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SUMMARY

We construct a simple probit model of the determinants of real house price slump endings. We find that the probability of a house price slump ending is higher, the smaller was the pre-slump house price run-up; the greater has been the cumulative house price decline; the lower are real mortgage interest rates; and the higher is GDP growth. Slumps are longer, other things being equal, where housing supply is more elastic, but shorter the more developed are financial institutions. For slumps of a given size, shorter sharper slumps are associated with worse macroeconomic performance in the short run, but with better performance in the long run. This suggests that for sufficiently low discount rates, policy makers should not impede the decline in real house prices, and this conclusion is reinforced by the finding that after a certain duration, house price slumps can become self-reinforcing. On the other hand, we also find evidence that during downturns, falling house prices can lead to lower private sector credit flows. Policy makers thus face a delicate balancing act. While they should not intervene to artificially prop up overvalued house prices, they should ensure that their macroeconomic and banking policies are such as to make a bottoming-out more likely. This suggests that they should keep real interest rates low, and ensue that banks are well-capitalised.

1. INTRODUCTION

The housing cycle, Leamer (2007) has argued, *is* the business cycle. Exaggeration or not, there is no question, in light of the magnitude of the decline in housing prices in the advanced economies, that how and when the current housing slump ends will matter importantly for the timing and vigour of economic recovery. But there is high uncertainty about when housing prices will end their descent. Prices have fallen further and for longer than in any other post-1970 housing slump. What can we say about when this process might finally come to a close?

Taking data for the OECD countries from 1970 through the mid-1990s, Loungani (2010) finds that housing slumps have lasted on average for 4 ½ years, during which prices fell by an inflation-adjusted 20 per cent. Booms, in contrast, lasted just over five years, during which housing prices rose by 40 per cent in real terms. Such regularities could conceivably be useful for predicting future behaviour.

But "this time is different." The most recent boom was longer – prices rose for 41 quarters rather than 21 – and the run-up in prices adjusted for inflation was three times greater.[1] To understand better when the current housing slump might end, we would therefore want an analysis that looks not just at average behaviour but also at variations and their determinants – one that exploits the relationship between the extent of the earlier boom and the depth and duration of the subsequent slump, for example. The fact that experience since the 1990s has differed also suggests that, in order to understand how and when the current housing slump might end, it is important to bring data and analysis up to date.

While previous work has focused on housing booms – when they start, how they grow, and why they come to an end – there is almost no research on house-price slumps, the issue of concern today. And there is reason to think that the relationship between price dynamics and their determinants are not the same in the expansionary and contractionary phases of the cycle. Rising prices tend to elicit additional construction activity that increases supply, although the extent of this will depend on land-use policy, permitting practices, and so forth. But although construction activity similarly falls when prices fall, there is less of a tendency to destroy a portion of the existing housing stock.[2] This is likely to limit the negative supply response in deep slumps in particular. The behaviour of homeowners may similarly differ when prices are rising and falling. Homeowners show little reluctance to raise asking prices when demand is strong, but hesitate to cut them when it is weak. Price dynamics and their determinants may thus be very different during booms and slumps. It may therefore be misleading to draw inferences about how macroeconomic and financial developments – say, faster GDP growth or lower interest rates – will affect the likelihood of a housing slump coming to an end from previous work on the impact of these variables on prices during booms.

Then there is the possibility that the broader environment has changed in ways with implications for housing markets. The Committee on the Global Financial System (2006) suggests that the Great Moderation, by reducing uncertainty about incomes, employment and funding costs, stimulated the demand for long-lived, big-ticket items like homes. If the Great Moderation is now over, then this could have implications for the length and depth of the housing slump.[3] Similarly, the OECD suggests that the ongoing deregulation of mortgage and financial markets has altered the relationship between housing prices and, inter alia, monetary policy. This makes it important to look for structural changes and, insofar as possible, to bring the data up to date.

In this paper we focus on housing slumps and how they end. We bring the data up as close to the present as possible. We estimate models that allow the probability of a slump ending to depend on its depth and the size of the preceding boom. We allow a role for both macroeconomic and financial factors, and ask whether and how the institutional environment matters. And we report a number of new findings. In the penultimate section of the paper we use them to ask a series of question about how policy makers should respond to housing slumps.

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[1] Again, according to Loungani.

[2] Although there are some darkly amusing exceptions to the rule: see inter alia Jenkins (2008) and Streitfeld (2009).

[3] Ceron and Suarez (2006) similarly document a negative relationship between volatility and the strength of housing price increases (see below).

2. RELATED LITERATURE

An extensive list of studies shows that house price dynamics exhibit cycles and attempts to identify their correlates. Case and Shiller (1989) and Muelbauer and Murply (1997) show that house price increases are autocorrelated: that lagged price increases help to predict current price increases. Other papers like Englund and Ioannides (1997), Capozza et al. (2002),Tsatsaronis and Zhu (2004) and Claessens, Kose and Terrones (2011) study the relationship between house prices and macroeconomic variables such as GDP growth, unemployment, interest rates and inflation. There are also studies of the relationship between prices and housing-specific variables like the volume of transactions and time on the market (Stein 1995, Krainer 2001, Glindro et al 2011).

Other studies closer to our own attempt to distinguish price dynamics in different subperiods. Using a two-state Markov model with country-specific dynamics, Ceron and Suarez (2006) find that prices are characterized by a low-volatility state with high house-price growth and a high-volatility state with slower price increases. The average duration of these high- and low-volatility phases is 6 and 6 ½ years, respectively, and switches from low- to high-volatility states typically precede or coincide with peaks in house prices. Controlling for latent factors and macroeconomic variables, the authors confirm the Case-Shiller-Muelbauer-Murply finding that house prices exhibit significant autocorrelation.

Other papers relate housing prices to financial-market conditions. Bordo and Jeanne (2002) show that boom-and-bust episodes are more frequent in housing than equity prices.[4] Using data for 13 advanced economies, Borio and McGuire (2004) estimate probit models to assess the probability of a house price peak, finding that house-price peaks follow equity price peaks with a lag of roughly two years. Moreover, positive shocks to interest rates increase the likelihood of a house price peak. Finally, the magnitude of the subsequent slump is larger the greater was the preceding cumulative house price increase, and the larger are cumulated financial imbalances, as measured by unusually rapid and sustained credit and equity price growth during the boom phase.[5]

Another group of studies focuses on influence of housing finance. Zhu (2006) finds that house prices behave more like asset prices in countries where mortgage markets are better developed; they are more responsive to changes in economic conditions, including equity-market innovations. IMF (2008) asks whether mortgage-market and financial-market development generally have altered the relationship between housing and the business cycle. It concludes that increased use of real estate as collateral has tightened the connection between spending and housing prices. It shows that monetary policy has a larger impact on house prices in countries with more developed mortgage markets.[6]

[4] In addition, banking crises usually occur at the peak of the housing boom or soon thereafter, reflecting the involvement of banks in housing finance. This is in line with the evidence reported by Reinhart and Rogoff (2009), especially for major banking crises, where major banking crises means their "Big Five" crises (Spain, 1977; Norway, 1987; Finland and Sweden, 1991; and Japan 1992). In a study for Norway, Gerdrup (2003) similarly provides a long-term perspective on the links between banking crises in the 1890-1993 period and the boom and bust in house prices.

[5] Van den Noord (2006) similarly studies the determinants of house price peaks in advanced countries. He finds that house prices have tended to co-vary more closely across countries over time, and that global factors (notably increases in global liquidity) have played an increasingly important role in both country-specific and common trends.

[6] Something that in turn amplifies the impact of monetary policy on consumption and output.

Finally it suggests that shocks to home prices have a larger impact on macroeconomic activity in countries with more developed markets.[7]

The only paper of which we are aware focusing specifically on housing slumps is Carson and Dastrup (2009). Comparing house-price falls across U.S. metropolitan areas, they find that a significant fraction of the variation can be explained by new construction, lending behaviour, and demographics. Relatively large slumps occur in places with larger preceding increases in house prices, a higher percentage of high priced and/or low quality loans, and faster increases in building relative to the increase in the workforce before the onset of the slump.

The literature thus suggests that in attempting to answer the question of how and when housing slumps end, we should start by focusing on earlier price developments, macroeconomic variables, financial conditions, and the structure of housing and mortgage markets. It is to the basics of this task that we now turn.

3. WHEN DO HOUSING SLUMPS END?

The first important step is defining house-price slumps. We define slumps using a cycle-dating method analogous to that of van den Noord (2006).[8] We identify the start of a slump as the period when the house price index, adjusted for inflation, reaches a local maximum, and its end as when it reaches a local minimum. For the latter, we also require that inflation-adjusted prices rise on average over the four subsequent quarters. In contrast to the literature on house-price run-ups that generally takes 15 per cent as the minimum relative price increase needed to define a boom, we do not require house prices to fall below a threshold level in the course of a slump.[9]

Figure 1 shows inflation-adjusted house price indices in 18 advanced countries over from 1970 through 2010.[10] Vertical lines indicate the end of house price slumps as we define them. The figure underscores the heterogeneity of price dynamics, although there are some interesting commonalities. Many countries exhibit a house price peak at the end of the 'eighties or beginning of the 'nineties, while some countries (e.g. Germany and Japan) present unusually persistent house price declines.

Our method identifies 55 slumps with both start and end dates, and 4 slumps that are ongoing at the time of writing (Ireland, the Netherlands, Spain and the United States). Table 1 lists these, together with the declines in inflation-adjusted prices and the average house price growth rate in the four quarters following the end of each slump. The current crisis triggered persistent house price falls in

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[7]Other papers study what determines the development, rather than the consequences, of housing finance (Warnock and Warnock 2008).

[8]However, he implements this method to date house price peaks. Another paper using a similar dating procedure is Girouard et al. (2006).

[9] Since house prices display downward stickiness, imposing such a threshold would eliminate a number of potentially interesting episodes. Van der Noord (2006) argues that owners of existing homes tend to withdraw from the market, rather than experience a capital loss, and builders usually reduce the housing supply in bad times. Below we perform a robustness check where we impose a minimum fall of at least 15 per cent and show that our results carry over.

[10] Quarterly inflation-adjusted house price data are used throughout.

13 of the 18 countries in the sample, including the four above-mentioned slumps which are still ongoing.[11]

To study how different covariates affect the probability of house price slumps ending, we estimate the probit model $\text{Prob}\ (\mathrm{Y}=1|\mathbf{x})=\int_{-\infty}^{\mathbf{x}'\boldsymbol{\beta}}\phi(\mathrm{t})\mathrm{dt}=\Phi(\mathbf{x}'\boldsymbol{\beta})$, where ϕ and Φ are the normal density and distribution functions, respectively. Y is our dependent variable, a dummy variable that takes the value $Y=1$ at each slump end and $Y=0$ otherwise. $\boldsymbol{\beta}$ is the vector of coefficients measuring the impact of the explanatory variables included in $\mathbf{x}$ on the probability of house prices bottoming out.

$\mathbf{x}$ indicates our core explanatory variables. The first is the cumulative rise in house prices prior to the slump. This is the percentage price change between the preceding local minimum and maximum (the latter coinciding with the start date of the slump). It is designed to capture the intuition of, inter alia, Borio and McGuire (2004) that the duration of a house price bust should be related to the size of the immediately preceding boom.[12] If slumps involve the realignment of prices to sustainable long-term levels, then the probability of their ending will depend on how much of the price adjustment has taken place. As a second explanatory variable we therefore include the cumulative house price fall during the slump. Previous studies having reported a tight relationship between house prices and the business cycle, we include GDP growth as a third explanatory variable. Our fourth variable is the mortgage interest rate, as a measure of the cost of housing finance.[13] In addition, $\mathbf{x}$ includes fixed effects, to control for time-invariant country-specific heterogeneity.[14]

3.1. BASELINE RESULTS

The first column of Table 2 shows the coefficients associated with these variables, while the other columns report semi-elasticities at different points of the distribution.[15] As expected, the impact of previous house price booms on the probability of the slump ending in the current quarter is negative. However, the coefficient is statistically insignificant. The cumulative house price fall has a positive effect on the probability of the slump ending. In contrast, this coefficient is significant. A 1 percentage point increase in the cumulative fall (relative to the level at the start of the slump) increases the probability of bottoming out by 3.8-4.3 per cent.[16]

GDP growth has a negative effect on the duration of the slump, as anticipated. A 1 percentage point increase in GDP growth rates raises the probability of bottoming out in the current quarter by 32 to 35 per cent. Again, this variable is statistically significant at the 1 per cent confidence level. Financial conditions also matter. Higher mortgage rates raise the likelihood of the slump continuing. More

[11] Although some of these housing markets are currently showing signs of recovery, we do not include the end of these episodes in the sample, since there is still not enough evidence of recovery (four quarters in which prices rise on average) for us to declare a definitive end to the slump.

[12] Something that is most plausible if the preceding boom is accurately characterized as a bubble, during which unsustainable increases in prices occurred.

[13] We take mortgage interest rates from the IMF IFS and deflate these using private consumption prices. However these data are not available for all time periods. In periods where they are missing, we interpolate using inter-bank interest rates (the correlation coefficient between the two interest rates is 0.72). We later perform a series of robustness checks using different interest rate measures, and find that our qualitative and quantitative results are basically unaltered.

[14] Unless otherwise stated.

[15] Since this is a non-linear model, the impact of a change in each exogenous variable depends on the point at which the marginal effects are evaluated. Here we report the marginal effects (semi-elasticities) evaluated at the variables' mean, median, and 10^{th} and 90^{th} percentiles.

