Working Paper No.495

December 2014

The Role of Credit in the Housing Market[1]

Petra Gerlach-Kristen[*] and Niall McInerney

Abstract: We estimate a structural model of the Irish housing and mortgage markets and isolate the role of demand and supply factors in each market. We focus on the pre-2004 period during which house prices and mortgage credit exhibited a stable relationship. We find that mortgage demand is determined by interest rates, income and house price growth while mortgage supply is mainly a function of deposits. We show that the demand for housing is predominantly driven by house prices, mortgage credit and demographics and that supply depends on the profitability of housing construction. We then use the model to forecast how these markets will develop based on different scenarios about the model's exogenous variables. The high-growth scenario sees house prices rising by 50 percent over the next decade with an annual increase in the housing stock of 18,500 units.

Key Words: house prices, mortgage credit, simultaneous equations, simulation

Corresponding Author: niall.mcinerney@esri.ie

[*] Swiss National Bank

[1] The views in this paper are the authors' and do not represent those of the Swiss National Bank. We thank Alan Barrett, David Duffy, John Fitz Gerald, Austin Hughes, Kieran McQuinn, Rossa White and seminar participants at the ESRI for comments and suggestions. All remaining errors are our own. This paper was prepared as part of a research programme funded jointly by the National Asset Management Agency (NAMA) and the Banking and Payments Federation Ireland (BPFI).

The Role of Credit in the Housing Market

1. Introduction

In the decade prior to 2007, Ireland experienced the highest rate of house price appreciation amongst advanced countries. Since the onset of the financial crisis, prices have fallen by approximately half of their peak value - one of the largest property price declines in recent history among advanced countries. Only in 2013, six years after the peak, did prices begin to stabilise.

In synchrony with the growth in house prices was the explosion in mortgage lending. In the decade ending in 2007, the mortgage stock per capita grew from 4,000 to 32,000 euro. Behind this expansion, there was significant structural change in banks' access to funding. In particular, the reliance of the Irish banking sector on deposit growth to finance new lending began to change as cheaper short-term funding became increasingly available from wholesale money markets (Coates and Everett, 2013). This positive supply shock allowed banks to relax non-interest rate related credit conditions such as increasing the Loan-to-Value ratio and the share of income represented by mortgage repayments (McCarthy and McQuinn, 2013).

Clearly, a certain proportion of the rise in house prices and mortgage credit could be attributed to fundamental factors such as income growth, demographics, and falling interest rates. However, the usual metrics for gauging the overvaluation of house prices such as the house price to income and the house price to rent ratios suggest that house prices began to deviate from their fundamental level beginning in 2003 (Rae and van den Noord, 2006). Similarly, the credit-to-GDP ratio, which is often used to measure the appropriate size of the financial system relative to the economic development of a country, suggests that Ireland began to exhibit unusually large growth in credit aggregates from 2002-2003 (Beck, 2014).

The recent bubble and bust episode has therefore shown that the positive feedbacks between housing and credit markets can create significant macroeconomic distortions that have highly persistent consequences. In particular, shocks to one market produce accelerator effects that amplify the shock in the other market (Almeida et al, 2006). Therefore, from a macroprudential perspective, understanding the nature of the interaction between credit and housing cycles is a key component in any policy framework that has the objective of preserving financial stability. This is particularly important in the Irish case, where the credit-fuelled housing boom has had particularly dire consequences for the balance sheets of banks, households and the government.

This paper analyses the role of mortgage credit in Irish house price developments and provides a framework that highlights the spillovers between financial variables and the real economy. Most studies that have analysed the relationship between credit and housing have tended to estimate reduced-form models and do not disentangle the impact of supply and demand factors in each market. A distinguishing feature of this paper is that we specify and estimate a fully structural model of the Irish housing and mortgage market so that we can identify the main drivers of the credit-housing interaction from both the demand side and the supply side.

While such decomposition is clearly important from a macroprudential policy perspective in terms of the relative importance of credit in determining house prices and impact of house prices on bank lending, it is also important in terms of examining the sensitivity of mortgage supply to changes in

the funding environment facing the banking system. For example, the model can answer questions such as what is the likely increase in credit for a given change in retails deposits or change in the money market rate.

Our main findings are the following. First, mortgages volumes and house prices in Ireland displayed a stable relationship up until 2003, but thereafter, mortgage growth changed onto an unsustainably explosive path. Moreover, we find that the supply of mortgage credit is exogenous with respect to house prices in the long run so that it is house prices that adjust to the level of credit in order to restore equilibrium between the two variables.

Second, concentrating on the stable pre-2004 period, we find that mortgage demand depends on interest rates, income and house price growth, and that mortgage supply is mainly determined by interest rates and the level of retail deposits. In the housing market, demographics are the key variable that drives demand, although house prices and mortgage credit are also important, while housing supply is found to be a function of the profitability of housing construction.

Finally, the forecasts that the model generates based on assumptions taken from the ESRI's most recent *Medium Term Review (MTR)* illustrate the importance of recovery in the macroeconomy to developments in the mortgage and housing markets. For example, based on the statistical relationships identified using the pre-2004 period, we find that average national house prices reach over 252,000 euro by 2023 if the Irish economy follows the *Recovery* scenario outlined in the *MTR*, but less than 219,000 euro if it follows the *Delayed Adjustment* scenario.

The paper is organised as follows. Section 2 reviews the literature and discusses the model used to analyse demand and supply in the mortgage and housing market. Section 3 presents the data used in the analysis and demonstrates that the stability between mortgage volumes and house prices broke down in 2003. Section 4 estimates demand and supply in the mortgage and housing markets and Section 5 performs simulations to assess likely future developments in these markets. Section 6 concludes.

2. Literature and the model

Although the academic literature on the determination of Irish house prices is relatively rich, the role of credit in house price dynamics has received little attention.[1] The impact of credit is usually captured though the inclusion of the mortgage interest rate in an inverted housing demand equation with the estimated coefficient often statistically insignificant or opposite to the expected (negative) sign. Moreover, this literature mostly ignores the interaction between housing and mortgage markets and therefore takes the prevailing mortgage rate as exogenous.

The direction of causation between credit and house prices appears to differ by country and whether a measure of total bank lending or of mortgage credit specifically is used in the model. Theoretically, causation can go in either direction. Allen and Gale (1999) suggest that changes in credit availability, for example due to financial liberalisation, stimulate the demand for assets like

[1] See Murphy (2004) for a comprehensive survey of the literature on the determination of Irish house prices prior to the financial crisis.

housing leading to rising asset prices. In this case, causation goes from mortgage credit to house prices. From an Irish perspective, this would imply that the impulse to the housing boom was a change in credit conditions that allowed banks to access funding more cheaply and therefore provide a greater volume of credit to both households and the construction sector.[2]

However, if bank lending is characterised by strong collateral effect then it is likely that causation goes in the opposite direction. For example, rising income levels can lead to a greater demand for housing and to rising house prices. The latter increases the value of housing collateral which can be used to obtain a larger amount of mortgage credit than prior to the increase in house prices. In this case, it is changes in asset prices that provide the impetus to the increase in lending.[3]

Much of the empirical literature that examines the interaction between house prices and credit find that the direction of causation goes from the former to the latter.[4] However, these studies tend to use the volume of total bank lending as the credit variable, rather than just the mortgage component. Hoffmann (2004) finds that house prices have significant explanatory power for total bank lending in a Vector Autoregression for 16 OECD countries. Similarly, Gerlach and Peng (2005) find that property prices tend to drive bank credit in Hong Kong.

