A recent and growing literature investigates the implications of using loan-to-value ratios to contain boom-bust cycles in credit and housing prices (e.g. Christensen and Meh, 2011; Angelini et al., 2011 Lambertini et al., 2013).

shows that the mere expectation of a house price fall reduces consumption. As soon as households start expecting a house price decrease, they start consuming less and deleveraging. This precautionary behaviour is more marked when the maximum loan-to-value ratio is low, which suggests that households are better able to protect themselves from the risk of falling asset prices if they are not heavily indebted.

Comparing the simulations in Figures 1 and 2, we see that consumption responds less to an anticipated than to an unanticipated house price fall, while deleveraging is stronger. This reflects that households are able to smooth consumption somewhat when the credit constraint is not binding yet.

Figure 2: Anticipated future drop in house prices



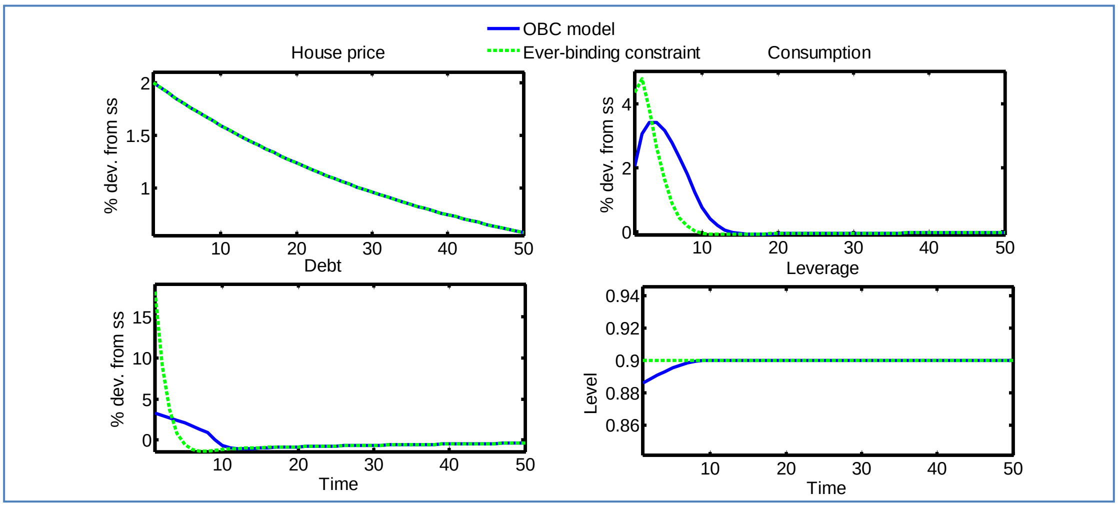
Note: Figure 2 shows the responses of macroeconomic variables in the model with an occasionally-binding constraint to a 2% drop in the house price. The house price shock materialises at time t+1 and is fully anticipated by households at current time t. Variables are reported as deviations from the steady-state, except for the leverage which is reported in level. The line marked with triangles shows the responses for the baseline calibration of the loan-to-value ratio (LTV= 0.9). The line marked with circles shows the response for an alternative calibration (LTV=0.8).

Figure 3 turns to recovery, which the data analysed in this paper do not cover. We here assume an unexpected 2% increase in the housing price. As discussed at the beginning of this section, households start smoothing consumption when a positive shock occurs in the model with the occasionally binding constraints. To show how this assumption, which we deem realistic, matters, we plot in Figure 3 also the impulse responses for a model which assumes that the borrowing constraint is always binding (denoted as ever-binding constraint model, dashed green lines). The responses are based on the baseline calibration of the maximum loan-to-value ratio ($LTV = 0.9$).

An increase in house price relaxes the credit constraint and allows households to borrow more in order to finance consumption in the short run. Households therefore consume more. However, the response of consumption in the model with the occasionally binding constraint is only modest when compared with the model with the ever-binding constraint.