[16] Recall that all prices are in real (inflation-adjusted) terms.

specifically, a 1 percentage point increase in the real mortgage rate reduces the probability of a slump ending by 17.5-19.5 per cent.

In summary, the baseline model suggests that the probability of a housing slump ending depends on how much price adjustment has occurred, on the health of the economy, and on financial conditions. While the predictive power of the model is low, this is to be expected, given the small number of slump ends relative to the sample size.[17]

We can use these results and the latest available information on the four explanatory variables to estimate the probability that housing-price slumps have now come to an end in the four countries where slumps are still ongoing.[18] Table 3 shows these estimates, with column (1) reporting the slump end probabilities in each country. Since such point estimates are subject to a wide margin of uncertainty, Figure 2 therefore plots the simulated density functions of slump end probabilities. Table 3 suggests that there is now a statistically significant likelihood of slumps ending in Spain and in the U.S. That said, even in the United States, where the point estimate of the probability of bottoming out is highest, it is still less than 20 per cent. Figure 2 shows that the probability that the US slump has ended is not above 40 percent.

The point estimates of Table 3 also suggest a 12 per cent probability of the slump ending in Ireland, but this result is only statistically significant at the 10 per cent confidence level. While the distribution function in Figure 2 suggests that the probability of an Irish slump end may be larger, the likelihood of this being the case is very small.

We can also use our baseline results to see how these predicted probabilities would change, under alternative macroeconomic scenarios. What happens to them if GDP growth recovers strongly, or alternatively if there is a double dip recession? And how will changing interest rates influence the probability of house price slumps ending?

To get a handle on how GDP growth affects these probabilities, we simulate probabilities using the best and worst GDP growth rate performances in our country sample. In recent years these were both to be found in Ireland, with the values of -2.35% and 2.37% corresponding to 2008 and 2000, respectively.[19] Columns (2) and (3) report these probabilities, with other explanatory variables set at their latest value in each country.

As expected, a GDP contraction leads to a large reduction in the probability of slump ends: probabilities fall by a half or more in all countries, relative to the baseline scenario, with end probabilities in Ireland and the Netherlands becoming statistically zero. The largest proportional

17 We evaluated this using a variety of measures: McFadden's R^2 (0.09), McKelvey and Zavoina's R^2 (0.16), Maximum Likelihood R^2 (0.03), Cragg & Uhler's R^2 (0.10) and Efron's R^2 (0.03) and Count R^2 (0.95).

18 Of course, this assumes that the model continues to apply in current circumstances, and that there has not been a structural break in the relationships between these variables as a result of the current crisis. We have estimated our models excluding the current crisis and find that the relationships are consistent with those reported here (see also footnote 49), but are aware that this cannot definitively exclude the possibility of such a break. (The main difference that we find is that excluding the current crisis, the impact of mortgage interest rates becomes smaller, suggesting that insofar as there has been a structural break this has been in the direction of making interest rates more important in determining when slumps end.)

19 It is important to take into account that these upper and lower bounds are chosen purely to give an indication of the magnitude of possible effects. The same comment applies to the upper and lower bound interest rates used later.

declines are in Ireland and the U.S.[20] Similarly faster GDP growth leads to an increase in these probabilities of 50% or more. Again, the U.S. exhibits the largest proportional increase in the slump end probability. This suggest that after conditioning on country-specific values of cumulative house price adjustment, previous price run ups and the latest mortgage interest rate, the link between GDP and house prices is tighter in the U.S. than in the other countries currently experiencing housing slumps. Figure 3 shows that different scenarios for GDP growth rates shift the distribution of slump end probabilities and also alter their shape. For instance, larger GDP growth rates are associated with flatter probability distributions.

Columns (4) and (5) report the simulated probabilities for the lowest and highest real mortgage interest rates in our sample, 0.07% and 9.14%. Table 3 shows that the scenario with the low interest rate is typically associated with a higher probability of slump ends, with the probability distribution becoming flatter and shifting to the right (Figure 3). As before, the U.S. exhibits the largest proportional increase. For completeness, we also present a scenario using the larger interest rate. As can be seen, this dramatically reduces the probability of house prices bottoming out in all four countries.

We conclude that the probability of house price slumps bottoming out is very sensitive to changes in GDP growth rates and mortgage interest rates. While the current probability of house price slumps ending is not particularly large, even on optimistic assumptions about growth and interest rates, these probabilities can fall a lot if GDP growth turns negative or interest rates are increased. Equally, they can rise a lot if GDP growth increases or mortgage interest rates are reduced. The latter result is of particular significance for policy makers, of course, since they have some control over interest rates. We have also found that housing markets in the U.S. and Ireland appear to be more responsive to shifts in GDP growth and interest rates.

3.2. ROBUSTNESS CHECKS

We check the robustness of the baseline results following several strategies.

As a first pass, we estimated a linear probability model and found that our qualitative findings also emerge in this alternative empirical strategy.[21] Next, we excluded the country-specific fixed effects. As noted, our baseline specifications include fixed effects to control for the country-specific heterogeneity not captured by the explanatory variables. When the cross-section dimension is large relative to the time dimension, fixed effects may lead to an incidental parameters problem (Greene 2003), since the fixed-effects estimator is inconsistent and biased away from zero when group sizes are small. The baseline results are mainly unaffected by excluding them (column (2), Table 4). To control for global trends, we estimate the models including year fixed effects in column (3), finding that most of the baseline qualitative results carry over. The only exception is for the house price run-up variable. This now becomes statistically significant at the 10 per cent level.

Readers may worry about simultaneity between output growth and the probability of a housing slump coming to an end. We therefore estimated a probit model using instrumental variables in which

[20] We compute the proportional change as the ratio between the change in the probability of slump end and the change in GDP or the interest rate.

[21] This approach has the advantage of producing coefficients which are easily interpretable. However, its main flaw is that, unless vector is severely restricted, it cannot be a good description of the population response probability. Predicted probabilities generated by this model can be either greater than one or negative.

current GDP growth was instrumented with the trade-weighted average of foreign countries' GDP growth plus its own four lags. Column (4) reports the estimates produced by a maximum likelihood estimation procedure.[22] Reassuringly, these models yield point estimates for GDP that are similar to those in the baseline specification. We also checked whether the exclusion of GDP may have an impact on the point estimates of the other coefficients by estimating the probit model excluding GDP growth from the list of explanatory variables. As shown in column (5), this does not significantly alter the size of the other variables' coefficients.

Additional tests focus on the definition of slump ends and interest rates. We consider a forward-looking version of the baseline empirical specification in order to estimate the probability of the end of a slump happening in the near future. We use a dummy variable that takes the value one not only at the end of the slump but also in the preceding one or two quarters. This is one way of reducing the arbitrariness surrounding the dating of the slump end.[23] These estimates are reported in columns (2)-(3) of Panel B. They are consistent with what we report above, the main difference being that the coefficient on GDP growth becomes smaller and statistically insignificant. In addition, the coefficients associated with the preceding house price run up now become statistically significant at the 5 percent level.[24]

Column (4) presents a version of the model that excludes the four slumps that are still ongoing and shows that our results are unaltered. Column (5) limits our analysis to slumps with at least a 15 per cent fall in house prices. Again, the results carry over, the main difference being that all coefficients are larger and that the performance of the model improves significantly. The pseudo R^2 rises from 0.1 to 0.24, and the statistical significance of the house price run-up variable improves. This makes sense, since larger slumps are more likely to have been preceded by, and driven by, housing bubbles.

We also estimate models using alternative interest rate measures: nominal mortgage rates and nominal and real long- and short-term government bond yields. As before, the probability of a slump coming to an end increases when there is a reduction in the interest rate. This result holds for all interest rate measures.[25] Indeed, interest rates seem to be the most robust of all our explanatory variables, which is important since as noted earlier interest rates are the variable in our baseline model over which policy makers have the greatest control.

[22] We also estimated the Newey's minimum chi-squared estimator that estimates the probit model in two steps, as an alternative IV approach. This approach yields similar results to those of the Maximum Likelihood approach. Different tests for the validity and strength of instruments show that it is appropriate to instrument GDP growth with a trade-weighted average of the rest-of-the-world GDP growth and with its own lags. We checked whether these correctly span the endogenous variables with the Kleibergen-Paaprk LM statistic (underidentification test) and find that the system is identified with a Kleibergen-PaaprkChi-sq statistic of 57.90 and associated p-value of 0.0000. We also conducted a weak identification test. Here we reject the null hypothesis of weak identification with a Cragg-Donald Wald F statistic of 51.60 and Kleibergen-Paap Wald rk F statistic of 35.27. These statistics are larger than the Stock-Yogo (2005) tabulated critical values.

[23] Something that may be of particular importance in the context of quarterly data (van der Noord 2006).

[24] We also estimated models for different forecast horizons to check whether the explanatory variables in the baseline specification do a good job in predicting directional changes in house prices happening in quarter . is the current quarter and are the forecast horizons. (Note that in our baseline specification.) Our finding is that most of the coefficients' signs do not change. The exception is the effect of GDP growth, which exhibits a small, negative and statistically insignificant coefficient when . By contrast, the interest rate is a good predictor for slump ending in or : this is the most robust of our variables predicting slump ends.

[25]To conserve on space, we do not report these models. However, they are available upon request from the authors.

As an additional robustness check, we estimate a Cox proportional hazard model of the form: $h_j(t|\boldsymbol{x_j}) = h_0(t)\exp(\boldsymbol{x_j}\boldsymbol{\beta_x})$; where $h_j(t)$ is the hazard function, $h_0(t)$ is the baseline hazard, t denotes time, $\boldsymbol{x_j}$ are the core explanatory variables used in the baseline probit model and $\boldsymbol{\beta_x}$ the associated coefficients.[26] This takes into account the fact that, since slump ends occur at given times, these can be ordered and the analysis can be performed using that resulting ordering exclusively. The advantage of this approach is that we do not have to make a particular assumption regarding the distribution of slump ends, i.e. on the shape of the baseline hazard function $h_0(t)$.[27] The disadvantage is that, given our small slump sample, the coefficient estimates are likely to be less precise than those that could be estimated with a parametric duration model. However, the latter requires an explicit assumption for the slump length distribution.[28]

The results, in Table 5, show that the likelihood of a slump ending increases when GDP grows faster and when the interest rate falls. However, we do not find statistically significant effects for either the house price run-up or the cumulative house price decline variables.[29]

Ceron and Suarez (2006) having noted that high volatility is associated with weak housing prices, we therefore examined the influence of housing-price volatility on the probability of a slump ending. Our volatility measure is a backward-looking coefficient of variation computed over the two preceding years. While the impact of volatility on the probability of prices bottoming out is indeed negative, its effect is small. If volatility doubles, the probability of bottoming out falls by just 1 per cent (Table 6, Panel A, column 1).

Borio and McGuire (2004) suggest that when prices have been falling for an extended period, expectations of further price falls may become entrenched. To test this, we augment the baseline specification by including linear and quadratic trends in columns (2) and (3), respectively. The positive coefficient on the linear trend indicates that the length of the slump to date affects the probability of its ending positively, other things equal. Column (2) shows that lengthening it by 1 quarter (relative to the mean duration of 14 quarters) raises the probability of prices bottoming out by 9.2 per cent. For the model in column (3) we find that the coefficient on the linear trend increases. This implies that lengthening the slump by 1 quarter increases the probability of bottoming out by 14.3 per cent. However, the negative coefficient on the quadratic term indicates that this relationship weakens with time and ultimately reverses. This is consistent with the observation that experience of Germany, Japan and Switzerland suggests that house price slumps can be extremely long-lasting once they become entrenched.

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[26] Another option could be to put the slump duration on the left hand side and estimate a model by ordinary least squares. This would be problematic, however, since we would be assuming that the distribution of the residuals is normal. The duration of the slump conditional on the set of explanatory variables would be assumed to follow a normal distribution, which implies allowing slumps to have negative duration. Instead we estimate a duration model which allows us to relax the normality assumption.

[27] However, whatever the shape is, it is assumed that it is the same for all slumps, and that it does not change over time.

[28] For more details on the Cox proportional hazard model see Green (2003) and Cleves et al (2004).

[29] The loss of statistical significance and change of sign of the cumulative house price fall is associated with the fact that the Cox model uses a different measure for the cumulative house price fall. The reason for this is that the Cox model assumes that the explanatory variables are time independent. We follow the standard approach and interact with a linear time trend the only variable that does not pass the proportional hazard assumption, i.e. the cumulative house price fall. As a result, the coefficients associated with this variable in the probit model and in the Cox model are not directly comparable.

We also experimented with including the cumulative price decline squared along with the cumulative price decline. The rationale for this specification is to look for evidence showing that slumps become self-perpetuating not after a certain period of time but after prices have fallen by a certain extent. There is little support for this alternative formulation. From the results in column (4) it appears that it is the length rather than the depth of a slump that can lead to it becoming self-perpetuating.

Earlier studies having implied a link between stock markets and house prices, we add the growth of total stock market return indices (columns 1-3 of panel B in Table 6). As expected, we find that the likelihood of house slumps ending is positively correlated with the stock market. In addition, future growth in stock market returns helps predict the probability of house slumps coming to an end in the current quarter.