However, studies that use mortgage rather than total bank lending as the credit variable find evidence that the direction of causation is country-specific. Brissimis and Vlassopoulos (2008) find that property prices influence mortgage credit in Greece. Gimeno and Martinez-Carrascal (2010) suggest that the relationship between housing and mortgage markets is mutually reinforcing in Spain, while Oikarinen (2009) obtains a similar result for Finland. By contrast, Linder (2014) shows that it is innovations in the mortgage market that tend to drive house prices in the United States.[5]

From an Irish perspective, Fitzpatrick and McQuinn (2007) is one of the few studies that examine this interaction. They model the equilibrium level of credit as a function of house prices, disposable income and mortgage interest rates in a single equation framework. This credit variable is also included as a regressor in the house price equation and house prices are included in the credit equation. Both variables are positive and significant indicating that there is a two-way interaction between housing and credit markets in the long run.

This paper differs from Fitzpatrick and McQuinn (2007) in that we focus on disentangling the individual impact of supply and demand factors in the determination of equilibrium credit volumes, rather than including them together in a single-equation. In addition, we find that house prices only influence mortgage credit in the short-run so that there is only a uni-directional relationship between credit and house prices in the long run.

McQuinn and O'Reilly (2006) and Addison-Smyth et al (2009) consider the relationship between house prices and both the actual and "affordable" level of mortgage credit. The latter is based on

[2] McCarthy and McQuinn (2013) relate the change in credit conditions that coincided with the housing boom to the availability relatively cheap wholesale funding that followed the introduction of the euro.

[3] See Bernanke and Gertler (1989) and Kiyotaki and Moore (1997) for a formal analysis of how increasing asset prices can lead to a rediction in interest rates or credit constraints facing borrowers.

[4] See Lindner (2014) for a literature review on the relation between house prices and bank credit.

[5] This finding is supported by Duca et al (2011) who show that exogenous changes in the Loan-to-Value ratio, a proxy for credit condition, had a significant impact on house prices in the US in the pre-crisis bubble period.

the calculation of a mortgage annuity for a given level of income, mortgage interest rate and mortgage duration. Both papers find that actual and affordable credit levels begin diverging in 2003 leading to a divergence between the actual and "fundamental" level of house prices. Addison-Smyth et al (2009) show that the divergence in mortgage levels is a function of a "funding gap" variable, essentially an increase in the loan-to-deposit ratio, and the level of mortgage securitisation.

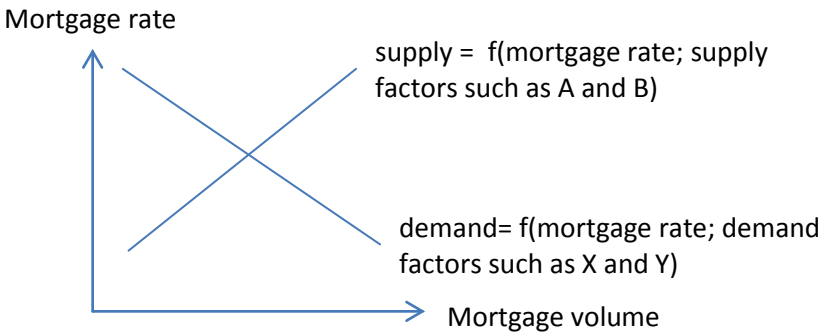
Our conceptual framework is similar to McQuinn and O'Reilly (2006) and Addison-Smyth et al (2009) in that we also try to determine the level of credit that is consistent with the fundamental economic variables that drive the equilibrium volume of mortgage credit. However, both of these papers model the level of credit as a single equation, treating the mortgage rate as exogenous. In our framework, we allow both the volume of credit and the mortgage interest rate to be determined endogenously via the interaction of the factors affect the supply and demand for credit. In addition, preliminary analysis indicates that mortgage lending became explosive after 2003 Q2 so we chose to confine our study to the period during which there is a stable relationship between house prices and mortgage levels.

Our model is also related to Nobili and Zollino (2012) in that we allow for spillovers between the housing and the mortgage market. In contrast to their study, we take the simultaneity econometrically into account by estimating a system that instruments potentially simultaneous variables. This simultaneity arises due to equilibrium in the housing and mortgage markets being jointly determined. For example, our model allows for the stock of mortgages to affect house prices and for house prices to affect the stock of mortgages. As these interactions occur simultaneously, we need to take account of the impact of equilibrium in one market on the equilibrium in the other. Estimating housing demand and supply and mortgage demand and supply together in a system allows us to do this.

In addition, we differ from Nobili and Zollino (2012) in that we assume that the supply of mortgage credit is an increasing function of the mortgage interest rate. Intuitively, this assumes that banks face funding constraints when they want to make new loans and therefore must raise deposit rates (or pay higher interest rates on wholesale borrowing) in order to attract the funding to make these loans. The main funding constraint in our model is the volume of retail deposits in the banking sector.

For each of the two markets, we model demand and supply separately. Focusing on the mortgage market here, we thus estimate two equations that have the mortgage volume as the left-hand side variable and include as one of the right-hand side variables the mortgage rate. Additionally, we let demand depend on some factors that do not matter for supply, and vice versa. X and Y are such demand factors, such as disposable income), while A and B are supply factors, such as the short-term money market rate. Figure 1 shows the two schedules.

Figure 1: The mortgage market



We follow the classical text book case for simultaneous equations and use the supply factors as instruments for the mortgage rate in the demand equation. This captures the fact that changes in supply have an impact on the mortgage and hence on mortgage volumes that is unrelated to demand but needs to be accounted for. Conversely, we use the demand factors as instruments for the mortgage rate in the supply equation to control for the impact of changes in demand on mortgage rates and volumes.

The housing market is modelled in the same way, with the housing stock as left-hand side variable and the house price as right-hand side variable in both the demand and the supply schedule.

A special feature of our model is that we estimate the housing and mortgage market jointly and control for endogeneity across markets. The mortgage volume, which is given by the equilibrium in the mortgage market, presumably is a determinant of housing demand; conversely, the house price, given by the equilibrium in the housing market, may enter in the mortgage demand schedule.

As Section 4 will show, interest rates, disposable income, and house price growth are important determinants of mortgage demand in Ireland, while mortgage supply is mainly a function of interest rates and the level of deposits. In the housing market, demand is predominantly driven by demographics, house prices and mortgages credit, while supply is depends on the profitability of housing construction.

3. Data

We model supply and demand in the credit and housing markets in per capita terms. In doing so, we incorporate the impact of population growth, mainly via migration, on these markets. Quarterly data on the total population are taken from the OECD's *Main Economic Indicators.*

Our house price series is constructed from three different data sources as we combine series that have greater coverage with those that are available for a longer period.[6] Specifically, we use the average new and old house price from the Department of Environment, Community and Local Government (DoECLG) from 1985 to 1995, the ESRI-Permanent TSB House Price index from 1996 to

[6] See Browne, Conefrey and Kennedy (2013) for a discussion of these issues in the Irish context.