The reason for this is that in the ever-binding constraint model, households always borrow as much as banks are willing to lend them and consume correspondingly. In the model with the occasionally binding constraint, households smooth consumption, so that the initial response of consumption is smaller but consumption is raised for longer.

Figure 3: Positive house price shock



Note: The simulations show the response of macroeconomic variables to a 2% increase in house price. Variables are reported as deviations from the steady-state, except for the leverage which is reported in level. The solid line denotes the response in the model with an occasionally binding constraint. The dashed line denotes the response in a model which assumes that the borrowing constraint is always binding. The loan-to-value ratio, LTV, is set equal to 0.9.

The asymmetric response of consumption generated by the occasionally binding nature of the credit constraint suggests that one has to distinguish between periods of rising and falling house prices when forecasting consumption.[12] It also suggests that if house prices undershoot after the collapse of a property price bubble and then recover somewhat, the response in consumption will be comparatively small.

To summarise the model, we find that a decline in house prices reduces consumption for mortgage households with high leverage, because they face credit constraints. Thus, consumption falls while income stays constant. This means that the permanent income hypothesis does not hold for highly leveraged households, and this is what we will test for in the micro data in Section 4. The model also predicts that households that expect to find themselves with too high a leverage in the future cut back in consumption already today, and we will also test for this effect.

[12] For instance, in a small open economy DSGE model with occasionally binding collateral constraints, Benigno et al. (2009) find that government should intervene aggressively by subsidising the consumption of non-tradable goods only in periods of stress, when the borrowing constraint is binding. In “normal” times, it is not optimal to intervene before the constraint actually binds, and therefore the optimal policy does not exhibit any precautionary motive.

3. The data

The Irish Household Budget Survey provides detailed information on household composition, expenditure, labour situation and income.[13] There is also information on financial circumstances, though this is more limited (e.g. the number of loans is reported, but not their value). In the regressions below, we concentrate on the latest wave of HBS interviews, which covers 2009 and 2010 and for which 5889 households gave answers.

3.1 Consumption, actual and permanent income

We define as consumption all expenditure items except mortgage and rent payments.[14, 15] Figure 4 shows weekly consumption and disposable income by age group for the last four waves of the HBS. The data are inflation-adjusted to the 2010 price level. The percentage indicated in each plot reflects how large the respective age group is relative to the whole population. Income measures disposable income, i.e. earnings from labour, property and other assets after taxes.

The impact of the crisis is most clearly visible for young households (defined as having a household reference person under the age of 35). Both disposable income and consumption drop sharply between 2004/05 and 2009/10, by on average 25.2% and 41.3%, respectively. For households in the middle-age bracket (head between 35 and 54 years of age), income rose by 4.4% in real terms, while consumption declined by 14.2%. For older households, income rose by 62.5% and consumption by 49.8%.

In interpreting these results, it is important to note that the plots in Figure 4 show households in the respective age group at the time of data collection. Thus, a household with a head aged 50 in the 1999/2000 survey contributes to the average shown for that period in the “middle-aged” plot. In the 2009/2010 survey, this household, the head now being aged 60, contributes to the “older” plot. Since education and thus income levels of those aged 60 in 2009/10 clearly exceeded those of 60-year olds in 1999/2000, the rise in income for older households is at least partly explained by more highly educated individuals aging. That said, Callan et al. (2013) examine the impact of the crisis on the Irish income distribution and find that older households have suffered least.