Inspired by Reinhart and Reinhart's (2008) observation that capital inflows can fuel house price increases, we add the current account scaled by GDP to the specification in column (4) of panel B. The sign of the current account balance is positive, indicating that current account surpluses (capital outflows) are associated with an increase in the probability of house prices bottoming out. This is in contrast with the finding of the related literature that capital inflows are associated with house price run-ups. Since this is an unexpected result, we tried different empirical specifications to gain a better understanding of this effect. We estimated a simple dynamic model using house prices as the dependent variable and the current account balance as an explanatory variable, together with GDP growth and the interest rate as in the baseline specification.[30] We did this using the full sample (i.e. estimating the relationship across the different phases of the housing cycle), and we also conditioned the effect of the current account on the phase of the house cycle. We implemented this by including a dummy variable for house slumps, together with an interaction term with the current account.

When we estimate the relationship between the current account and house prices over the cycle as a whole, the current account is statistically insignificant. However, when the impact of the current account is conditioned on being in a slump, we obtain statistically significant effects, whose sign depends on the state of the cycle. During periods where house prices are not slumping, we find evidence suggesting that current account deficits (capital inflows) are associated with house price increases, consistent with the findings of the related literature. In line with our previous results for the probit model, however, the effect of the current account is the opposite when house prices are slumping.

Thus far, our study of the determinants of slump ends has mainly focused on developments within each country and, as discussed above, on the role of external factors such as capital inflows. Now we ask how house prices abroad affect the probability of slumps coming to an end at home. To this end, we include the average house price growth rate in other countries as an additional explanatory variable in column (5) of panel B. We find that house prices abroad are positively correlated with the likelihood of a house price slump coming to an end in the domestic economy. Specifically, a 1 percentage point increase in the rest-of-the-world unweighted average house price growth rate (relative to its mean) increases the probability of a slump ending by 25 per cent.

Since capital flows and developments in foreign housing sectors both seem to affect slump ends, we modify the previous specification to combine international financial linkages and foreign house price developments simultaneously. The conjecture is that innovations in foreign housing sectors are transmitted internationally through financial linkages. Specifically, we study the extent to which the

[30]These models are available upon request from the authors.

correlation between house prices across countries is determined by the intensity of cross-border bilateral financial linkages. To this end, we construct a rest-of-the-world house price measure as a weighted average of house price growth in foreign countries, using cross-border bilateral bank data to construct time-varying bilateral weights.[31]

If the primary impact of foreign house prices comes via financial linkages, we would expect that the coefficient on the weighted average of foreign house prices exceeds the coefficient on the unweighted average; this was not what we find in column (6) of panel B. As in the previous case, the coefficient associated with this rest-of-the-world measure is positive and statistically significant. However, now a 1 percentage point increase in the rest-of-the-world house price growth, relative to its mean, increases the probability of house prices bottoming out in the home economy by just 19 per cent, as opposed to 25 per cent. That said, the difference between these two estimates, reported in column (7), is statistically insignificant.[32]

4. IS THERE A ROLE FOR INSTITUTIONS?

4.1. MORTGAGE MARKET AND CREDIT INSTITUTIONS

This section asks whether financial and housing institutions can help predict the probability of house slumps bottoming out. We first focus on the IMF's mortgage-market-development index and its subcomponents. This index is an aggregate of five indicators: (1) freedom of home equity withdrawals, (2) scope for prepaying mortgages without fees, (3) the typical loan-to-value ratio, (4) the typical length of mortgage loans and, (5) the development of secondary markets for mortgage loans.

Mortgage markets were progressively deregulated starting at the beginning of the 1980s in most advanced countries. The U.S. and U.K. took the lead, followed by Canada, Australia and the Nordic countries. In other advanced countries, mainly Japan and Continental Europe, progress was slower. However, deregulation was largely complete in most of these countries by the beginning of the 1990s (IMF 2008). Given this, here we focus on just those slumps which took place after 1990.[33]

Most of these indicators of mortgage market development have a positive impact on the probability of slumps ending. Panel A of Table 7 shows these regressions. The largest effect is associated with the overall mortgage development index, but most of its subcomponents also have a positive impact on slump ends. The largest effect is associated with the freedom of home equity withdrawals, while the exception is the scope for prepaying mortgages without fees (refinance). For the latter, we find no relationship with the probability of house prices bottoming out.

We next focus on ease of credit access. We measure this by constructing a dummy variable that splits the World Bank Doing Business country ranking for ease of obtaining credit at the median country. This World Bank ranking is based on indicators describing how well collateral and bankruptcy laws

[31] The source of these data is the BIS Locational Banking Statistics.

[32] To check the robustness of these results, we also estimated a version including the current account balance as an additional control. This model yields coefficients for the rest-of-the-world house price variables that are of similar size. However, the inclusion of the current account balance makes these coefficients statistically insignificant.

[33] Since the IMF reports these indicators for one point in time, some time in the 2000s, we are forced to assume that mortgage market institutions do not change over time.

facilitate lending, and the coverage, scope and accessibility of credit information.[34] These rankings have been produced for recent years only, and here we take the ranking for 2010. Thus, our results should be interpreted with the caveat that, due to lack of data, we are forced to assume that these institutions have not changed over the 1990-2010 period.

When this measure is included as an additional explanatory variable in the probit model, its associated coefficient is positive and statistically significant, suggesting that in countries where getting credit is easier, slumps are shorter (Table 7, Panel B).

A fairly consistent message emerges from these exercises: more developed financial markets are associated with shorter slumps, all else equal.[35]

4.2. HOUSING-SECTOR INSTITUTIONS

We also examine the impact of supply-side conditions in the housing and construction sector. We have information on housing supply responsiveness to changes in demand, the time required to obtain a building permit, government housing rent controls, and transaction costs for house buyers and sellers.[36] As before, we first explored the impact of these institutional variables individually. However, unlike in the case of the financial and mortgage market institutions, we did not find statistically significant effects.[37] On the other hand – and again in contrast with our findings regarding financial and mortgage institutions – we found consistent and strong effects of housing sector institutions *on the impact of other variables*, in particular our house price variables. These are reported in Panel C of Table 7.

Our expectation is that, for a given housing price run-up, countries with more upwardly elastic housing supplies should exhibit larger price contractions than those with smaller supply elasticities. While house quantities do not adjust downward during house price slumps, they do adjust upwards during house price booms. In countries with more elastic housing supplies, therefore, house price run-ups should lead to greater supply overhangs, requiring larger subsequent price adjustments to restore market equilibrium. The estimates in column (1) of Panel C are consistent with this reasoning. The more elastic is housing supply, the more negative is the effect of the previous house price run-up. The negative and statistically significant coefficient on the interaction term between the supply elasticity and the cumulative house price fall gives further support for our hypothesis. More specifically, this negative sign suggests that when the elasticity of house supply is high, the required adjustment in house prices to get the slump out of the way is larger.

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[34]Although this variable relates more to obtaining credit for the purpose of doing business, we take it as a proxy for how easy is to obtain credit for housing.

[35]We also looked at whether these financial market institutions influenced the impact of the other variables in our model. By and large, when we estimated models including not only the institutional variables, but their interactions with our four core variables, these interaction terms were statistically insignificant (results available on request from the authors). The exceptions were mostly to do with the impact of house price movements themselves. A bigger house price run-up lowers the probability of bottoming out by more in countries with more developed mortgage markets, while the impact of a given price adjustment on the probability of bottoming out is smaller. Ease of access to credit has no effect on the impact of other variables.

[36] For government housing rent controls we have a composite indicator of the extent of controls on rents. This measures how increases in rents are determined, and the permitted cost pass-through onto rents in each country. The indicator includes information on whether rent levels can be freely negotiated between the landlord and the tenant, the coverage of controls on rent levels, and the criteria for setting rent levels. These institutional variables were obtained from OECD (2011).

[37]Results available on request.

Column (2) presents a similar model where the institutional variable is the number of days required to obtain a construction permit. As expected, this variable has the opposite effect to that of housing supply elasticities, since it is a proxy for an *inelastic* housing supply. Here, the effect of house price run-ups is smaller in countries where the time required to obtain a permit is longer. (The interaction effect between the house price run-up and the institutional variable is positive and statistically significant.) In addition, since a more inelastic supply is associated with smaller overhangs, the required house price adjustment to get the slump ended is smaller (the interaction effect with the cumulative price fall is positive and statistically significant).

Rent controls are considered in column (3). Since house prices represent the discounted present value of future rent flows, institutions altering the responsiveness of rents to changes in macro or financial variables should also affect house prices. This model shows that when rent controls are high, the effect of house price run-ups on slump duration is smaller. (The coefficient associated with the interaction effect between this institution and the house price run-up is positive and statistically significant.) In relation to the cumulative house price adjustment, countries with rent controls required smaller house price adjustments.

The final housing-sector institutional variable is transaction costs. The results in column (4) do not show any statistically significant effects associated with interaction terms between transactions costs and our other variables.

In sum, different institutions influence the probability of housing slumps coming to an end in different ways. In countries with more flexible construction sectors, house price run-ups give rise to greater supply overhangs and thus require larger price declines in their wake. On the other hand, more flexible and well-developed financial institutions seem to be associated with shorter slumps.

5. SHORT AND SHARP VERSUS GRADUAL SLUMPS

There is little doubt that how and when this housing slump comes to an end will matter importantly for the timing and vigour of economic recovery. However, it is not clear whether allowing prices to fall of their own accord is better than intervening to slow their adjustment, for example by taking measures to prevent households in arrears on their mortgages from being thrown out of their homes.[38]

We therefore compare the experiences of economies in which house prices end up being lowered by the same amount, but over different periods. We estimate a panel vector autoregression model with the following structural form $A_0 Y_{i,t} = A(L)Y_{i,t-1} + CX_{i,t} + \varepsilon_{i,t}$, where $Y_{i,t}$ is a vector that includes the real house price index and the three outcome variables: GDP, private consumption and investment, i.e. $Y_{i,t} = [GDP_{i,t}, CONS_{i,t}, INV_{i,t}, HP_{i,t}]$.[39] Matrix A_0 captures the contemporaneous relations between these four variables while $A(L)$ is the matrix polynomial in the lag operator L measuring the link between these variables and their lagged values. We set the lag length to be four quarters to account for seasonal effects. $X_{i,t}$ are fixed effects that we include to account for country-specific heterogeneity and country-specific linear trends. $\varepsilon_{i,t}$ are the orthogonal structural shocks. We estimate the above model in its reduced form version $Y_{i,t} = B(L)Y_{i,t-1} + DX_{i,t} + u_{i,t}$, where $B(L) =$

[38]While the main political motivation of this may be to protect vulnerable households, by reducing the frequency of distress sales such policies may also moderate the decline in house prices.
[39]In addition, we control for cross-country heterogeneity by including country fixed effects and country specific linear trends.

$A_0^{-1}A(L)$, $D = A_0^{-1}C$ and $u_{i,t} = A_0^{-1}\varepsilon_{i,t}$ and use the coefficients in $B(L)$ to simulate the dynamic effects of slumps that have identical size but different durations.[40]

In order to simulate a slump with a shorter duration we alter the autoregressive coefficients in the house price equation. Specifically, we scale down the coefficients in the last row of $B(L)$. In order to keep the slump size constant we calibrate the initial impulse accordingly. We also present an alternative approach in which we replace the coefficients in the last row of $B(L)$ with "real world" house price persistence using the autoregressive coefficients of the house price process in two distinct countries.[41] The first slump is constructed using data for Japanese house prices. As shown in Figure 1, these exhibit a considerable degree of persistence. To illustrate the impact of a sharp slump, we use Irish data. Figure 1 and current evidence from recent data releases suggest that the downward flexibility of Irish house prices, at least during the current slump, is high.

Figure 4 shows dynamic simulations following the first strategy, while Figure 5 reports the associated cumulative responses. These show that the outcome variables fall faster during sharp house price slumps than during shallow slumps, which is hardly surprising. When the sharp slump is over, the outcome variables continue their convergence to the initial steady state but at a much slower pace. Although the outcome variables fall more slowly during a shallow slump, these negative trends last longer, since the slump also lasts longer. As a result, the assessment of whether it is more desirable to have a sharper or a shallower slump depends on the horizon that the policy maker is interested in.

Figure 4 shows that the contraction in GDP is less substantial during the first 16 quarters in a shallow slump. However, in the long run a sharp slump may be more desirable than a shallow one. Figure 5 shows that the cumulative GDP performance of the sharp slump is superior after 26 quarters. While shallow slumps are less painful in the short run, sharp slumps are better in the long run. By and large, these results carry over when we take real world coefficients to simulate house price dynamics. Once again, a short, sharp Irish slump is worse than a more protracted Japanese-style slump in the short run. However, Figures 6 and 7 show that an Irish-style price decline produces a better GDP and consumption response than a Japanese-style decline in the long run. However, the point estimates of the investment responses do not suggest a clear difference between the Irish and Japanese cases.

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6. THE LINK BETWEEN THE FINANCIAL SYSTEM AND THE HOUSING SECTOR

Much literature shows that the financial system can act as an "accelerator", amplifying shocks to housing markets in the upside of the cycle. When housing prices rise, banks make profits on their real estate investments. As a result, these better capitalized banks lend more to the housing market, and therefore contribute to further increases in house prices. However, our focus is on the financial-system-house-price link during the down cycle. During slumps, can this financial accelerator go into reverse, such that falling house prices lead to a decline in lending, and hence further declines in house prices (along with falling levels of economic activity)?