2004, and the CSO's property price index for the remaining sample period. The annual housing stock is obtained from the ESRI's databank and is interpolated using new housing completions from the DoECLG.

Data on mortgage volumes, average mortgage interest rates and personal disposable income are obtained from the Central Bank of Ireland (CBI). One of the determinants of mortgage supply in our model is the level of deposits and the latter are taken from the IMF's *International Financial Statistics* and the CBI's *Credit, Money and Banking Statistics*. We also relate mortgage supply to the cost of alternative sources of funding and to the opportunity cost of mortgage lending. The former is captured by the three-month money market rate and is obtained from the Central Bank of Ireland, while the latter is approximated by interest rate on ten-year government bonds and is taken from the OECD's *Economic Outlook* database.

The housing component of the model assumes that the demand for housing services is partly determined by new household formation, as approximated by the share of 25 to 34 year olds in the population, and also by the rate of unemployment. Both of these variables are taken from the CSO.

On the supply side, housing is modelled as an inverse function of the cost of credit to construction firms and of construction costs. We use the interest rate on loans to non-financial corporations, obtained from the Central Bank, as a proxy for the cost of bank credit to construction firms.[7] We capture changes in building costs via the DoECLG's index of construction costs. We also constructed a measure of material costs from the CSO's wholesale price index for Building and Construction Materials, controlling for breaks in the series over our sample period and interpolating to obtain quarterly estimates.[8] We suspected that this variable might be more exogenous with respect to housing market activity than the index of building costs but it proved to be insignificant and so was dropped from the model.

Figure 2 below plots both total mortgage credit and mortgage credit per capita for our sample period 1980 Q1 to 2013 Q1.[9] The acceleration in mortgage lending beginning in the early 2000s is particularly striking and remains even after removing the impact of population growth on total mortgage lending. Figure 2 also illustrates how strongly the financial crisis and subsequent recession has impacted on outstanding mortgage volumes as both households and banks seek to repair balance sheets.

Figure 3 shows how average nominal house prices and the total housing stock have evolved over our sample period. House prices remained relatively flat until the late 1990s when we observe a sharp

[7] Although the interest rate on lending to construction firms is likely to be higher than the average to all non-financial corporation, a sectoral breakdown of lending rates is not available.

[8] The index is only available at an annual frequency prior to 2006.

[9] The mortgage volume series uses transactions data since 2003 to calculate the change in the mortgage stock and therefore excludes the impact of revaluations and other factors that affect the stock of credit but not the underlying flow to the economy. The series also includes mortgage lending that has been securitised as it is the total volume of credit that has been extended that affects house prices and not just the amount that has been retained on the balance sheet of the retail banking sector.

increase in trend appreciation, which continued until early 2007. Since the crisis however, house prices have fallen to approximately half of their peak values. The supply of housing also exhibits a break in trend in the early 2000s as housing completions responded to the price signal and has accordingly been flat since the crisis as completions are barely sufficient to offset the impact of depreciation.

Figure 2: Total and per capita mortgage volumes

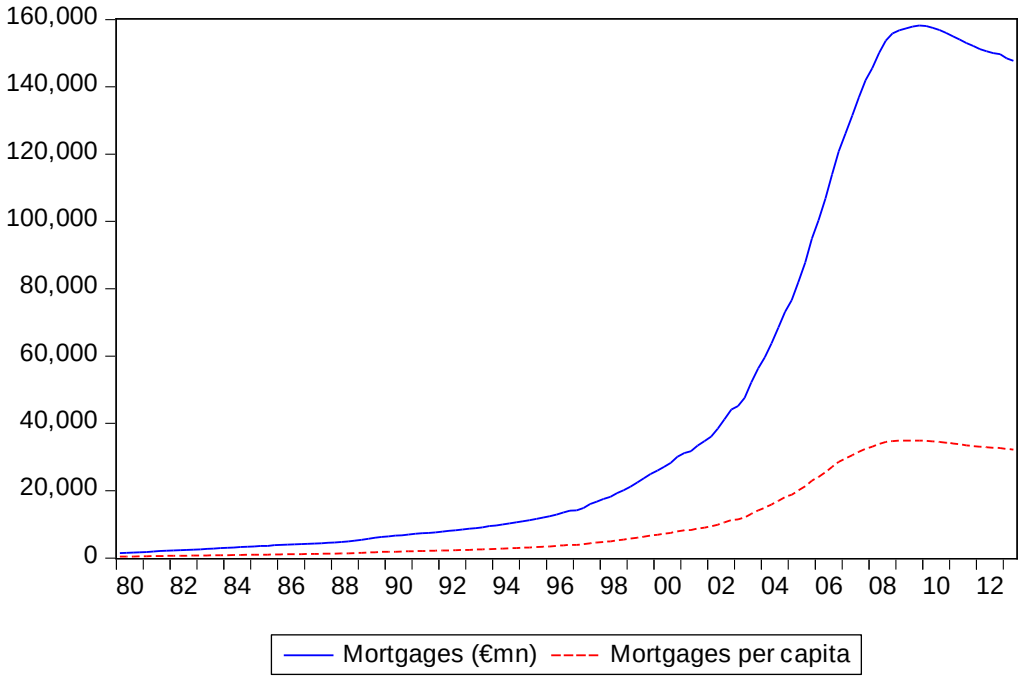
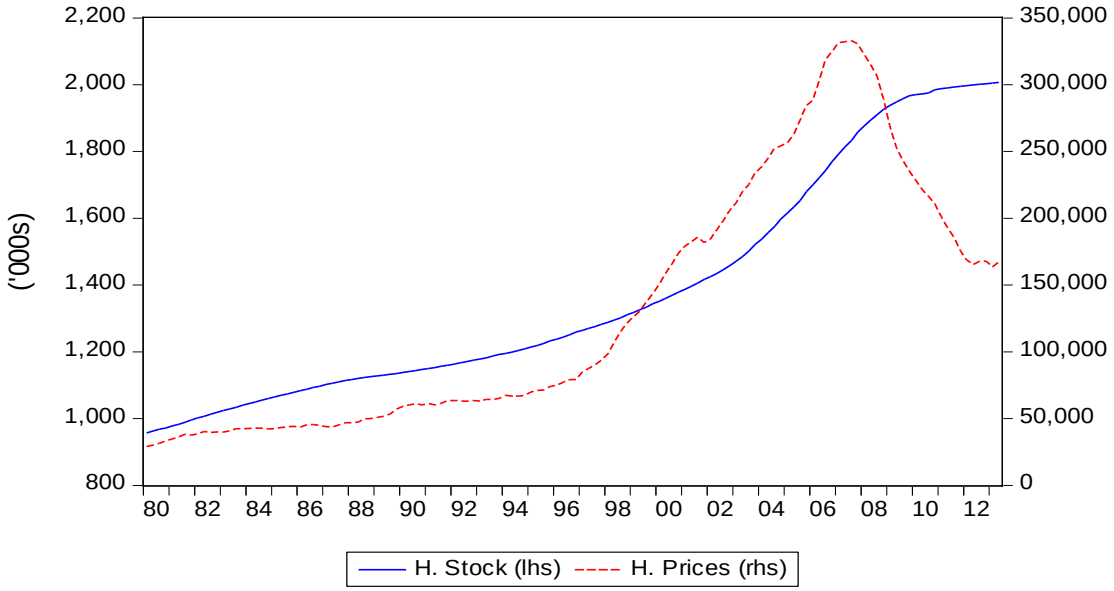


Figure 3: Housing Stock and House Prices



The similar dynamic behaviour of mortgage and housing variables suggests a strong relationship between these two markets and our model is designed to disentangle the underlying factors which are driving this relationship. However, one crucial issue in modelling the Irish housing and mortgage

market is whether the aim is to describe the build-up and collapse of the bubble in the mid 2000s, or if the goal is to analyse how housing and mortgage variables behave in normal times. In this paper, our objective is the latter: we aim to describe how these markets most likely will develop, and normal times are by definition more common than exceptional events such as a bubble.