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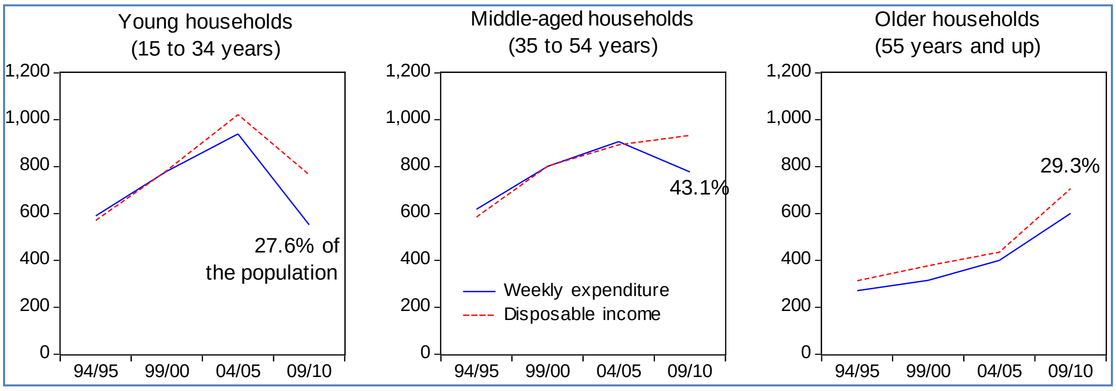
[13] Income and consumption are reported for the household as a whole, not broken down by individual.

[14] The HBS reports expenditure, not consumption. This means that a household’s consumption jumps up if for instance a new car is bought. The consumption utility derived from the services of the car is not recorded in the data.

[15] We also performed robustness checks that include housing expenditure in consumption, and the results are robust to this change in definition.

Figure 4: Weekly real consumption and disposable income by age group



Note: Values in 2010 prices, age of the household reference person. Average income and consumption by group, taking into account the grossing factors capturing the representativeness of the individual households interviewed in the HBS. Percentage numbers indicate the size of a group in question relative to the full population.

Figure 4 suggests that the typical older household was saving in all four HBS waves. Young households began consuming less than their current income in the 2004/05 survey, and middle-aged households in 2009/10.[16]

The permanent income hypothesis states that consumption decisions as based on permanent, rather than current, income. Current income is related to permanent income, since actual fluctuates around permanent. In the consumption regressions below, we treat actual income as a poor measure of permanent and instrument it with other variables that are related to permanent income but do not impact on consumption.

In particular, we use three instruments. The first is education, since more highly educated households tend to have higher permanent income. The second instrument is gender of the household head, since men tend to earn more than equally qualified women. The third measure is a proxy for permanent income derived using earlier HBS waves and a pseudo-panel approach.[17]

In micro panel studies, permanent income is often proxied by the long-term average income of the individual household. We are not able to construct individual average income from the HBS, since the survey waves constitute a series of cross-sectional datasets rather than a panel.

Nevertheless, there is a way to make use of the time-series dimension in income. Similar to the work on pseudo-panels in Alessie et al. (1997), we create groups of households with shared characteristics and compute their average income over time. In particular, we create 27 groups that differ by age (young, middle-aged, older), by education level (low, middle, high) and by tenancy (renters, mortgage and outright owners). We thus obtain a measure of

[16] For the economy as a whole, the savings rate computed from gross national disposable income and personal savings before stock appreciation is 4.2% for 1995, -0.5% for the year 2000, 2.9% for 2005 and 3.8% for 2010.

[17] J-tests for the exogeneity of these instruments with respect to consumption do not reject by a wide margin.

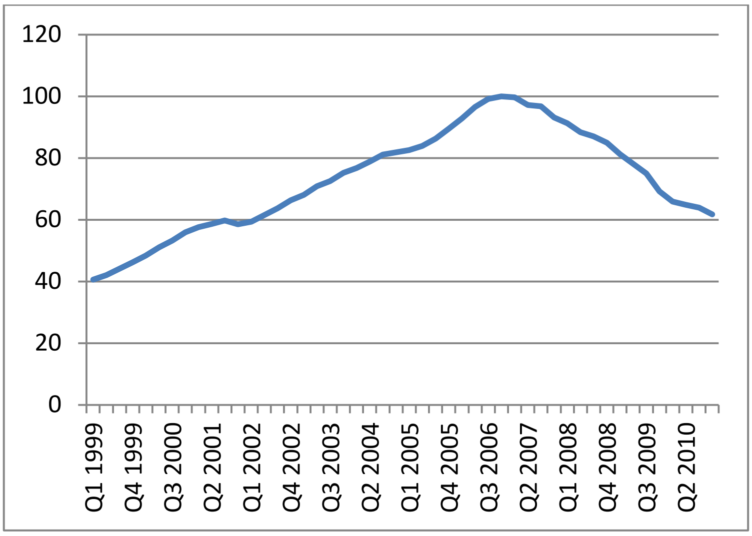
typical income for these 27 different population groups (Appendix B provides the details), and this is the third instrument we use on current income in the consumption regression.