As a measure of the health of the banking system, we look at the level of private credit in the economy. We start by estimating a panel vector autoregression using the outcome variables employed

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[40]We also compared slumps of identical duration, but different sizes. These results are not reported here for the simple reason that they are trivial: bigger slumps are worse.
[41]These country-specific coefficients are estimated using four lags of house prices and four lags of the outcome variables as controls. In addition, we include a constant and a linear trend.

in the previous section (GDP, consumption and investment), together with house prices. We now add private credit and the real mortgage interest rate as additional endogenous variables. [42] Since we are interested in how these relationships change when house prices are slumping, we adapt the model so as to isolate the dynamics during slump episodes. To this end we include interaction terms with a dummy variable that takes the value one when house prices are not slumping, and zero otherwise. To split the sample between "on slump" and "off slump" dynamics we interact this dummy variable with all the lagged values of the endogenous variables and include these as additional explanatory variables in each equation.[43]

Figures 8-10 show the impulse-response functions for shocks to credit, interest rates and house prices. The available strategies for the identification of shocks in vector autoregression models include the narrative, sign restrictions, and structural approaches. The former requires narrative information on the dates of shocks for the different variables. Unfortunately, these data are not available for the shocks that we consider here. In any case, this strategy would be difficult to implement in the context of a panel vector autoregression model.[44] The last two approaches require theoretical models to motivate the restrictions that are needed for shock identification. The sign restriction approach uses theoretical models to motivate the assumptions regarding the predicted sign impact of shocks, as well as the "duration" of these restrictions, i.e. for how many periods these restrictions ought to hold. The structural approach implements short- and long-run constraints that are used to identify structural innovations. These approaches are not well suited for the analysis conducted here since we do not have a theoretical model to aid the identification of shocks in a country panel. With this in mind, we opt for implementing a recursive ordering.

Following several papers focusing on the impact of monetary shocks, we order GDP before the interest rate.[45] Since consumption and investment are subcomponents of GDP, we order these in the first positions as well. The interest rate, house prices and credit are placed in the last three places. The resulting ordering is GDP, consumption, investment, interest rates, house prices, and credit.

The focus of this section is on shocks to credit, interest rates and house prices. Thus, the above recursive ordering implies that credit affects the rest of the endogenous variables with one lag. It means that shifts in the mortgage interest rate can contemporaneously affect house prices and credit. It assumes that house prices can have a contemporaneous impact effect on credit.

The rationale for placing credit after house prices is that we find (as shown next) that house prices cause credit and not the other way around. Placing the interest rate before house prices is theoretically sensible, given that house prices can be defined as the discounted present value of the stream of

[42]Due to data availability for credit, we estimate these models using annual data. The lag length is set to two. All models include country fixed effects and linear trends.

[43] We checked the performance of this model following two alternative strategies. First, we looked at the in-sample fit in each equation of the system and found that the model fits the data well. Its equations exhibit small mean squared errors and high adjusted R-squares. Second, we studied its out-of-sample performance by looking at forecasts at different horizons. We computed the mean forecast error, mean absolute error, root mean square error and the Theil's U statistic for each equation in the system. This model does a good job in producing forecasts. The only exception is the credit equation, for which we are unable to beat the naive forecasting approach for horizons greater than one period.

[44] It has been used in the context of monetary and fiscal shocks in single-country models.

[45] One example following this strategy for GDP and the policy rate is Christiano et al (2005).

income that houses produce. We do not have a strong rationale for placing the interest rate before credit, since intuition suggests that causality can go in both directions.

Figure 8 shows that a positive shock to credit has a delayed positive effect on house prices and consumption and a negative effect on the interest rate. GDP and investment, in contrast, are unaltered by this shock. When we compute these responses for periods when house price are slumping, the results are qualitatively similar, but the responses of consumption and house prices are now stronger.[46] This suggests that the link between bank credit and house prices is stronger during slumps.

Figure 9 presents the responses to a negative shock in the mortgage interest rate. As expected, the impact is expansionary. However, these responses are smaller when house prices are slumping. Together with the previous finding of a stronger effect of credit on house prices during a slump, this points to the existence of credit rationing during periods of distress: households might wish to respond to lower interest rates by borrowing more, but are in many cases unable to do so.[47]

Figure 10 looks at shocks to house prices.[48] In line with the previous findings, the effect of a shock to house prices on credit is greater when house prices are slumping. This provides further evidence that the link between credit and house prices tightens during slumps; the financial accelerator linking these two variables appears to be even stronger on the downside than on the upside.[49]

It seems clear that causation runs predominantly from house prices to credit rather than the other way around. Table 8 presents a set of tests that look for evidence of causation between house prices and credit. Row (1) presents Granger causality tests while the other rows are tests of joint significance that also include contemporaneous values of credit (or house prices) in the set of explanatory variables. Thus, these tests are complementary since they do not test causality. Here we test whether current and past values of these variables have the power to explain the other variable.

Row (1) shows that we can reject the null of house prices not causing credit. In contrast, we are not able to reject the null hypothesis of credit not causing house prices. This is in line with Gerlach and Peng (2005), who find evidence of house prices causing credit and not the other way around in Hong Kong.

In sum, it appears that the correlation between credit and house prices becomes tighter during house price slumps, with the causation going more from falling house prices to falling credit. But while credit may not directly drive house prices during slumps, Figure 8 indicates that shocks to credit end up affecting house prices indirectly, via their effects on the rest of the economy. This is a cost of

[46] Although we note that in both Figures 8 and 10, the confidence bands between the baseline and slump responses generally overlap.

[47] There is abundant evidence to suggest that this is happening in contemporary Ireland, for example.

[48] As before, we study this using the full sample as well as focusing on slump periods.

[49] We checked the robustness of these results implementing four alternative specifications. First we estimated a more parsimonious model including only the interest rate, house prices, and credit. Second, we estimated a version of the model with the previous three variables and GDP. Third, we estimated a six-variable model and identified shocks flipping the position of the interest rate and credit variables. More precisely, we put credit in the third position and the interest rate in the sixth position. Finally, we estimated the model excluding crisis years, taking into account the possibility that recent crises may have generated structural breaks in the relationships between these variables. The results reported here are robust to all these alterations of the model.

allowing house prices to fall rapidly during a slump, since it opens the possibility of negative feedbacks from falling house prices to falling credit, and on to further falls in house prices. That said, the evidence presented earlier suggests that on average, it is better to get the required house price adjustment over and done with, once a housing bubble has burst.

This suggests the optimal set of policies might involve allowing property prices to find their new equilibrium level but simultaneously restructuring the financial sector in such a way as to permit the resumption of private credit flows as speedily as possible. There also seems to be an important role for supportive macroeconomic policies, since low real interest rates and the resumption of GDP growth can both help in bringing about the end of housing slumps, and thus in breaking any negative feedback loops linking house prices and the financial sector.

7. POLICY IMPLICATIONS

We have presented a parsimonious model of the determinants of the end of house price slumps, focusing on four variables – the extent of the prior house-price boom, the post-boom slump in prices, GDP growth as a measure of the state of the overall economy, and mortgage interest rates. As shown, that model can be used to forecast the likelihood of slumps now coming to an end. We find that this is now most likely in the U.S. and Spain, although even here the estimated probabilities are still relatively low and subject to a substantial degree of uncertainty. We find that the probability of housing slumps coming to an end, in these and other countries, in the not-too-distant future, will depend importantly on the kind of GDP growth rates and mortgage interest rates that eventuate.

Mortgage interest rates are, according to our model, the single most robust predictor of the probability of a house price slump ending. This observation was one of the popularly-voiced justifications for the Federal Reserve System's first and second rounds of quantitative easing in 2008-10, and it is similarly a rationale for the recently launched Operation Twist. By purchasing longer-term government securities, the Fed has attempted to put downward pressure on long-term interest rates generally and mortgage interest rates in particular, with the goal of helping to revive the housing market.

In addition, the Fed intervened directly in markets for agency residential mortgage backed securities linked to housing finance, and the Fed committed in September 2011, in connection with its Operation Twist, to purchase additional mortgage-linked securities as its existing holdings matured. Chairman Bernanke himself distinguished quantitative easing, which was designed to expand the supply of money broadly defined by purchasing treasury and related securities in a manner not explicitly designed to target a particular market, in much the same the same manner that a reduction in the central bank's standard policy instruments were normally designed to operate, from "credit easing," which focused on interventions in specific credit markets and instruments, such as securitized mortgages, designed to re-liquify those particular markets and reduce the cost of specific kinds of credit, notably including mortgage credit.

Our results suggest that real rather than nominal mortgage rates are what appear to matter in this context. This suggests that insofar as the central bank can avoid deflation and, further, actively push up the inflation rate without putting commensurate upward pressure on nominal rates, central bank policy can increase the likelihood of a revival of the housing market. Insofar as the decline in real housing prices since the peak is another significant determinant of the probability of the housing market bottoming out, higher inflation which means lower real housing prices, ceteris paribus, has a second separate effect working in the same direction.

Does this mean, more generally, that economic policy makers and monetary policy makers in particular should adjust their instruments with the goal of bringing mortgage rates down when confronted with a housing slump? The notion that the central bank should respond, either with conventional instruments or unconventional operations, to movements in asset prices – whether housing prices or other asset prices – remains controversial. The controversy is typically framed as whether central banks should lean against pronounced increases in asset prices on the grounds that these could place financial stability at risk. Prior to the global credit crisis, the consensus was that central banks should focus on maintaining low and stable inflation. They should react to asset prices only insofar as asset-price movements had implications for the inflation rate and short run movements in the output gap (this view was known as the "Jackson Hole consensus"). There may have been a handful of dissenters (see inter alia Borio and Lowe 2004, Disyatat 2005, White 2008 for example), but a broad-based professional consensus, it is fair to say, there nonetheless was.

Post-crisis the consensus has shifted toward the view that asset-price movements with potential implications for financial stability cannot be treated with neglect. Policy makers may not be able to identify bubbles with certainty, but they still need to make a judgment about whether sharp increases in asset prices are evidence of mounting financial risks – whether they are associated with dangerous increases in leverage and declining credit quality. And where they see evidence of this association they should act preemptively. (For a statement of this new conventional wisdom see CIEPR 2011.)

What is true of sharp asset price increases is true also, we would argue, of sharp asset price reductions. Policy makers cannot treat sharp falls in housing prices with benign neglect when they pose a threat to economic and financial stability. But this does not imply that they should respond mechanically. They must form a judgment about whether those price declines are having a serious negative effect on consumer confidence. They must ask whether this is undermining macroeconomic stability by, inter alia, depressing spending and raising the danger of deflation. They need to make a judgment as to whether house price declines, by causing losses for lenders, pose a potential threat to financial stability. And where they reach positive answers, it is appropriate that they respond in ways with the potential to reduce mortgage rates and/or increase the supply of mortgage credit, thereby raising the likelihood of the house-price slump coming to an end.

At what point should they respond? Our results suggest that house prices have a tendency to fall further when a slump has already been underway for an extended period. After some point, the evidence suggests, price falls can elicit further price falls in a vicious spiral out of which it becomes hard for the market to break. Since falling house prices lead to falling levels of private credit, this in turn raises the risk of the kind of destabilizing macroeconomic and financial effects described in the previous paragraph. Again, this is an argument for the authorities to act preemptively. They should intervene, perhaps with reductions in policy rates and, where they have spent their interest-rate ammunition, with quantitative and credit easing in order to prevent the housing market from slipping into this kind of self-reinforcing downward price spiral. This is analogous to the argument that policy makers should react preemptively to falls in the economy-wide rate of inflation in order to prevent the economy from entering a deflationary trap from which it then becomes difficult to escape.

Are policy makers capable of recognizing this kind of situation? Economic science provides an answer: maybe. Some of our models identify fairly precisely the point where a housing slump becomes self-reinforcing and hence a potential danger to the economy. Other specifications do not. But this uncertainty does not relieve policy makers of responsibility for making a judgment and, where appropriate, of acting.

Macroeconomic policy makers, of course, should not be concerned with the housing market for its own sake. Rather they should be concerned about the implications of the housing slump for the economy as a whole. Our analysis confirms that the same price adjustment stretched out over a longer period tends to limit the damage to growth in the short run while accentuating it in the longer run. A sharp downward adjustment in prices, Irish style, leads to a sharper short-run recession but an earlier recovery than a more moderate "Japanese style" decline in prices of the same cumulative magnitude.

Which path is preferable will depend on policy makers' discount rate: the higher the rate the greater the likelihood that the Japanese alternative will be preferred. Our estimates suggest that policy makers will be indifferent between the two paths when the discount rate is 6.9% (from Figure 4) and 14.9% (from Figure 6) percent. For lower discount rates, policy makers should favour the Irish alternative. Of course, there may well be a difference between the optimal social discount rate, and the subjective discount rates of politicians hoping to get re-elected: while the 'correct' response might be to get the required house price adjustment over quickly, this may not in fact be what we observe.

Housing market interventions that delay downward house price adjustment thus will appeal to governments worried about households with negative equity and about the balance sheets of financial institutions. During the Great Depression in the United States, for example, the federal government established the Home Owners' Loan Corporation in order to break the cycle of forced sales and declining house prices and keep home owners in their homes. While the policy was successful in arresting the decline in house prices and maintaining the level of home ownership, it had no impact on home building, which is what matters from the perspective of economic recovery. Not that is this particularly surprising, since most HOLC loans were advanced in those regions were housing markets were most distressed – which is where the housing supply overhang was greatest (Courtemanche and Snowdon 2010).