In terms of data, this consideration implies that our analysis must concentrate on the pre-bubble period. Our prior is that the bubble began to inflate sometime between 2002 and 2004. Rather than arbitrarily picking a date, we let the data decide on the break point.

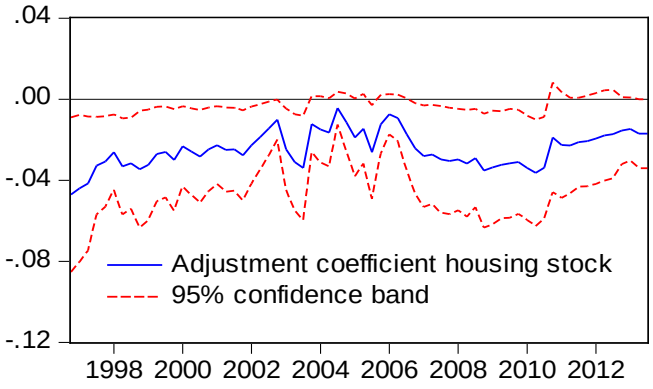
To do so, we concentrate on mortgage volume per capita and the housing stock per capita, and estimate a simple vector error-correction model (VECM). This VECM assumes that there is a long-term relationship between the two variables (they tend to grow together). Typically, if one variable, for instance the housing stock is unusually large compared with the other, in our case the mortgage volume, the housing stock grows more slowly in the following periods and the mortgage volume faster, so that the equilibrium is restored. Stability is also achieved if only one of the two variables adjusts in the way just described. Explosive behaviour manifests itself if the housing stock, instead of growing more slowly, grows faster, or mortgages grow more slowly.

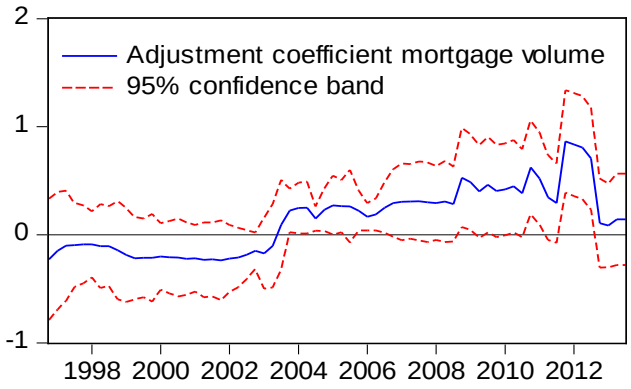
Figure 4 shows the adjustment coefficient for both variables. The coefficient is plotted such that a negative value indicates that the variable grows more slowly if it was unusually large in the last period. The VECM has six lags (as suggested by lag length tests) and is initially estimated using data from 1980 Q1 to 1996 Q4, before the break in the trend growth rates of house prices and mortgage credit. The coefficient estimate for the housing stock adjustment is -0.047 for that sample and the starting point for the blue line in the top panel of Figure 4. We then lengthen the sample by one quarter and obtain a coefficient estimate of -0.044. Adding more and more quarters allows us to trace out the solid line. The dashed lines demark the 95% confidence band. The figure suggests that the adjustment coefficient of housing has the expected negative sign and significant at the 5% level. Thus, when the housing stock is unusually large, or the mortgage volume unusually large, the housing stock tends to grow more slowly.

The lower plot shows that the same cannot be said for mortgages. We find the expected negative sign only up to 2003 Q2. Thus, up to that point mortgages tended to grow more slowly when their past level was unusually high or the housing stock unusually low (though the coefficient is insignificant even in this period). Thereafter, the coefficient is significantly positive, implying explosive behaviour.

Given this evidence, we treat the observations after 2003 Q2 as the years of the inflating and collapsing bubble. This is consistent with the findings of Beck (2014), who compares the level of mortgage credit to that which would have been predicted by socio-economic factors, and shows that they begin to diverge in 2003. For the estimation of demand and supply in the mortgage and housing market during normal times, which we turn to in the next section, we concentrate on the period 1980 Q1 to 2003 Q2.

Figure 4: VECM adjustment coefficients using an expanding sample





Note: Coefficient sign adjusted such that a negative sign indicates slower growth if the lagged value of the housing stock (mortgage volume) was large. Coefficients for a sample starting in 1980Q1, with the end date moving from 1996 Q1 to 2013 Q2. VECM has six lags as suggested by lag length tests.

This analysis implies that prior to 2003, changes in credit availability tended to drive house prices in the long run. This suggests that the collateral effect of house prices on borrowing was weak over this period and that it is innovations in credit markets that are more important drivers of house prices in the longer term.

Before proceeding, it is worth noting that, while we find no long-run impact of house prices on mortgages in the error correction framework, there is evidence for a short-run effect. Table A1 in the Appendix reports the complete estimation output for the VECM estimate for the period 1980 Q1 to 2003 Q2. There it can be seen that house price growth tends to raise mortgage growth. In the estimation below, we take this into account by including house price growth, but not the level, when modelling the mortgage market. When modelling the housing market, we include the level instead, which accounts for the long-run impact identified in Figure 3.

4. Estimation

We estimate the following equations for the supply and demand for mortgage credit and housing as a system of simultaneous equations:

Mortgage demand:

$$MorVol_t = \propto_1 + \beta_1 MorVol_{t-1} + \beta_2 MorRate_t + \beta_3 Income_t + \beta_4 \Delta HPrice_{t-1} + \varepsilon_{1t} \quad (1)$$

Mortgage Supply:

$$MorVol_t = \propto_2 + \beta_5 MorVol_{t-1} + \beta_6 MorRate_t + \beta_7 MorRate_{t-1} + \beta_8 Deposits_t + \beta_9 MMRate_t + \beta_{10} BondRate_t + \varepsilon_{2t} \quad (2)$$

Housing Demand:

$$HStock_t = \propto_3 + \beta_{11} HStock_{t-1} + \beta_{12} HPrice_t + \beta_{13} MorVol_t + \beta_{14} Share2534_t + \beta_{15} URate_t + \varepsilon_{3t} \quad (3)$$

Housing Supply:

$$HStock_t = \propto_4 + \beta_{16} HStock_{t-1} + \beta_{17} HPrice_t + \beta_{18} BCost_t + \beta_{19} NFCRate_t + \varepsilon_{4t} \quad (4)$$

4.1 The mortgage market

We estimate mortgage demand and supply as depending on the past per-capita mortgage level (*MorVol*) and the current and lagged mortgage rate (*MorRate*).[10] For mortgage demand (1), we consider two specific demand factors that seem independent of supply. The first of these is personal disposable income per capita *(Income)* and is a standard determinant of credit demand in the literature (see Davis and Iadze (2012), Nobili and Zollino (2012)). The combination of the interest rate and disposable income per capita reflect the capacity of households to repay the debt stock and thus reflect the level of mortgages that is "affordable" given the behaviour of economic fundamentals.