3.2 Leverage

Since our model predicts that the permanent income hypothesis does not hold for highly leveraged households, we need to construct a measure of leverage. Generally, the HBS gives little information on assets and liabilities. However, we do know whether a household has a mortgage and when it last moved place. This information, in combination with the house price index, allows us to construct a proxy for leverage.

Figure 5 shows the Irish house price index, which is normalised to 100 in 2006Q4, since 1999. It suggests that a household that bought in 2006Q4, when the index peaks, and got a mortgage with an 85% loan-to-value ratio saw its leverage ratio rise above 85% in the following quarter. As house prices declined further, also households that had bought in 2006Q3 and earlier became overly leveraged.

Figure 5: Irish house prices (2006Q4 = 100)



Note: Permanent tsb/ESRI house price index, normalised to 100 for 2006Q4. The index was discontinued in 2011, when the CSO began publishing its own index.

To compute household leverage in 2009/10, we make use of data published by Duffy and O'Hanlon (2013) and of the average mortgage interest rate published by the Central Statistics Office. Duffy and O'Hanlon present data showing that in each year since 2005, the median mortgage was issued at a loan-to-value ratio of between 80% and 90%.[18] We therefore assume as loan-to-value ratio at origination a rate of 85%. Moreover, they show that the median mortgage had a maturity of between 26 and 30 years, and we therefore assume a maturity of 28 years.

[18] Kennedy and McIndoe Calder (2011) report a somewhat lower average loan-to-value ratio of between 50% and 80% for the years before the crisis.

We furthermore assume that mortgage payments combine an interest element and an amortisation element. We assume a fixed-rate contract and use as interest rate the average mortgage rate at the time of origination. Based on these assumptions, we are able to compute the leverage at the time of the household survey by year of mortgage origination. Appendix C presents details. Roughly speaking, we find that mortgage households that purchased in 2004 or later had a leverage ratio that exceeded 85% at the time of their HBS interview. The leverage ratio is lower for mortgage households that moved earlier.

Of course, our measure of leverage is just a proxy. One further caveat is that we implicitly assume that all house prices declined in line with the general house price index. In reality, there is clearly variation around this index. Nevertheless, our leverage ratio should roughly capture the financial situation Irish mortgage households were facing in 2009/10.

In the consumption analysis below, we make use of these numbers in two ways. First, we use the leverage ratio per se. This has the advantage of allowing for a stronger response in consumption for the most highly indebted households. It has the disadvantage that we have to exclude mortgage households that purchased their house before 1999, since we do not have mortgage rate information prior to that year. Second, we construct a dummy for highly leveraged households, for which the model implies a binding credit constraint. In particular, we set this dummy to unity for all households with a leverage ratio above 84%. We also construct a dummy for households at risk of facing a credit constraint in the near future, defined as those households having a leverage ratio between 60% and 84%.

Before turning to the question how credit constraints change consumption decisions in the Irish dataset, two further observations are in order. The first one concerns deleveraging. Many mortgage contracts allow an early repayment of the principal only at a penalty rate. Households in this situation may prefer to accumulate savings and thus reduce their net liabilities rather than paying back the principal and thus reducing their outstanding debt. The second observation is that credit constraints may have an effect even without households actually applying for credit. If households believe that they would be rejected, their consumption decisions will not be distinguishable from those of households that actually have restricted access to finance.[19]

4. Consumption function estimates

To assess whether the permanent income hypothesis is rejected for highly leveraged households, we turn to estimating consumption functions. If we find that highly leveraged households consume less than other comparable households, we interpret this as evidence of credit constraints and deleveraging. If we find that also households with a leverage ratio below normal loan-to-value ratios consume less than expected, we take this as evidence of

[19] The CSO (2013) reports that in 2011/12, a quarter of Irish households applied for bank credit, and that a quarter of these were rejected.

precautionary deleveraging that is caused by households' concern that house price might fall further and a credit constraint therefore might start binding in the future.