One of our findings is that mortgage market deregulation increases the probability of housing slumps coming to an end. Slumps are more likely to end when loan-to-equity ratios are high, term to maturity is long, mortgages are securitized, and homeowners are able to withdraw equity. These are structures that are likely to make mortgage credit more freely available, something that will make it easier for potential purchasers to enter the market when prices are weak. Of course, many of these features were also associated, with good reason, with the problems leading to the housing bubble and subsequent crash in countries like the United States. Low loan-to-value ratios allowed homeowners to get into houses they could not afford and quickly left them under water when prices declined. The opportunity to withdraw equity when price were rising led some homeowners to use their houses as automatic teller machines, again raising the danger of default and foreclosure if prices fell. Securitization created agency problems between mortgage originators, distributors and investors that artificially depressed the price of mortgage finance, feeding the housing boom, and depressed credit quality.

We do not dispute any of this. But once a slump is underway low down-payment requirements, the availability of long-dated mortgages, and extensive mortgage securitization that increase the availability of mortgage credit raise the probability that buyers will reenter the market. This suggests that harsh, across-the-board regulation is not the answer. Better would be for regulators to vary loan-to-value ratios over the cycle, raising them in housing booms (as suggested after a fashion by Geanakoplos 2010), in much the manner that it is now argued that they should raise banks' capital-to-asset ratios during credit booms.[50]

More fundamentally, this perspective suggests that policy makers should attempt to balance the advantages of tighter regulation, which will help to prevent problems from developing subsequently, with the advantages of deregulation, among whose benefits are that it should make it easier for the housing market to recover from a slump. The idea that regulators should seek a balance is of course a commonplace, but the observation is no less valid for the fact.

More generally, policy makers face a number of delicate balancing acts during house price slumps. The first is achieving a balance between excessive and insufficient regulation, as just mentioned. The second is achieving a balance regarding the optimal speed of adjustment of house prices. In those countries that have experienced the largest run-ups, such as Spain or Ireland, it is important that property prices be allowed to adjust downward so as to increase the likelihood that the slumps will come to an end. In favour of speedy adjustment is our finding that short sharp house price slumps are less damaging for the economy in the long run, even if they are more immediately painful; and our finding that there is a point in time after which slumps can become self-reinforcing. Germany, and especially Japan, provide us with cautionary examples in this regard.

But falling house prices can impair bank balance sheets and lead to falling levels of credit to the economy. There may thus be a danger that economies can be locked into a vicious circle of falling property prices driving falling bank lending, driving further declines in property prices. It is important, therefore, to ensure that price adjustments in the housing market be accompanied by supportive banking and macroeconomic policies. Limiting the impairment of bank balance sheets and disruptions to the provision of bank credit to the housing market will be critically important. This points to the importance of conducting realistic stress tests of bank balance sheets with respect to sharp declines in housing prices during boom times and early and concerted bank recapitalization where necessary in response to slumps.

Low real interest rates can help in ensuring that house prices bottom out, implying that central bankers should keep nominal interest rates low and avoid deflation. Avoiding deflation suggests that a moderate level of inflation can help to bring housing slumps to an end by further reducing real interest rates where nominal rates have been pushed to the lower bound.

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[50] This would not be easy politically, however.

Table 1: House price slumps

No.	Country	Start date year	Start date Quarter	End date year	End date quarter	Slump size	Growth afterwards
1	Australia	1974	1	1978	4	-17.5	1.7
2	Australia	1986	2	1987	3	-8.4	4.0
3	Australia	1989	2	1996	4	-7.3	1.1
4	Australia	2007	4	2009	1	-10.1	3.7
5	Belgium	1970	1	1971	3	-8.2	1.2
6	Belgium	1979	3	1985	2	-35.6	0.9
7	Canada	1976	1	1984	3	-21.8	0.5
8	Canada	1989	4	1991	3	-12.3	0.6
9	Canada	2007	4	2009	1	-11.6	3.7
10	Denmark	1973	3	1974	3	-13.7	3.2
11	Denmark	1979	2	1982	4	-36.0	4.9
12	Denmark	1986	1	1993	2	-35.6	3.4
13	Denmark	2007	2	2009	2	-21.1	0.3
14	Finland	1970	4	1972	2	-6.8	3.6
15	Finland	1974	1	1979	4	-26.5	0.4
16	Finland	1989	2	1995	4	-50.8	3.0
17	Finland	1999	4	2001	4	-5.3	1.7
18	Finland	2007	3	2009	1	-8.9	2.1
19	France	1970	1	1971	2	-6.2	1.7
20	France	1980	4	1984	4	-19.2	0.4
21	France	1991	1	1997	1	-16.6	0.7
22	France	2007	2	2008	4	-13.8	2.1
23	Germany	1975	1	1976	3	-5.1	0.7
24	Germany	1981	2	1989	2	-14.2	1.4
25	Germany	1994	4	2009	3	-25.0	0.04
26	Ireland	1970	4	1973	2	-9.6	0.9
27	Ireland	1979	2	1987	2	-32.0	1.4
28	Ireland	2007	2	ongoing		-29.5	
29	Italy	1981	2	1986	3	-36.3	0.7
30	Italy	1992	4	1996	1	-12.5	0.5
31	Italy	1997	2	1999	4	-3.4	0.3
32	Japan	1973	4	1978	1	-28.7	0.9
33	Japan	1991	2	2009	4	-42.5	0.5

Note: The size of Ireland's ongoing slump size is computed using 2010q3 house price data.

Table 1 con't: House price slumps

No.	Country	Start date year	Start date quarter	End date year	End date quarter	Slump size	Growth afterwards
34	Netherlands	1978	2	1986	1	-50.3	1.4
35	Netherlands	2007	3	ongoing		-12.2	
36	New Zealand	1974	3	1980	4	-38.2	3.3
37	New Zealand	1984	2	1986	4	-8.3	2.9
38	New Zealand	1990	1	1992	1	-7.9	0.4
39	New Zealand	1997	2	2000	4	-7.2	0.6
40	New Zealand	2007	3	2009	1	-14.6	1.1
41	Norway	1970	1	1973	1	-5.1	1.0
42	Norway	1980	2	1983	4	-9.1	4.0
43	Norway	1987	2	1993	1	-41.4	3.5
44	Norway	2007	2	2008	4	-14.3	2.5
45	Spain	1978	2	1982	2	-35.0	2.0
46	Spain	1991	4	1997	4	-24.1	1.5
47	Spain	2007	2	ongoing		-14.4	
48	Sweden	1970	1	1971	3	-7.0	0.8
49	Sweden	1979	3	1986	2	-40.0	1.7
50	Sweden	1990	1	1995	4	-31.9	0.6
51	Sweden	2007	3	2009	1	-9.0	2.0
52	Switzerland	1973	1	1977	1	-27.4	0.3
53	Switzerland	1989	4	2000	4	-36.8	0.6
54	United Kingdom	1973	3	1978	1	-32.8	3.6
55	United Kingdom	1989	3	1996	2	-31.4	1.7
56	United Kingdom	2007	3	2009	2	-16.1	0.8
57	United States	1979	2	1983	4	-9.4	0.4
58	United States	1989	3	1996	4	-11.6	0.7
59	United States	2006	1	ongoing		-38.3	

Note: The sizes of the ongoing slumps are calculated using house price 2010 q2 data for Netherlands and United States and 2010q3 data for Spain.

Table 2: Baseline probit model

	Coefficient	Semi-elasticities. Variables evaluated at:			
		Mean	Median	10th percentile	90th percentile
House price run-up	-0.002	-0.005	-0.005	-0.005	-0.005
	(0.002)	(0.004)	(0.004)	(0.004)	(0.005)
Cum. price fall	0.018***	0.041***	0.042***	0.038***	0.043***
	(0.006)	(0.013)	(0.013)	(0.013)	(0.012)
GDP growth	0.154***	0.345***	0.348***	0.319***	0.354***
	(0.049)	(0.110)	(0.112)	(0.112)	(0.109)
Interest rate	-0.085***	-0.189***	-0.191***	-0.175***	-0.195***
	(0.025)	(0.057)	(0.058)	(0.044)	(0.069)
Obs.	1126	1126	1126	1126	1126
Pseudo R^2	0.09	0.09	0.09	0.09	0.09
Prob.		0.033	0.030	0.049	0.028

Note: *, ** and *** indicate statistical significance at 10%, 5% and 1% respectively. Robust standard errors reported in parentheses.

Table 3: Predicted end probabilities for ongoing slumps

Country	Latest values	GDP Min	GDP Max	Interest rate Min	Interest rate Max
country	(1)	(2)	(3)	(4)	(5)
Ireland	0.118*	0.051	0.170**	0.122*	0.028
The Netherlands	0.046*	0.022	0.095**	0.065*	0.011
Spain	0.090***	0.045**	0.164***	0.111***	0.022***
United States	0.166***	0.081***	0.247***	0.241***	0.068***
Baseline	0.032***				

Note: Monte Carlo simulated probabilities using Clarify software. These are obtained by evaluating the baseline probit model at different values for all explanatory variables. Column (1) shows the slump ends probabilities when the baseline probit model is evaluated at the latest value of each explanatory variable by country. Baseline, however, reports the estimated probability for variables set at the sample mean. We include this for comparison purposes. Columns (2) and (3) report different simulations for two alternative values of GDP growth rates: -2.35% and 2.37%. Columns (4) and (5) report probabilities using 0.07% and 9.14% as the extreme real mortgage interest rate values. These values are taken from the dataset used to estimate the baseline probit model. *, ** and *** indicate the statistical significant of these point estimates at 10%, 5% and 1%, respectively.

Table 4: Robustness checks

Panel A: fixed effects and instrumental variables

	(1) Baseline	(2) no FE	(3) cFE yFE	(4) IV	(5) No GDP
House price run-up	-0.002	-0.002	-0.005*	-0.003	-0.003*
	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)
Cum. price fall	0.018***	0.009*	0.026***	0.018***	0.020***
	(0.006)	(0.005)	(0.007)	(0.006)	(0.006)
GDP growth	0.154***	0.151***	0.204***	0.135	
	(0.049)	(0.048)	(0.059)	(0.160)	
Interest rate	-0.085***	-0.029*	-0.067**	-0.085***	-0.081***
	(0.025)	(0.015)	(0.031)	(0.024)	(0.023)
Obs.	1126	1126	1126	1122	1126
Pseudo R^2	0.09	0.03	0.24		0.07

Panel B: different slump end definitions

	(1) Baseline	(2) end t, t-1	(3) end t, t-1, t-2	(4) No ongoing	(5) Large
House price run-up	-0.002	-0.004**	-0.003**	-0.001	-0.010**
	(0.002)	(0.002)	(0.001)	(0.002)	(0.004)
Cum. Price fall	0.018***	0.027***	0.029***	0.019***	0.077***
	(0.006)	(0.005)	(0.004)	(0.006)	(0.019)
GDP growth	0.154***	0.028	0.042	0.152***	0.289***
	(0.049)	(0.049)	(0.045)	(0.050)	(0.085)
Interest rate	-0.085***	-0.093***	-0.084***	-0.097***	-0.221***
	(0.025)	(0.019)	(0.016)	(0.027)	(0.057)
Obs.	1126	1126	1126	1066	768
Pseudo R^2	0.09	0.10	0.10	0.09	0.24

Note: *, ** and *** indicate statistical significance at 10%, 5% and 1% respectively. Robust standard errors reported in parentheses.

Table 5: Duration model

House price run-up	0.0002
	(0.003)
Cum. Price fall	
	-0.0003
	(0.001)
GDP growth	0.1876*
	(0.101)
Interest rate	-0.1342***
	(0.051)
Obs.	1071
Pseudo R^2	0.09

Note: Coefficients from Cox regression model using Breslow method for ties. Country fixed effects included. Link and Schoenfeld residuals tests indicate that the proportional hazard assumption is satisfied, i.e. the log hazard ratio is constant over time. Cumulative house price fall is interacted with a linear trend. *, ** and *** indicate statistical significance at 10%, 5% and 1%, respectively. Robust standard errors reported in parentheses.

Table 6: Additional specifications, semi-elasticities evaluated at variables' means

Panel A

	(1)	(2)	(3)	(4)
Bubble	-0.006	-0.001	0.001	-0.005
	(0.004)	(0.005)	(0.005)	(0.004)
Cum. price fall	0.042***	-0.018	-0.036	0.073**
	(0.013)	(0.025)	(0.024)	(0.036)
GDP growth	0.352***	0.342***	0.328**	0.348***
	(0.115)	(0.111)	(0.149)	(0.111)
Interest rate	-0.192***	-0.174***	-0.178***	-0.189***
	(0.058)	(0.057)	(0.060)	(0.057)
HP volatility	-0.004*			
	(0.003)			
Duration		0.092**	0.171***	
		(0.039)	(0.050)	
Duration^2			-0.001*	
			(0.001)	
(Cum. price fall)^2				-0.001
				(0.001)
Obs.	1118	1126	1126	1126
Pseudo R^2	0.09	0.13	0.14	0.09

Note: *, ** and *** indicate statistical significance at 10%, 5% and 1% respectively. Robust standard errors reported in parentheses.