The second demand factor we include is lagged annual house price growth (*ΔHPrice)*.[11] By including growth, rather than the level, we allow only for a short-term impact of house prices on mortgage demand. This is in line with the preliminary VECM estimations reported above. One interpretation of this variable is that it is a proxy for expected house price appreciation, so that if combined with the mortgage rate would represent the user cost of housing. We also considered a number of additional demand factors, such as annual inflation, but they were insignificant.[12]

To model mortgage supply (2), we include as specific supply factors per-capita bank deposits (*Deposits)*, the ten-year government bond yield (*BondRate)* and the 3-month money market rate

[10] The lagged mortgage rate is only significant in the mortgage supply equation.

[11] We also attempted including house price growth in the mortgage supply equation (thus testing for a positive impact from rising household equity), but found no significant impact.

[12] The demand for mortgages can increase with inflation as the latter erodes the real cost of borrowing and investment in housing is often viewed as a hedge against inflation (see Pazarbasioglu (1996)).

(*MMRate)*. We assume that banks maximise the risk-adjusted return on a portfolio of assets and therefore the ten-year government bond rate represents the opportunity cost of mortgage lending. The money market rate is used as a proxy for the costs of alternative sources of funding and the monetary policy stance.

Table 1 reports the estimation output. The coefficients in the table represent the short-run elasticities with respect to the dependent variable but they can also be used to calculate the long run elasticities. [13]

Table 1: Mortgage and housing demand and supply estimates

Mortgage market (dependent variable: $MorVol_t$)		
	Demand	Supply
Constant	-0.188	0.478***
$MorVol_t$	0.951***	0.961***
$MorRate_t$	-0.003***	0.010**
$MorRate_{t-1}$		-0.004**
$Income_t$	0.080*	
$\Delta HPrice_{t-1}$	0.050**	
$Deposits_t$		0.028***
$MMRate_t$		-0.006**
$BondRate_t$		-0.003**
Housing market (dependent variable: $HStock_t$)		
Constant	0.223***	-0.005
$HStock_t$	0.935***	0.981***
$HPrice_t$	-0.024***	0.004***
$MorVol_t$	0.014***	
$Share2534_t$	0.045***	
$URate_t$	-0.009***	
$BCost_t$		-0.008**
$NFCRate_t$		-0.0002***

Note: Sample period 1985 Q1 to 2003 Q2. Three-stage least squares system estimates. All variables but interest rates are in logs. In the mortgage equations, the mortgage rate is instrumented with the demand and supply factors of both mortgage equations. This is also done in the housing equations, where moreover the mortgage volume is instrumented with its own lag to account for simultaneity across both markets.

It is clear that there is high autocorrelation in volumes. Mortgage demand is negatively related to the mortgage rate, and increases with income and house price growth. The coefficients suggest that the main drivers of mortgage demand in the short run are income and the growth in house prices. For example, a 1 percent increase in income per capita leads to close to a tenth of a percent increase in the mortgage stock in the short run and a 1.6 percent increase in the long run. In terms of house price growth, the mortgage stock increases by 0.05 percent in response to a 1 percent increase in house prices in the short run and adjusts one-for-one in the long run.

[13] The long-run elasticity of a variable in a partial adjustment model is the (short-run) coefficient on the variable divided by one minus the coefficient on the lagged dependent variable.

Table 1 also shows how mortgage supply rises with increasing interest rates, though this effect seems to be mainly temporary. Indeed, a test for whether the coefficients of the current and lagged mortgage rate sum to zero is not rejected (p-value of 0.13), which suggests only a short-run response of mortgage supply to interest rate changes. The main driver of mortgage supply during the sample period is the deposits. The coefficient on deposits implies that a 1 percent increase in deposits leads to a 0.03 percent increase in mortgage supply in the short run and 0.7 percent in the long run. Mortgage supply also rises as alternative sources of funding (via the money market) become cheaper and as the opportunity cost of mortgage lending declines.

4.2 The housing market

In terms of the housing market, both housing demand (3) and supply (4) should depend on house prices. We again allow for autocorrelation in the housing stock (*HStock)*. As demand-specific factors, we include the mortgage volume, the share of 25 to 34 year olds in the population (*Share2534)* and the unemployment rate (*URate)*. We include mortgages given that the evidence in Section 3 suggested that the housing stock depends on mortgage volumes. While an argument could be made that housing supply as well as demand depends on mortgages, this effect is not significant in a reduced system. In the estimation, to account for the fact that mortgage volumes and the housing stock are determined simultaneously, we instrument with the lagged mortgage volume.

The share of 25 to 34 year olds in the population is included to capture the impact of demographic change on the demand for new houses as household formation is generally strongest in this cohort. The unemployment rate is included to capture macroeconomic uncertainty which may deter household formation.

For housing supply, we include building costs (*BCost)* and the interest rate on credit extended to non-financial corporations (*NFCRate)* as additional explanatory variables. The latter is used as a proxy for the cost of finance facing construction firms and represents an additional credit channel (together with household mortgage lending) in the model.

In Table 1, it can be seen that housing demand falls if house prices increase. This effect appears to be permanent as lagged house prices were found to be insignificant and therefore it is the level of house prices and not the growth rate of house prices that determine the demand for housing in the long run. In addition, mortgage volumes matter. Thus, if a rise in mortgage demand occurs, for instance because income increases, this raises housing demand and house prices. This leads to a feedback effect since mortgage demand depends on house price growth. The long-run elasticity of housing demand with respect to mortgage volumes is 0.22 indicating that credit does play a significant role in house price dynamics.

Demographic change appears to have the strongest impact on the demand for housing with an increase in the share of the population of those in the younger cohorts most likely to form new households associated with a higher demand for housing. Our results suggest that a one percent increase in this share is associated with a 0.05 percent increase in housing demand in the short run and 0.69 percent in the long run. We also find that lower unemployment rates are associated with higher demand for housing.

Housing supply, finally, rises when house prices increase. In addition, the housing stock grows if building costs fall, which reflects an increase in the profitability of constructing new houses. The coefficient on the interest rate on loans to non-financial corporations is also negative and significant, although the coefficient is negligibly small.

Having identified the significant drivers of mortgage and housing demand and supply, we now turn to simulations of the model.