The standard consumption function assumes that consumption of household j depends on permanent income in a nonlinear fashion,

$$C_j = AY_j^b,$$

where A is a shift factor and b is the income elasticity of consumption, also called the marginal propensity to consume out of income. The permanent income hypothesis states that $b = 1$. When permanent income changes by one percentage point, so does consumption.

Taking logarithms and denoting $c_j = \log{(C_j)}$ etc, one obtains

$$c_j = a + by_j.$$

In our regressions, we let a depend on demographic characteristics of the household, tenancy status and self employment. Moreover, we let a as well as b vary depending on whether a household is young (under 35 years of age), unemployed or leveraged.[20]

Formally, our hypotheses are the following. First, the permanent income hypothesis should hold for most households, i.e. $b = 1$. Second, highly leveraged households face credit constraints, which makes them deleverage and cease smoothing consumption, i.e. $b < 1$. Third, households with lower leverage may also deleverage and cease smoothing consumption because they expect a further house price drop. Again, this implies $b < 1$. Fourth, unemployed and young households also may face credit constraints, so that again $b < 1$.

We estimate the consumption equation using GMM. Since the permanent income hypothesis states that permanent, rather than current, income drives consumption decisions, we treat current household income as an imperfect measure of permanent. To control for measurement error, we instrument current income with variables related to permanent income, but not to consumption (see also Gerlach-Kristen, forthcoming). In particular, and as discussed in Section 3, we use the education level and the gender of the household reference person as well as the pseudo-panel estimate of permanent income derived in Appendix B.

Tables 2 and 3 present the estimates. In Table 2, we use the leverage ratio to capture households' difficulties in accessing credit. This variable has the disadvantage that we exclude households that moved prior to 1999, since no information on the mortgage rate is available. In Table 3, we use instead two dummy variables for households with high leverage (over 85%) and medium leverage (between 60% and 85%), and thus are able to include data for mortgage households that moved in 1999 or before.

[20] We also tried interacting *b* with demographic, tenancy and employment information, but these interactions were generally insignificant.

The first column in Table 2 shows that we estimate an income elasticity of consumption *b* of 1.04. The hypothesis that this coefficient is equal to unity, as predicted by the permanent income hypothesis, is not rejected (p-value of 0.33). The average Irish household thus smoothed consumption during the financial crisis. However, we find that for households with high leverage, $\hat{b} < 1$. These households thus appeared not to smooth consumption, and the effect is the stronger, the higher the leverage ratio. Thus, if an indebted household sees its income rise, it does not increase spending proportionally, but instead saves part of the additional income. This is compatible with deleveraging efforts of highly leveraged households and the existence of credit constraints.

Table 2: Consumption function estimates using leverage ratio

	Consumption	Durable consumption	Nondurable consumption
Constant	-0.754**	-2.548***	1.803***
Age	-0.017**	-0.005	-0.063***
Size	0.003	-0.049**	0.074***
Children	0.003	0.046**	-0.062***
Rural	0.035**	0.038**	-0.026
Local authority housing	0.190***	0.169***	-0.177***
Outright owned	0.321***	0.282***	-0.381***
Mortgage owned	0.372***	0.312***	0.112**
Self employed	0.168***	0.169***	0.167***
Young	-1.801	-0.886	-1.615
Unemployment	-1.249	-2.262	-0.643
Leverage	2.403***	2.631***	0.886
Income	1.045***	1.270***	0.595***
Income*young	0.277	0.127	0.253
Income*unemployment	0.231	0.399	0.135
Income*leverage	-0.382***	-0.416***	-0.119
Adjusted R^2	0.540	0.517	0.553
Test of permanent income hypothesis (p-values)			
Young	0.345	0.300	0.484
Unemployment	0.466	0.120	0.462
Leverage	0.000	0.030	0.000

Note: GMM estimates, 4687 observations. Income instrumented with pseudo-panel permanent income, household reference person age and gender. Income and consumption in logs. */**/*** denotes significance at the 10/5/1 percent level.