Table 6: Additional specifications, semi-elasticities evaluated at variables' means

Panel B

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
House price run-up	-0.003	-0.004	-0.003	-0.008*	-0.004	-0.004	-0.004
	(0.005)	(0.005)	(0.005)	(0.004)	(0.004)	(0.004)	(0.004)
Cum. price fall	0.052***	0.047***	0.047***	0.041***	0.042***	0.042***	0.042***
	(0.016)	(0.016)	(0.016)	(0.013)	(0.013)	(0.013)	(0.013)
GDP growth	0.459***	0.436***	0.452***	0.329***	0.310***	0.305***	0.302***
	(0.151)	(0.142)	(0.142)	(0.114)	(0.113)	(0.111)	(0.112)
Interest rate	-0.275***	-0.293***	-0.307***	-0.162***	-0.178***	-0.188***	-0.184***
	(0.071)	(0.075)	(0.068)	(0.058)	(0.059)	(0.058)	(0.060)
Stmkt. growth	0.023*						
	(0.014)						
Stmkt. growth (t+1)		0.039***					
		(0.012)					
Stmkt. growth (t+2)			0.030**				
			(0.013)				
Current account				0.156***			
				(0.056)			
RoWavHPg					0.249*		
					(0.146)		
RoWfinHPg						0.191*	0.235
						(0.100)	(0.148)
RoW							0.093
D(avHPg-finHPg)							(0.228)
Obs.	1023	1020	1016	1126	1126	1126	1126
Pseudo R^2	0.13	0.14	0.13	0.11	0.09	0.09	0.10

Note: *, ** and *** indicate statistical significance at 10%, 5% and 1% respectively. Robust standard errors reported in parentheses.

Table 7: The effect of institutions

Panel A: Mortgage market development

	(1) MMD index	(2) Equity withdrawal	(3) Loan refinance	(4) Loan to value ratio	(5) Mortgage length	(6) Securitisation
House price run-up	-0.002	-0.002	-0.002	-0.002	-0.002	0.003
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.005)
Cum. Price fall	0.028***	0.028***	0.028***	0.028***	0.028***	0.035*
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.019)
GDP growth	0.109	0.109	0.109	0.109	0.109	0.199
	(0.086)	(0.086)	(0.086)	(0.086)	(0.086)	(0.133)
Interest rate	-0.233***	-0.233***	-0.233***	-0.233***	-0.233***	-0.196***
	(0.051)	(0.051)	(0.051)	(0.051)	(0.051)	(0.055)
Institution	6.747***	1.957***	-0.804	0.196***	0.391***	0.729**
	(2.512)	(0.729)	(0.532)	(0.073)	(0.146)	(0.340)
Obs.	575	575	575	575	575	431
Pseudo R^2	0.210	0.210	0.210	0.210	0.210	0.225

Note: *, ** and *** indicate statistical significance at 10%, 5% and 1% respectively. Robust standard errors reported in parentheses. Models estimated using 1990-2010 data.

Table 7: The effect of institutions

Panel B: Ease of credit access

	Ease to get credit
House price run-up	-0.002
	(0.003)
Cum. Price fall	0.028***
	(0.010)
GDP growth	0.109
	(0.086)
Interest rate	-0.233***
	(0.051)
Institution	1.957***
	(0.729)
Obs.	575
Pseudo R^2	0.210

Note: *, ** and *** indicate statistical significance at 10%, 5% and 1% respectively. Robust standard errors reported in parentheses. Model estimated using 1990-2010 data.

Table 7: The effect of institutions

Panel C: Housing-sector institutions

	(1) Supply elasticity	(2) Construction permit	(3) Rent controls	(4) Transaction costs
House price run-up	0.019**	-0.047**	-0.012	-0.014
	(0.008)	(0.021)	(0.008)	(0.011)
Cum. Price fall	0.174***	-0.068	-0.028	0.002
	(0.041)	(0.048)	(0.025)	(0.039)
GDP growth	-0.321	0.259	-0.048	0.425*
	(0.257)	(0.293)	(0.126)	(0.245)
Interest rate	-0.418***	-0.034	-0.140	-0.279*
	(0.106)	(0.229)	(0.098)	(0.152)
Institution	5.894	-0.969	-1.830	-0.143
	(3.663)	(0.831)	(1.640)	(0.200)
Ins. X House price run-up	-0.028***	0.013**	0.012*	0.001
	(0.010)	(0.005)	(0.006)	(0.001)
Ins. X Cum. Price fall	-0.133***	0.047***	0.068***	0.004
	(0.038)	(0.015)	(0.026)	(0.005)
Ins. X GDP growth	0.498*	-0.040	0.148*	-0.046
	(0.261)	(0.091)	(0.086)	(0.036)
Inst. X int rate	0.057	-0.085	-0.072	0.001
	(0.112)	(0.060)	(0.073)	(0.017)
Obs.	575	575	575	575
Pseudo R^2	0.292	0.302	0.262	0.234

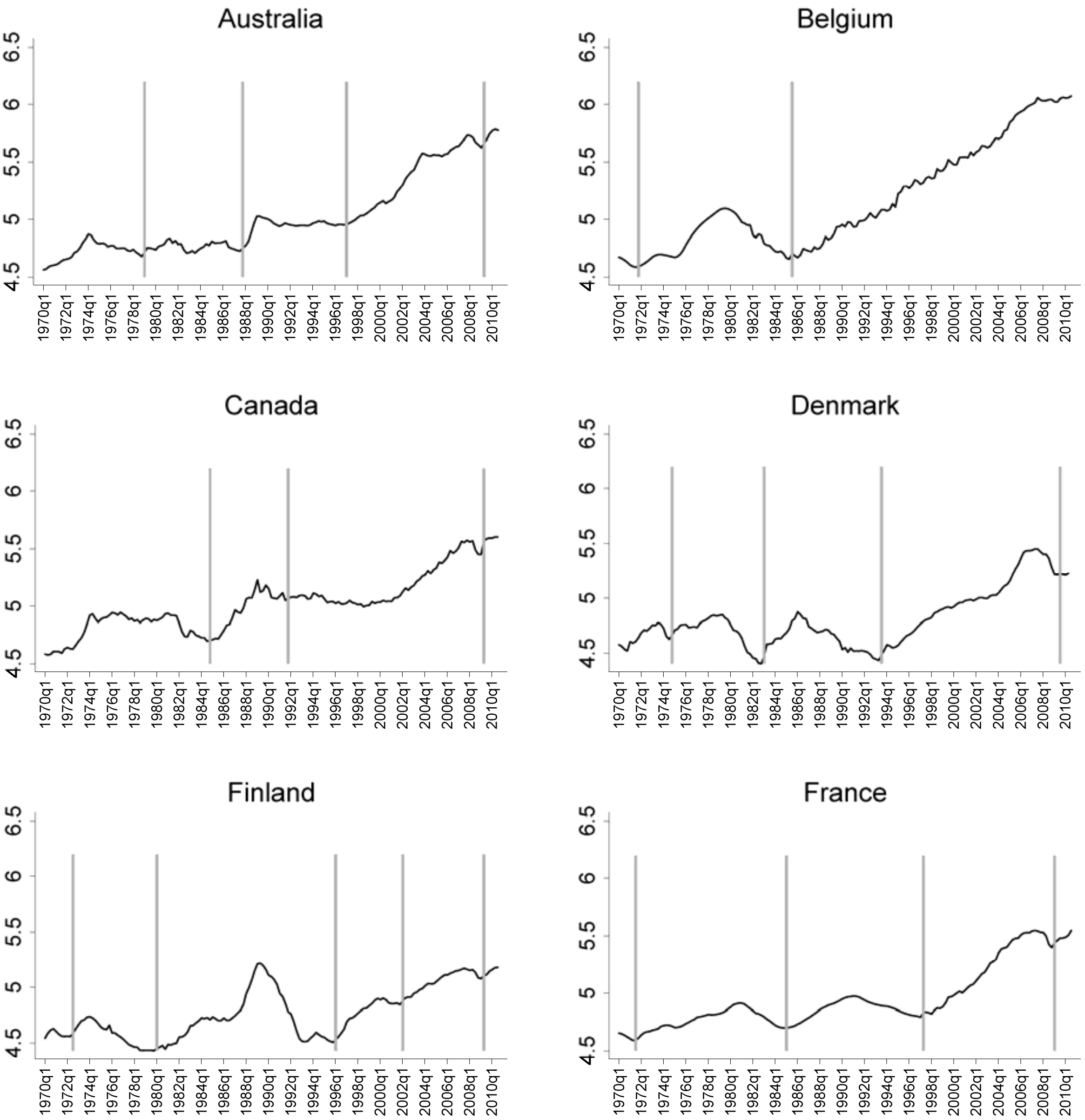
Note: *, ** and *** indicate statistical significance at 10%, 5% and 1% respectively. Robust standard errors reported in parentheses. Models estimated using 1990-2010 data.

Table 8: The effect of credit on house prices and house prices on credit during slumps

	Ho: Credit does not affect house prices (p-value)	Ho: House prices do not affect credit (p-value)
(1) Granger causality test (joint significance of two lags of credit or house prices). The set of controls includes lagged values of other endogenous variables.	0.29	0.08
(2) Joint significance of contemporaneous and two lags of credit or house prices. The set of controls includes lagged values of the other endogenous variables.	0.19	0.03
(3) Joint significance of contemporaneous and two lags of credit or house prices. The set of controls includes current and lagged values of the other endogenous variables.	0.50	0.05

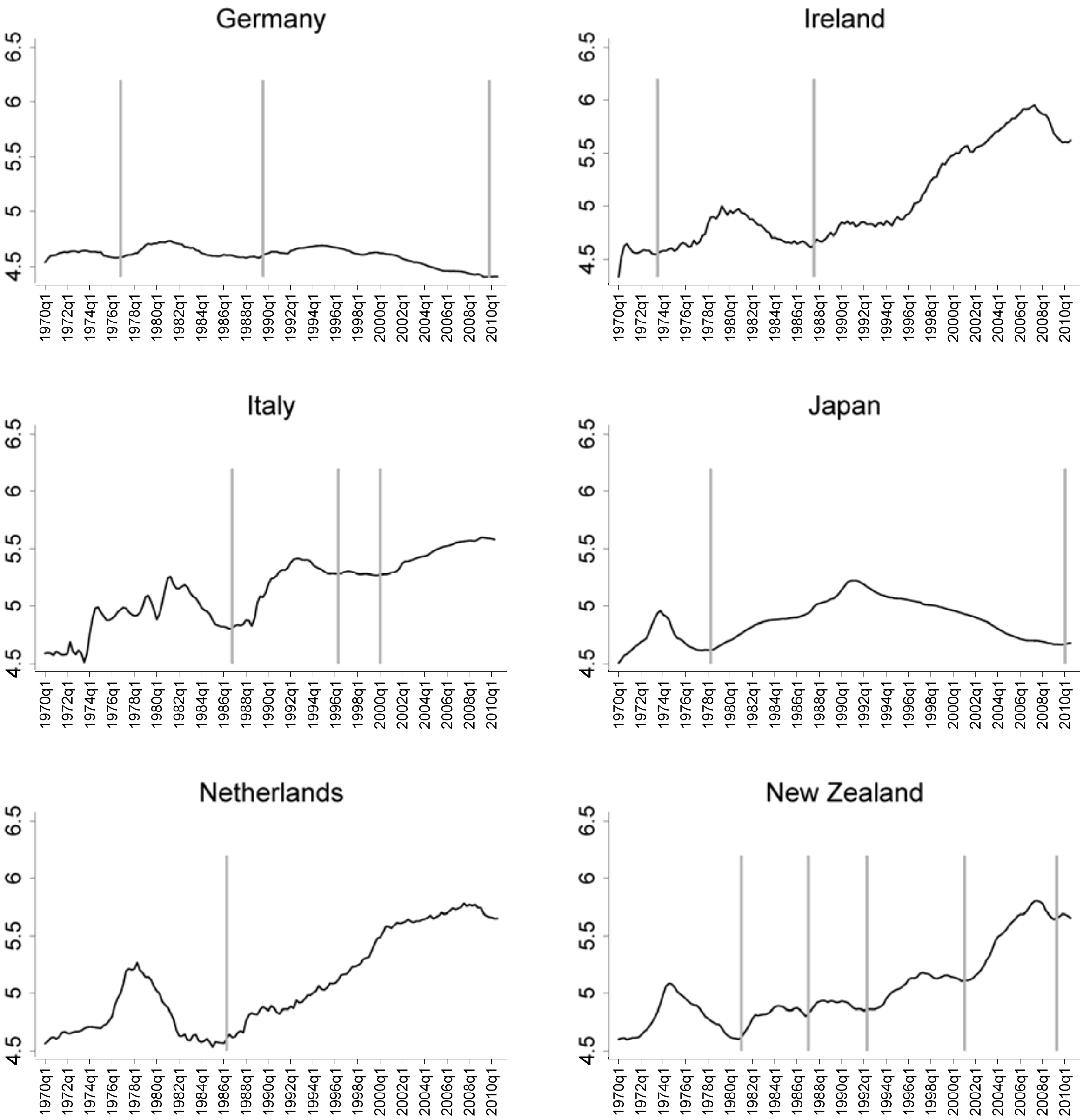
Note: the controls included as additional explanatory variables for credit and house price equations are the other endogenous variables included in the model, i.e. GDP, consumption, investment and the interest rate.