5. Simulations

5.1 In-Sample Model Predictions

Figure 5 shows the model's prediction for how mortgage volumes, mortgage interest rates, the housing stock and house prices would have evolved between 2003 Q2 and 2013 Q4 given the behaviour of the model's exogenous variables over the period. The simulations highlight how each housing and mortgage market variable has diverged significantly from that which would have been suggested by the evolution of the fundamental factors in each market. We could plausibly term this a "no bubble" scenario, given that our analysis in section 3 shows how some of these variables began exhibiting explosive dynamics in 2003. The fitted values in Figure 5 are based on parameters that are estimated on the more stable period prior to 2003.

In terms of mortgages, our model implies that predicted mortgage volumes would have grown much more slowly than the actual level and at the onset of the crisis would have been approximately 50 billion below the latter. It also implies an absence of deleveraging in the post-crisis period. The actual volume of mortgage credit has fallen by over 10 billion euro since its peak in Q4 2009, whereas the model simulation shows that the mortgage stock would have started to rise by late 2013 as house prices started to rise. This is due to the model more closely relating the dynamics of mortgage credit to indicators of affordability such as interest rates and income and less to the influence of debt overhang.

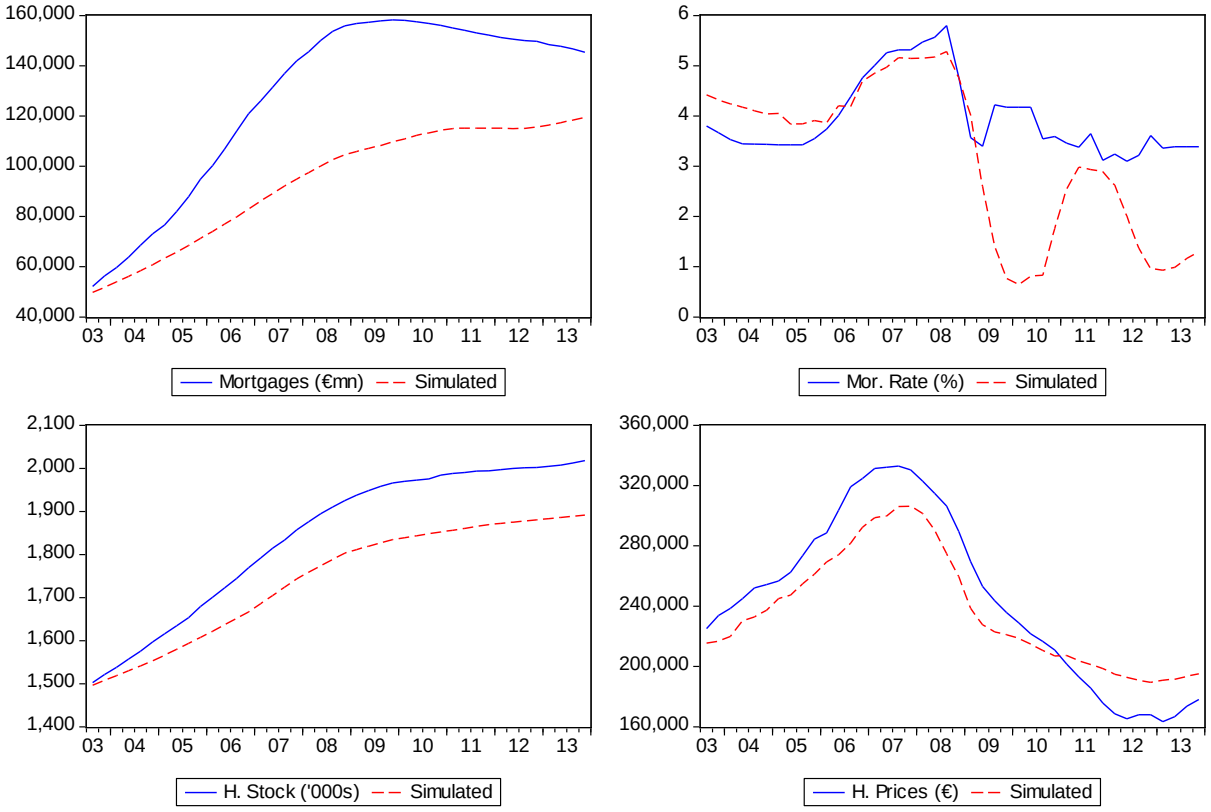
Actual and simulated mortgage interest rates are broadly similar in the pre-crisis period but diverge sharply at the beginning of 2009.[14] This suggests a degree of "stickiness" in nominal interest rates that the model does not capture.[15] However, given that the mortgage rate has only a short-run effect on mortgage supply and a relatively small impact on credit demand, we can reasonably expect that this would have a relatively small effect on the forecasting performance of the model in terms of the other endogenous variables.

Figure 5 also illustrates how this "excess" growth of mortgage credit drove a wedge between house prices and their fundamental values. The model tends to under-predict house prices by approximately 20,000 euro during the bubble period, although the wedge rises to 30,000 euro at the bubble's peak.

[14] The mortgage interest rate is obtained by inverting the equations for the quantity of credit demanded and supplied.

[15] It should also be noted that the mortgage interest rate used in this analysis relates to the average on the existing mortgage stock and not to the standard variable rate. This likely explains a significant amount of the persistence in the dynamics of .the mortgage rate described above.

Figure 5: Simulated values for Mortgage levels, Mortgage interest rates, House prices and the Housing Stock 2003-2013



Simulated house prices decline with actual house prices after 2008 and rose above the latter at the beginning of 2011, suggesting that the housing stock became undervalued at that time. The simulation implies that house prices were up to 30,000 euro below their fundamental values during 2012 but that this gap approximately halved during 2013.

Finally, Figure 5 shows how the gap between the simulated and actual level of the housing stock is driven mainly by housing construction over the 2003 to 2007 period but that this gap (approximately 120,000 units) has remained relatively constant in the post-crisis period. These results suggest that the elasticity of housing construction with respect to house prices was much higher in the post-2003 sample period than the model estimates for the pre-2003 period.

5.2 Forecasts

We now use the model to generate forecasts of mortgage volumes, mortgage interest rates, average house prices and the housing stock based on assumptions about how the model's exogenous variables will evolve. We use forecasts for the latter generated by the ESRI *HERMES* model under three scenarios: a "recovery" scenario, a "delayed adjustment/credit constrained" scenario, and a

"stagnation" scenario. These scenarios differ according to assumptions about the strength of the recovery in the Irish and European economies are outlined in ESRI's *Medium-Term Review* (*MTR*).[16]

Recovery Scenario

The *Recovery* scenario outlined in the *MTR* assumes that credit constraints will no longer continue to bind and that growth in the European Union will approximately return to its pre-crisis level, which will spur Irish growth via exports. In this scenario, real GNP grows at approximately 3.5 per cent a year between 2015 and 2020 and regains its 2007 level by 2017. Unemployment falls to 5 percent by 2023.

Demographic change will also have a strong impact on the size of the mortgage and housing markets. In the *Recovery* scenario, the total population reaches almost 5 million by 2023 while the number of 25 to 34 year olds remains above 700,000 over the next decade. The latter implies a strong demand for housing from purely demographic trends.[17]

In terms of the mortgage market, the rise in income has the largest impact on the demand for mortgages. In the *Recovery* scenario, personal disposable income increases 5 per cent a year on average between 2014 and 2023. In addition, the increase in house prices (see below) reduces the user cost of capital and makes owning a house more attractive relative to renting.