The bottom of the table shows p-values for a Wald test that the permanent income hypothesis holds for leveraged households (i.e. we test if the sum of the baseline $\hat{b}$ and the $\hat{b}$ estimated for leveraged households sums to unity). The test is clearly rejected.

Interestingly, being young does not seem to matter for consumption patterns, nor does unemployment.

It should be noted that we estimate a significantly larger shift factor a for leveraged households than for the baseline household. This suggests that consumption is reduced only from a certain income level onwards. In particular, leverage seems to depress consumption from a weekly income level of 560 euros onwards. Below that level, consumption expenditure appears to be larger than for households without mortgage debt.

Table 3: Consumption function estimates using leverage dummies

	Consumption	Durable consumption	Nondurable consumption
Constant	-0.582**	-2.280***	1.748***
Age	-0.017**	-0.008	-0.060***
Size	0.011	-0.040*	0.076***
Children	0.005	0.046***	-0.052***
Rural	0.035**	0.038**	-0.022
Local authority housing	0.176***	0.154***	-0.184***
Outright owned	0.321***	0.288***	-0.387***
Mortgage owned	0.296***	0.242***	0.066**
Self employed	0.164***	0.167***	0.163***
Young	-1.777	-0.944	-1.456
Unemployment	-1.237	-2.258	0.643
High leverage	2.180***	2.147***	0.855
Medium leverage	3.046***	3.282***	1.562*
Income	1.017***	1.227***	0.600***
Income*young	0.273	0.135	0.228
Income*unemployment	0.226	0.395	-0.078
Income*high leverage	-0.340***	-0.337***	-0.107
Income*medium leverage	-0.452***	-0.485***	-0.214*
Adjusted R^2	0.556	0.534	0.556
Test of permanent income hypothesis (p-values)			
Young	0.403	0.357	0.406
Unemployment	0.431	0.082	0.113
High leverage	0.000	0.165	0.000
Medium leverage	0.000	0.044	0.000

Note: GMM estimates, 5196 observations. Income instrumented with pseudo-panel permanent income, household reference person age and gender. Income and consumption in logs. */**/*** denotes significance at the 10/5/1 percent level.

The first column in Table 3 shows the analysis using leverage dummies rather than levels. Here we find that highly leveraged households, defined as those with a leverage ratio exceeding 84%, appear not to smooth consumption. For households with a medium leverage ratio, defined as ranging between 60% and 84%, the permanent income hypothesis also is rejected, and the coefficient estimates are similar to those of the highly leveraged households.[21] This supports the prediction that households that expect to face credit constraints in the future adjust consumption already today and try to deleverage.

The remainders of Tables 2 and 3 split consumption into durable and non-durable consumption. [22] For the baseline household, the permanent income hypothesis is rejected in both cases: households tend to increase their spending on durable goods more than proportionally when their incomes rise (p-value for test that $\hat{b} = 1$ of 0.00), while the expenditure on non-durables increases less (p-value of 0.00). This suggests that richer households spend a smaller fraction of their income on basic goods, such as food and fuel, than poorer households.

We find a similar pattern for households with leverage, although the rejection of the permanent income hypothesis is less clear for durable goods. This suggests that, when indebted households see their incomes rise, they do not increase spending on durable goods by as much as the baseline household. Again, this suggests that they are saving part of their additional income, presumably to deleverage.

5. Conclusions

Credit constraints are a major concern especially during financial crises. If households are unable to smooth consumption, the drop in aggregate spending can cause a vicious circle in terms of falling output, falling asset prices and rising credit constraints. The question when and how credit constraints emerge and spread is therefore crucial.