Figure 1: House price indices



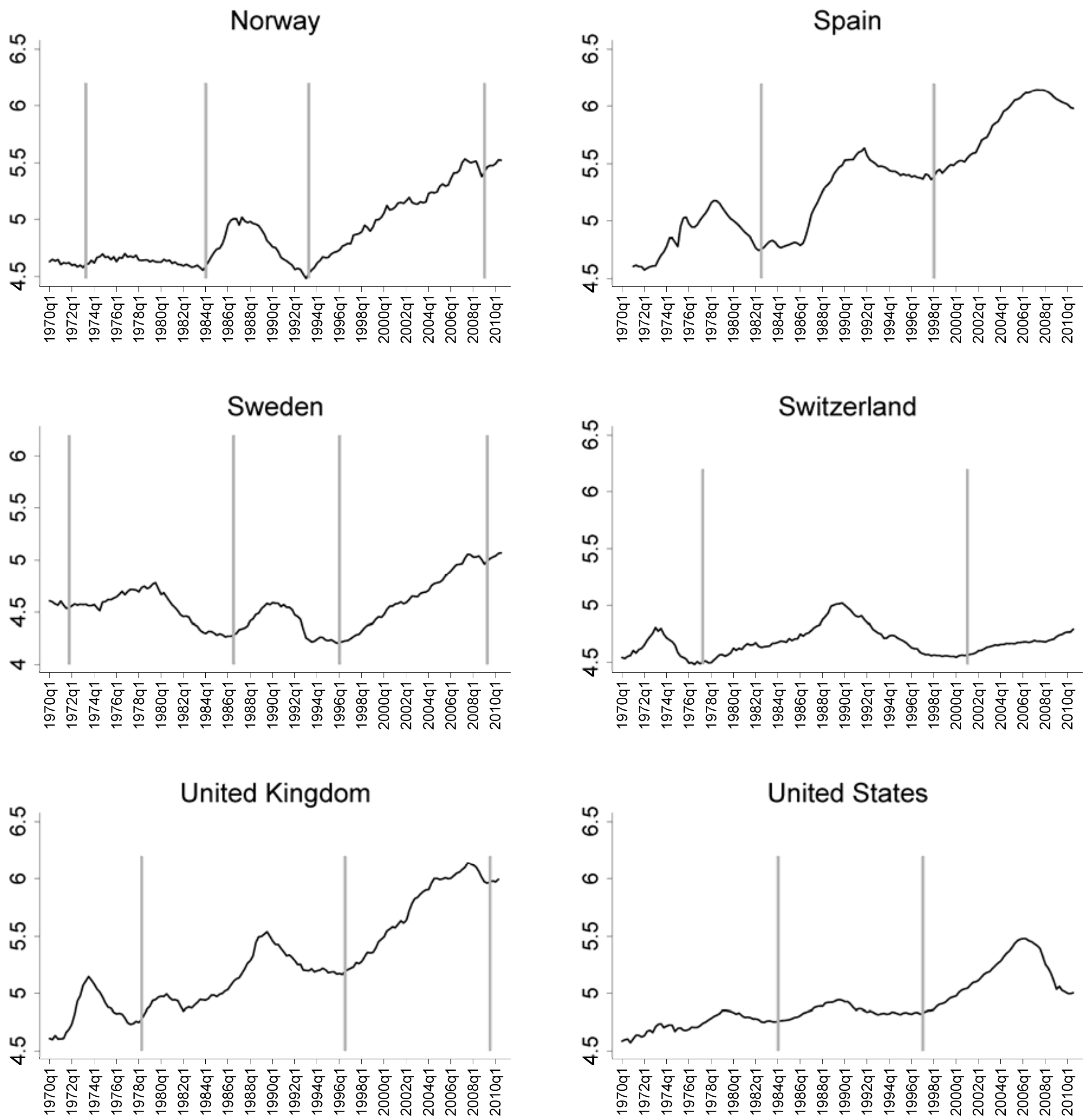
Note: House price indices are in log scale (base 1971:1=100). Source: Bank of International Settlements (BIS). Vertical lines indicate the end of house price slumps as defined in Section 3.

Figure 1 ‘cont: House price indices



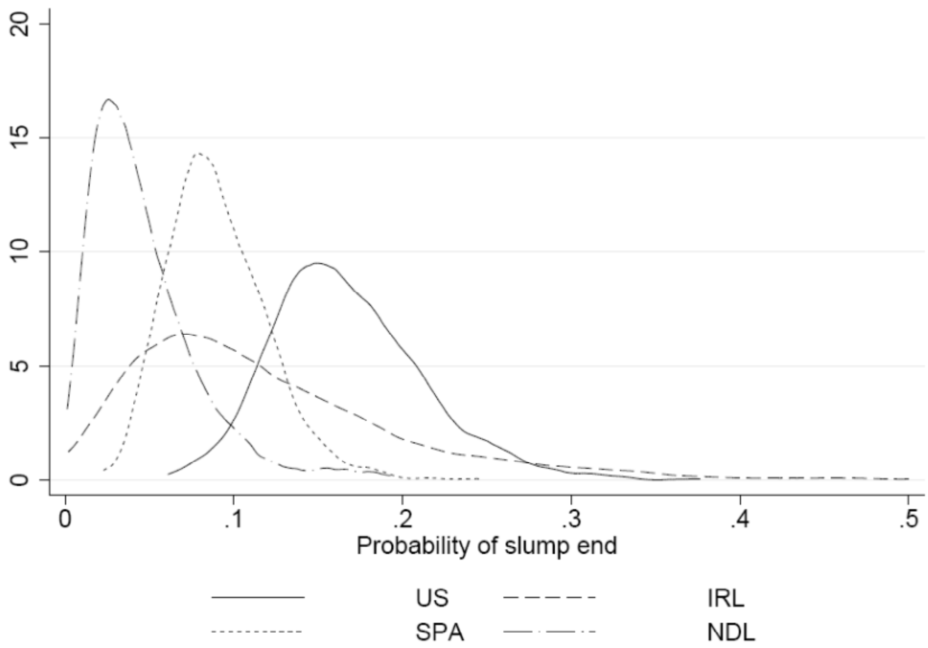
Note: House price indices are in log scale (base 1971:1=100). Source: Bank of International Settlements (BIS). Vertical lines indicate the end of house price slumps as defined in Section 3.

Figure 1 ‘cont: House price indices



Note: House price indices are in log scale (base 1971:1=100). Source: Bank of International Settlements (BIS). Vertical lines indicate the end of house price slumps as defined in Section 3.

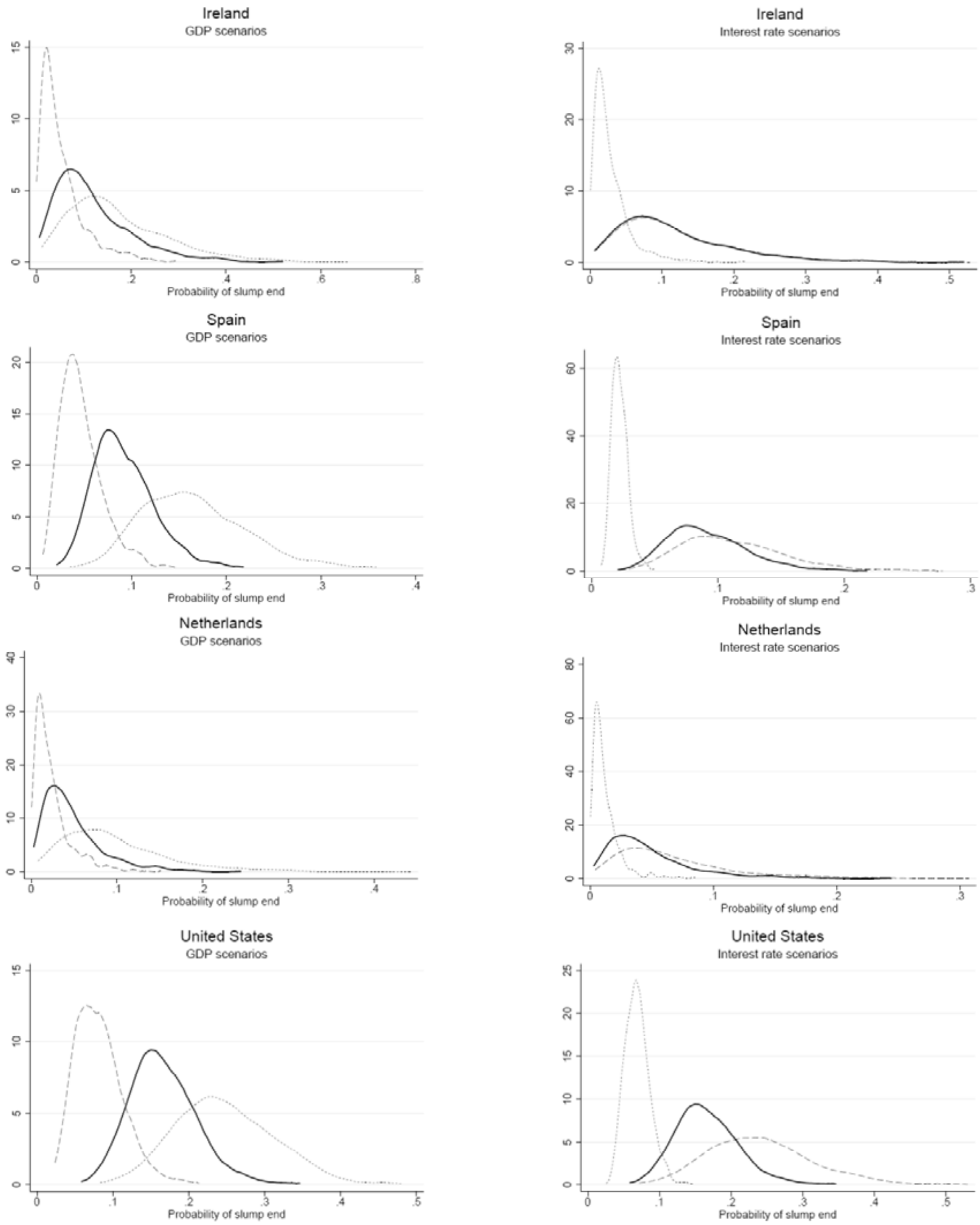
Figure 2: Simulations. Probability of slump ends.



Note: Density functions for simulated probabilities of slump ends. These are generated by evaluating the probit model at the latest values of the core variables in each country.

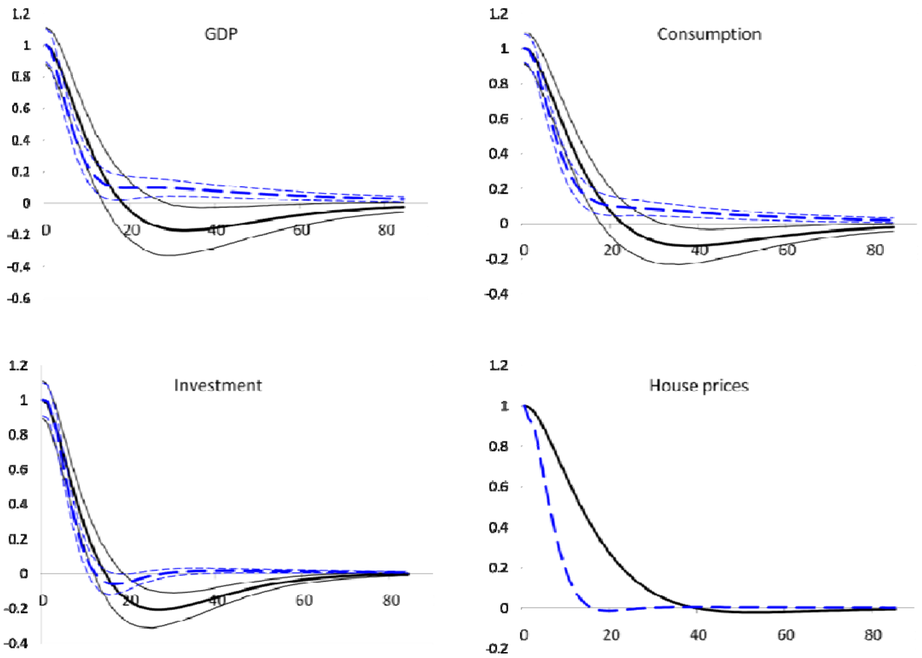
Figure 3: Simulations. Probability of slump ends.

GDP scenarios **Interest rate scenarios**



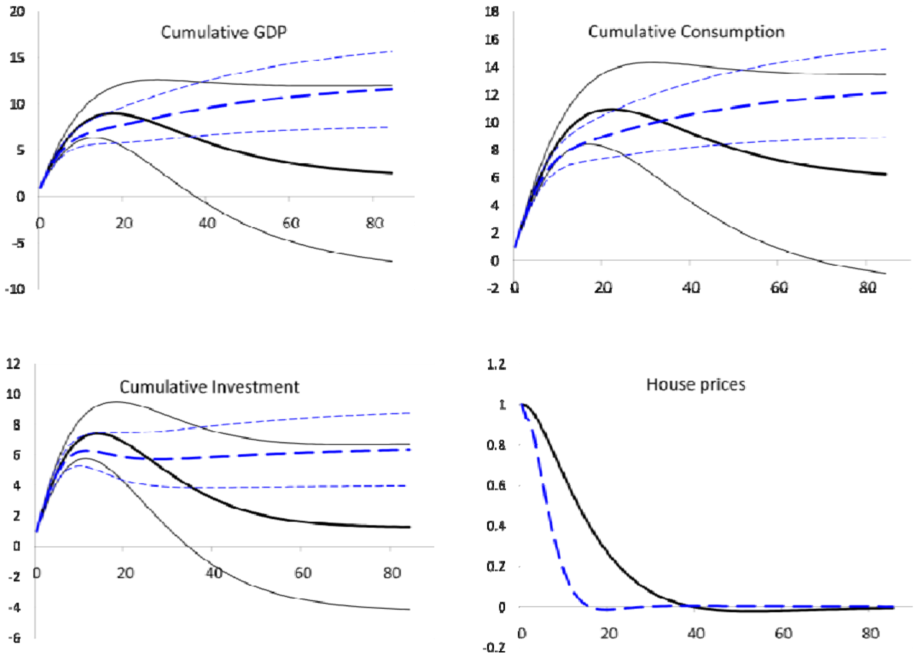
Note: Density functions for simulated probabilities of slump ends using the baseline probit model. Solid black lines are generated by setting the core variables to their latest value in each country. GDP scenarios are constructed by replacing the latest GDP growth value by two alternative values. Dashed lines correspond to a GDP growth rate of -2.35% while dotted lines plot the probability corresponding to a growth rate of 2.37%. For the interest rate scenarios, we followed a similar approach using 0.07% and 9.14% as the two alternative real mortgage interest rates. The former is represented by dashed lines and the latter by dotted lines. All values for the construction of these scenarios are taken from the dataset used to estimate the baseline probit model.