For a given interest rate, the increase in disposable income also makes mortgages more affordable from a bank's perspective and thus reduces the risk premium on mortgage lending. The supply of mortgages also responds positively to the growth in deposits, which are assumed to grow in line with income.

In terms of alternative source of funding, the 3-month money market rate is assumed to track the rate on three-month German government bonds. The *Recovery* scenario assumes that this rate increases gradually over the forecast horizon but remains below 3 per cent until 2020. Thus, the favourable funding environment assumed in this scenario is conducive to the expansion of mortgage credit.

However, our model assumes that banks maximise risk-adjusted returns across a portfolio of assets. The opportunity cost of mortgage lending is approximated by the interest rate on long-term government bonds and in the *Recovery* scenario is assumed to increase gradually until 2016 and decline thereafter. This implies that, all else equal, mortgage lending should expand until the risk-adjusted returns on mortgages and other assets are equal.

Figure 6 shows that this is what we actually observe. The deleveraging process continues until the end of 2015 with the mortgage stock falling to 147 billion euro- an 11 billion euro decline from its peak in 2009 Q4. As incomes grow, households demand for mortgages increases and affordability improves, leading banks to expand the supply of mortgage credit.

In addition, the supply factors mentioned above relax the funding constraints facing banks. Figure 6 suggests that between 2016 and 2023, the shift of the demand schedule is large enough to increase

[16] See ESRI (2013) for details about the *HERMES* model and the underlying assumptions in each scenario.
[17] See Duffy et al (2014) for a discussion of trends in future Irish household formation.

the mortgage rate by over 2.5 percentage points as the equilibrium mortgage stock reaches 203 billion euro.

Figure 6: Mortgage volumes, Interest rates, Housing stock and House Prices in the Recovery Scenario

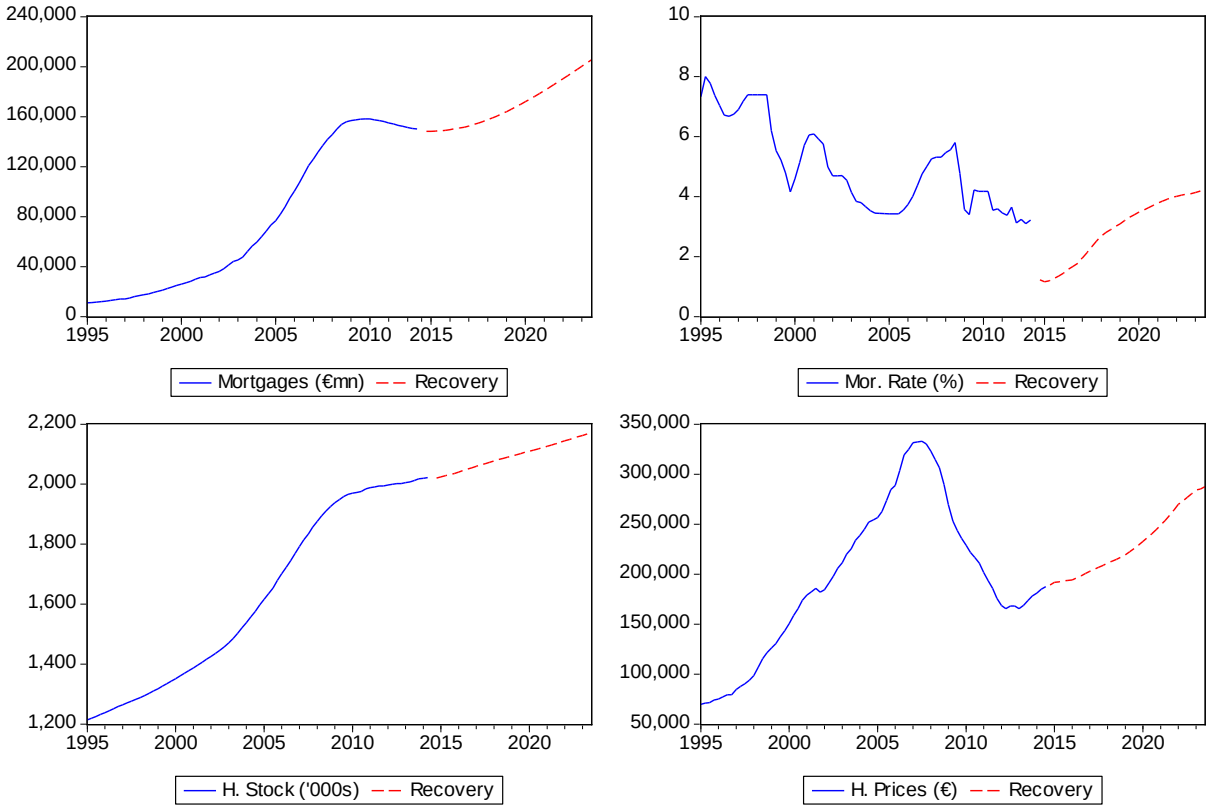


Figure 6 also illustrates the dynamics of house prices and the housing stock in the *Recovery* scenario. The increase in mortgage credit, the decline in unemployment and growth in the population lead to a rising demand for housing.

On the supply side, building costs grow by less than 2 per cent a year over the forecast horizon, while the interest rate on credit to non-financial corporations rises in line with the interest rate on government bonds.

Given the behaviour of these supply and demand factors, the model predicts that average house prices would rise to 285,000 euro by 2023, which, given the current level of house prices of 187,000 euro, corresponds approximately to a 50 percent increase over the next decade. There is also a significant supply response as housing completions increase by approximately 18,500 units per year resulting in a housing stock of 2.17 million units by 2023.

Although the recovery scenario does generate an increase in mortgage credit and house prices, it is noteworthy that the latter does not reach its pre-crisis level, even by 2023. This highlights the extent of the imbalances which developed in both the mortgage and housing markets and the role played by “non-fundamental” factors during the 2003-2007 period.

Credit-Constrained/Delayed Adjustment Scenario

The *MTR*'s *Delayed Adjustment* scenario assumes that growth in the European Union is similar to that in the *Recovery* scenario but that Irish growth is constrained by continuing problems in the financial sector and other adverse domestic shocks. Specifically, this scenario assumes that households continue deleveraging so that saving is higher and consumption lower than in the recovery scenario. The scenario also incorporates assumptions about credit constraints facing Small and Medium sized Enterprises (SMEs).[18]

In this scenario, Irish GNP grows by approximately 3 per cent a year and unemployment remains above 10 per cent for much of the decade. One of the key differences in the scenarios concerns demographic trends. In particular, the *Delayed Adjustment* scenario assumes that the number of 25 to 35 year olds in the population falls by approximately 50,000 over the next decade through net emigration. This implies a weaker demand for housing relative to the *Recovery* scenario.

Figure 7 illustrates the dynamics of the mortgage and housing markets in the *Delayed Adjustment* scenario. The paths of the endogenous variables from the *Recovery* scenario are also included for comparison.