In this paper, we present a small-scale DSGE model that links a household's access to credit to the value of the collateral it has to offer. This collateral is housing. If house prices decline, the leverage ratio of a household, defined as the mortgage debt relative to its housing wealth, rises. If the leverage ratio exceeds the maximum loan-to-value ratio used by banks in accepting loan applications, the household becomes credit constrained, ceases to smooth consumption and uses the savings to deleverage. We show that this effect is present even if households only expect a decline of house prices in the future and currently are not facing a credit constraint yet.

We then use an Irish dataset from 2009/10 to examine whether consumption smoothing is disrupted for highly leveraged households. We find this to be the case, and the deviation from the permanent income hypothesis to be the stronger, the higher the leverage ratio. Households with leverage close to but below the standard loan-to-value ratio of 85% also

[21] A Wald test for the equality of the income elasticities of households with medium and high leverage does not reject (p-value of 0.41).

[22] We define as durable consumption expenditures on what the HBS calls "durable household goods" and motor vehicles. Non-durables are all remaining expenditure items.

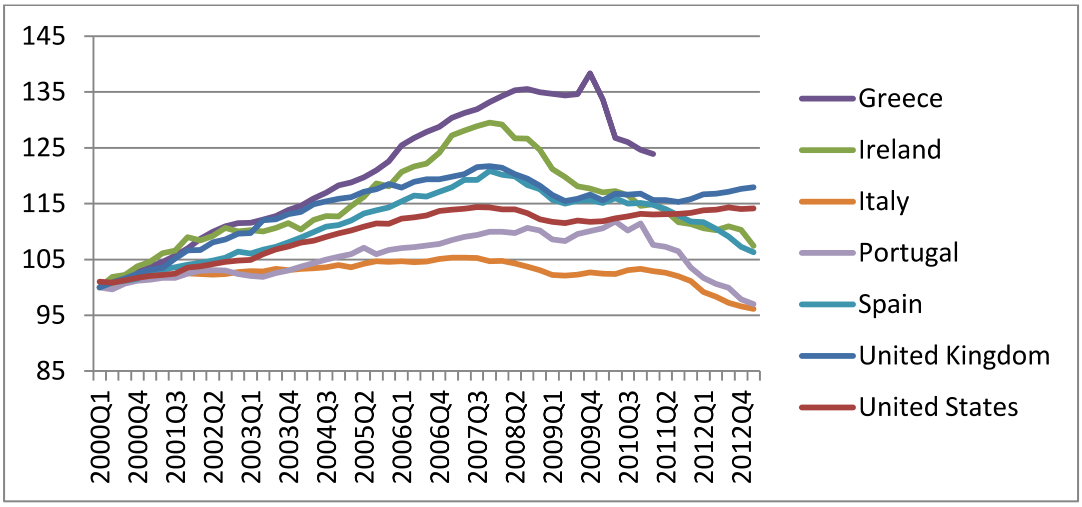
seem to smooth consumption less than normal households. This is rational if they expect a further house price decline.

In sum, this paper provides evidence of credit constraints that arise from falling property prices. In terms of policy, the model predicts a smaller effect if the loan-to-value ratio used by banks is lower. This is an argument for a regulatory maximum LTV ratio.

Appendix A: Consumption expenditure since 2000

Graph A shows real per capita consumption expenditure for the European periphery, the United Kingdom and the United States. Consumption has been normalised to 100 in 2000Q1. Data for Greece ends in 2011Q1, the other series end in 2013Q1.

Graph A: Real per-capita consumption expenditure (2000Q1 = 100)



Note: Consumption expenditure deflated with the CPI, from Eurostat, and corrected for population growth, from the United Nations.

Appendix B: Computation of permanent income

Table A shows permanent real income proxies by household tenancy, education and age. We compute this measure as the average over time (i.e. over HBS waves) of the average income within each population group. Mortgage owners, more educated households and middle-aged households tend to have the highest permanent incomes.