Figure 4: shallow vs. sharp slump



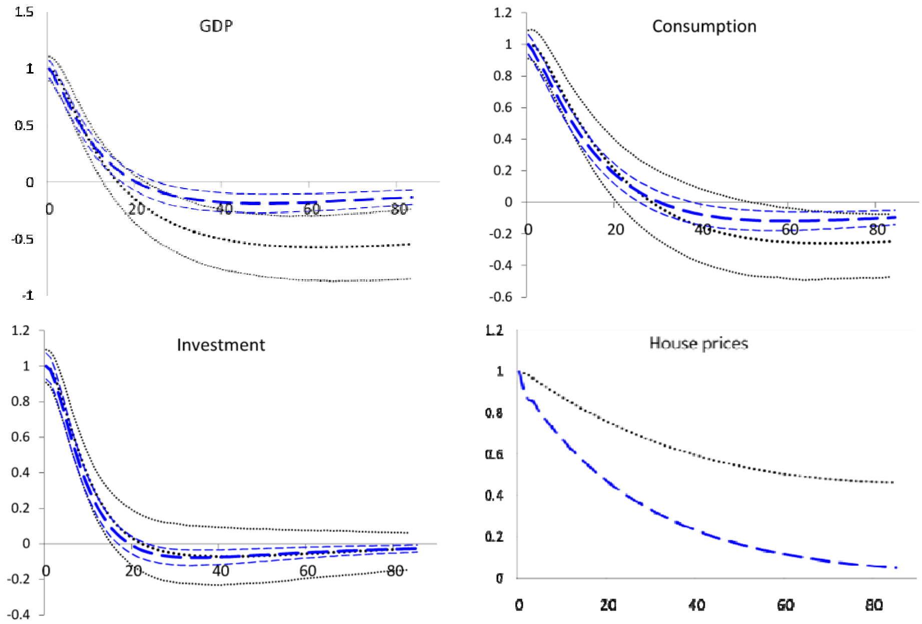
Note: Solid lines are the simulations for the shallow slump (the baseline model). Dashed blue lines are the simulations for the sharp slump. This is generated by scaling down the autoregressive coefficients in the house price equation by a factor of 0.9. Error bands are the 16th and 84th percentiles of the impulse-response distribution.

Figure 5: shallow vs. sharp slump, cumulative responses



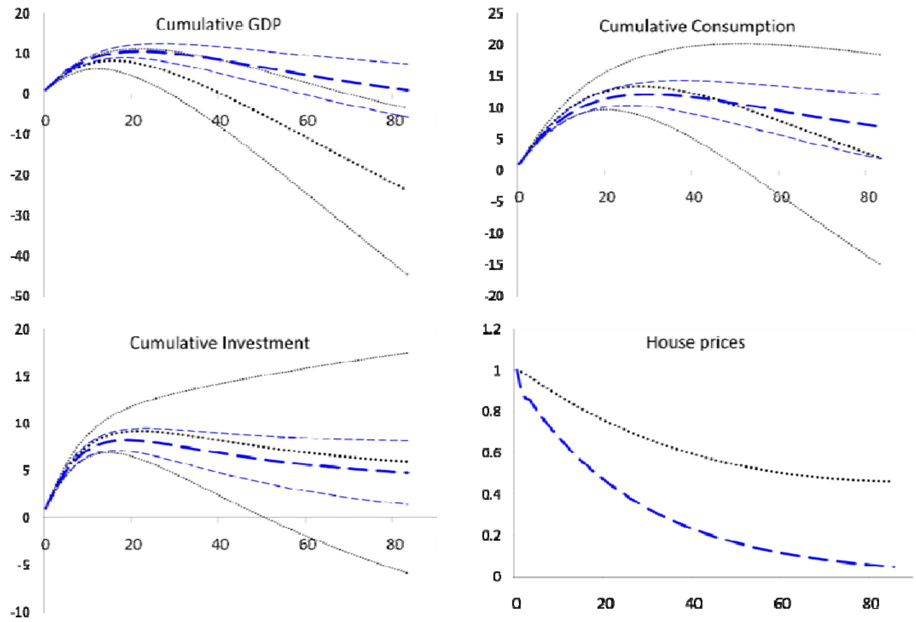
Note: Solid lines are the simulations for the shallow slump (the baseline model). Dashed blue lines are the simulations for the sharp slump. This is generated by scaling down the autoregressive coefficients in the house price equation by a factor of 0.9. Error bands are the 16th and 84th percentiles of the impulse-response distribution.

Figure 6: shallow slump (Japan) vs. sharp slump (Ireland)



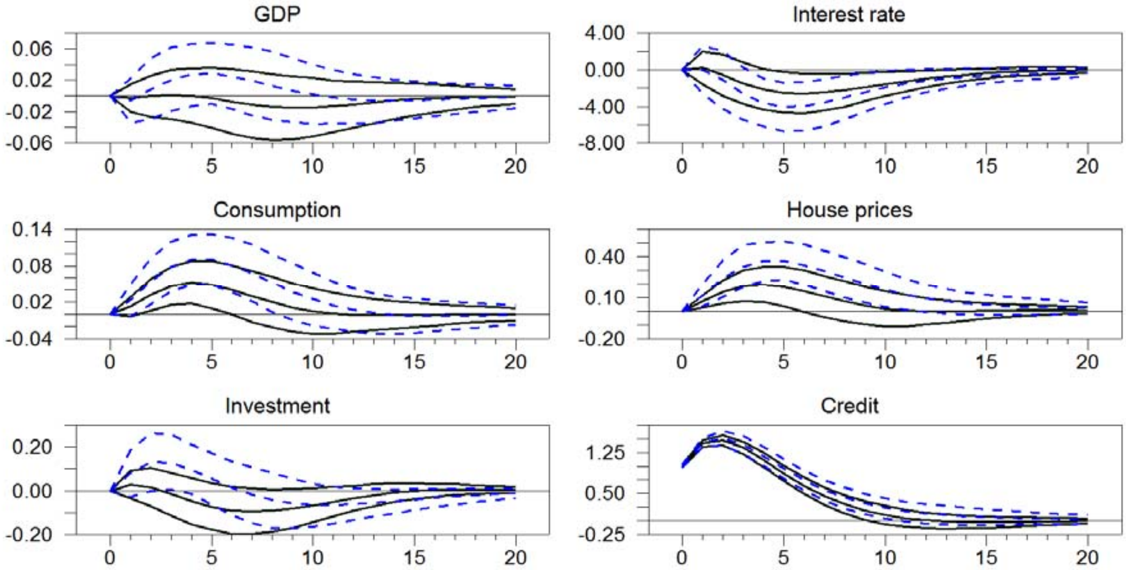
Note: Dotted black lines are simulations using Japanese house price coefficients. Dashed blue lines are simulations using Irish house price coefficients. Error bands are the 16th and 84th percentiles of the impulse-response distribution.

Figure 7: shallow slump (Japan) vs. sharp slump (Ireland), cumulative responses



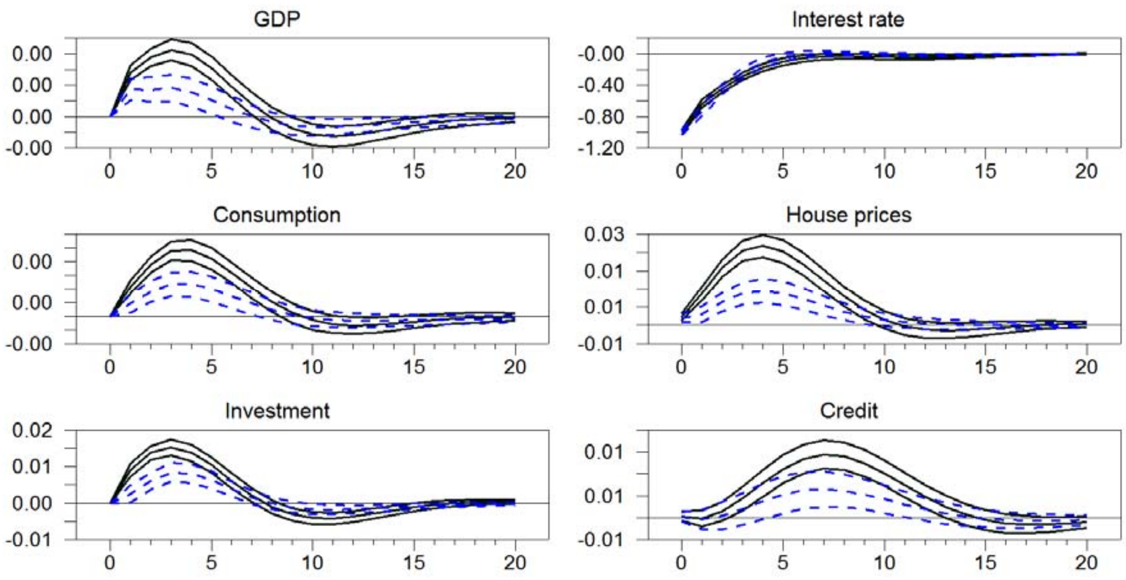
Note: Dotted black lines are simulations using Japanese house price coefficients. Dashed blue lines are simulations using Irish house price coefficients. Error bands are the 16th and 84th percentiles of the impulse-response distribution.

Figure 8: Responses to credit shock: baseline vs. slump



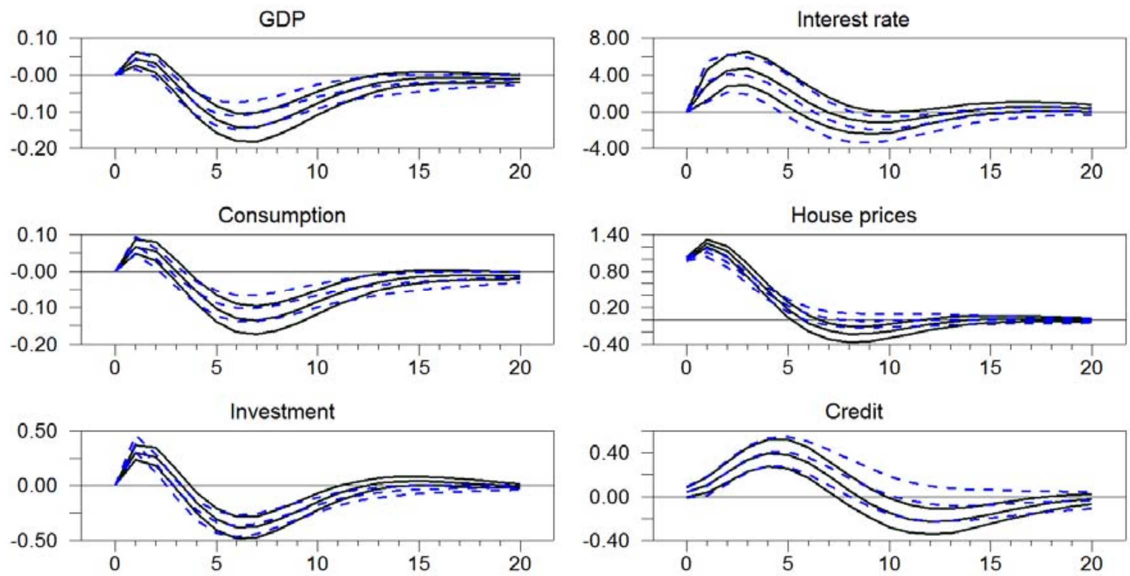
Note: Solid lines are the responses of the baseline model. Dashed lines represent the during slump dynamic responses. Error bands are the 16th and 84th percentiles of the impulse-response distribution.

Figure 9: Responses to interest rate shock: baseline vs. slump



Note: Solid lines are the responses of the baseline model. Dashed lines represent the during slump dynamic responses. Error bands are the 16th and 84th percentiles of the impulse-response distribution.

Figure 10: Responses to house price shock: baseline vs. slump



Note: Solid lines are the responses of the baseline model. Dashed lines represent the during slump dynamic responses. Error bands are the 16th and 84th percentiles of the impulse-response distribution.

APPENDIX: DATA SOURCES

House prices are inflation adjusted. The source of these data is the Bank of International Settlements (BIS). The source of real GDP growth is the OECD Economic Outlook No. 86 (December 2009). Mortgage interest rates are from International Financial Statistics (IMF). The source of interbank interest rate data is Global Financial Data. Long- and short-term government bond yields are from the OECD Economic Outlook No. 86 (December 2009). Credit is claims on the private sector by deposit money banks, from Becket al. (2010). To measure inflation we take the CPI growth rate. The source of these data is the OECD Economic Outlook No. 86 (December 2009). The source for total stock market return indices is Global Financial Data. The source of the investment, consumption and current account data is the OECD Economic Outlook No. 86 (December 2009). We obtain the Mortgage Market Development Index and its subcomponents from the IMF World Economic Outlook, April 2008, chapter 3. Bilateral bank data are obtained from the Bank of international Settlements (BIS).

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