Table A: Proxies for permanent income by age, tenancy and education level

	Renters			Mortgage owners			Outright owners		
Education	low	middle	high	low	middle	High	low	middle	high
Young	507	663	889	817	919	1098	672	689	899
Middle aged	467	575	820	827	996	1185	700	841	1100
Older	301	357	298	516	704	777	397	509	485

Note: Permanent income, in 2010 euros, by population group, constructed as the average over time of the average group income in the 1994/95 to 2009/10 HBS waves. Young = household reference person between 15 and 34 years of age, middle aged = between 35 and 54 years, older = 55 years and up.

Appendix C: Computation of household leverage ratios

Here we discuss how we compute the proxy for the leverage ratio of mortgage households. There are four main assumptions underlying this measure.

First, we assume a loan-to-value ratio of 85% at origination, so that the mortgage corresponds to 85% of the value of the property the household purchases. Thus, $d_{origination} = LTV p^h_{origination}$. We assume for simplicity that after the down-payment for the mortgage, the household does not have any assets but the house.

Second, we assume that the house value moves in unison with the general house price index presented in Figure 5. We use the house price index in the quarter in which the interview was conducted and we denote it by p^h_t. For each household, we know how many years ago it last moved, though there is no information on quarters. We therefore assume that the move was exactly the number of years ago the household indicates, with no additional quarters. This gives us the value at origination $p^h_{origination}$.

Third, we assume that the mortgage contract is fixed rate and has a maturity T of 28 years.[23] The monthly payments made are constant over time and combine the interest payment, which declines as the remaining principal decreases, and an amortisation payment, which correspondingly rises over time. As there are no data available on mortgage rates at origination, we use the average mortgage rate in the quarter of the house purchase and denote it by $mrate$. We calculate the monthly payment as

$$monthly\ payment = \frac{d_{origination}}{1 - \left[\frac{1}{(1+mrate)^{12T}}\right] / mrate}$$

We denote as $\sum payments\ made$ the sum of the monthly payments made since the origination of the mortgage.

Fourth, we assume that each household only has one mortgage, so that the number of real-estate properties per household is $h_t = 1$.

Based on these assumptions, we compute the leverage ratio in the quarter of the HBS interview as

$$\frac{d_t}{p^h_t} = lev_t = \frac{d_{origination} - \sum payments\ made}{p^h_t} = \frac{LTV p^h_{origination} - \sum payments\ made}{p^h_t}$$

[23] Kennedy and McIndoe Calder (2011) report that most Irish mortgages are flexible-rate contracts. Since the speed of amortisation primarily depends on maturity, our measure of outstanding debt at the time of the HBS interview should be roughly accurate nevertheless.

Table B presents the leverage ratios by interview quarter and year of house purchase.

Table B: Proxies for leverage ratios used in Section 4

Interview quarter / Purchase year	2009Q3	2009Q4	2010Q1	2010Q2	2010Q3
2010			85%	85%	85%
2009	85%	85%	103%	100%	98%
2008	97%	102%	114%	112%	112%
2007	106%	111%	122%	121%	122%
2006	106%	116%	109%	116%	120%
2005	89%	100%	94%	97%	101%
2004	81%	89%	85%	89%	93%
2003	66%	79%	74%	78%	81%
2002	61%	68%	63%	67%	70%
2001	56%	60%	62%	64%	66%
2000	50%	57%	48%	52%	55%
1999	39%	44%	40%	42%	45%

Table C shows which households were particularly likely to be highly leveraged. It can be seen that the younger the mortgage household, the more likely it is to be highly leveraged. There is also weak evidence that more highly educated households, small households, those with few children, those in rural areas and those unemployed are more affected.

Table C: Determinants of a high leverage ratio

Constant	1.685***
Age	-0.081***
Education	0.016*
Female	-0.001
Size	-0.014*
Children	-0.019*
Rural	0.023*
Self employed	0.000
Pseudo-panel measure of permanent income	-0.077
Current income	0.008
Unemployment	0.041*
Number of obs	1407
Adjusted R^2	0.128

Note: OLS estimates, robust standard errors, sample of mortgage households that last moved after 1998. Permanent and current income in logs. */**/*** denotes significance at the 10/5/1 percent level.

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