In terms of mortgage credit, the *Delayed Adjustment* scenario implies that the outstanding stock of mortgage credit does not begin to grow until the latter half of 2018 so that new mortgage lending is just sufficient to offset mortgage repayments. This reflects the impact of both supply and demand factors. Weaker income growth relative to the *Recovery* scenario reduces the quantity demanded while the associated decline in deposit growth acts as a quantitative restriction on lending.

As the money market rate is assumed to track the German rate the cost of alternative sources of funding is identical in both the *Recovery* and *Delayed Adjustment* scenarios. The long-term risk-free interest rate is marginally higher (15 basis points) in this scenario indicating that the opportunity cost of mortgage lending increases slightly, ceteris paribus. These factors together imply that credit supply contracts more than in the *Recovery* scenario. As interest rates are lower than in the latter scenario, the negative impact of the demand factors outweighs the negative impact of the supply factors.

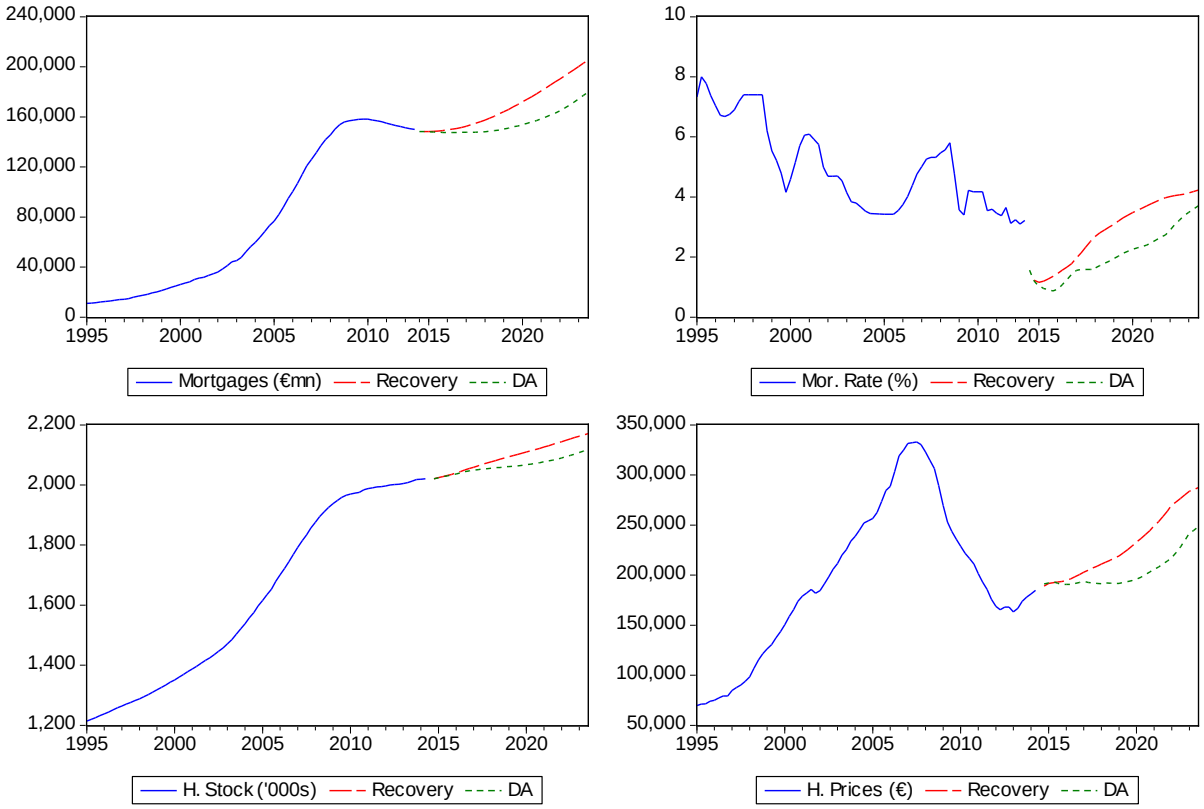
These supply and demand factors result in the equilibrium mortgage volume being 25 billion euro lower in 2023 than in the *Recovery* scenario while the mortgage rate is approximately 0.5 percentage points lower.

Figure 7 also shows the evolution of house prices and the housing stock in both the recovery and delayed adjustment scenarios. The diverging path of these variables in each scenario is primarily driven by demographics, and specifically the assumptions about the number of 25 to 34 year olds in

[18] As HERMES does not explicitly model credit markets, this scenario makes an assumption about the likely impact of credit constraints on the output of SMEs. Specifically, it assumes that the output of the distribution sector, which has a large presence of SMEs, falls by 2.5 percentage points a year until 2017.

the population. On the supply side, there is a negligible difference between building costs in both the *Recovery* and *Delayed Adjustment* scenarios.[19]

Figure 7: Comparing Mortgage volumes, Interest rates, Housing stock and House Prices in the *Delayed Adjustment* (DA) and *Recovery* Scenarios



In the delayed adjustment scenario, house prices remain flat until 2019 Q3 and rise to 249,000 by 2023- 35,000 euro below the level forecasted in the *Recovery* scenario. The equilibrium housing stock increases by 12,500 units per annum in the *Delayed Adjustment* scenario, reaching under 2.12 million units by 2023.

In summary, the assumption of continuing household deleveraging and binding credit constraints on investment at the firm level have a large negative impact on housing and mortgage markets. Weaker income and population growth, particularly in the younger first-time buyer cohort, are the main channels through which these constraints influence the dynamics of both of these markets in the *Delayed Adjustment* scenario.

[19] Recall that building costs are exogenous in our model. Clearly, the decline in construction activity in the delayed adjustment scenario would lead to a significantly greater difference in building costs relative to the recovery scenario if the latter were endogenous.

Stagnation scenario

The final scenario we consider assumes that the EU economy does not return to growth over the next decade, which restricts Irish nominal GDP growth to under 1 per cent a year over the period. The unemployment rate remains at its current level of over 12 per cent until 2020 and falls to 10 per cent by 2023.

The demographic change incorporated in this scenario has particularly adverse consequences for the scale of the mortgage lending and housing demand. In particular, the number of 25 to 34 year olds in the population falls by more than 100,000 over the next decade, primarily due to net emigration.

These income, employment and demographic trends imply a lower demand for housing and consequently, a lower demand for mortgage credit. In terms of mortgage supply, the weak growth in incomes constrains the size of the average affordable mortgage. In addition, banks face a less favourable funding environment relative to the other scenarios. In particular, weaker income growth results in lower deposit growth, while higher money market rates raise the cost of alternative financing. The ten-year government bond rate is also higher in this scenario so that mortgage lending becomes relatively less profitable, all else equal.

Figure 8 illustrates the impact of the assumptions incorporated in the *Stagnation scenario* on the model's endogenous variables. The total outstanding stock of mortgage credit remains relatively flat over the forecast horizon increasing by a little over 10 billion euro over the next decade: the stock of mortgages reaches 160 billion euro by 2023- approximately 40 billion lower than in *Recovery* scenario. Mortgage rates are similar in both scenarios until the end of 2018, but begin to diverge thereafter as the demand for mortgage credit increases with the recovery in income. By 2023, mortgage rates in the *Stagnation* scenario are approximately one percentage point lower those in those in the *Recovery* scenario.

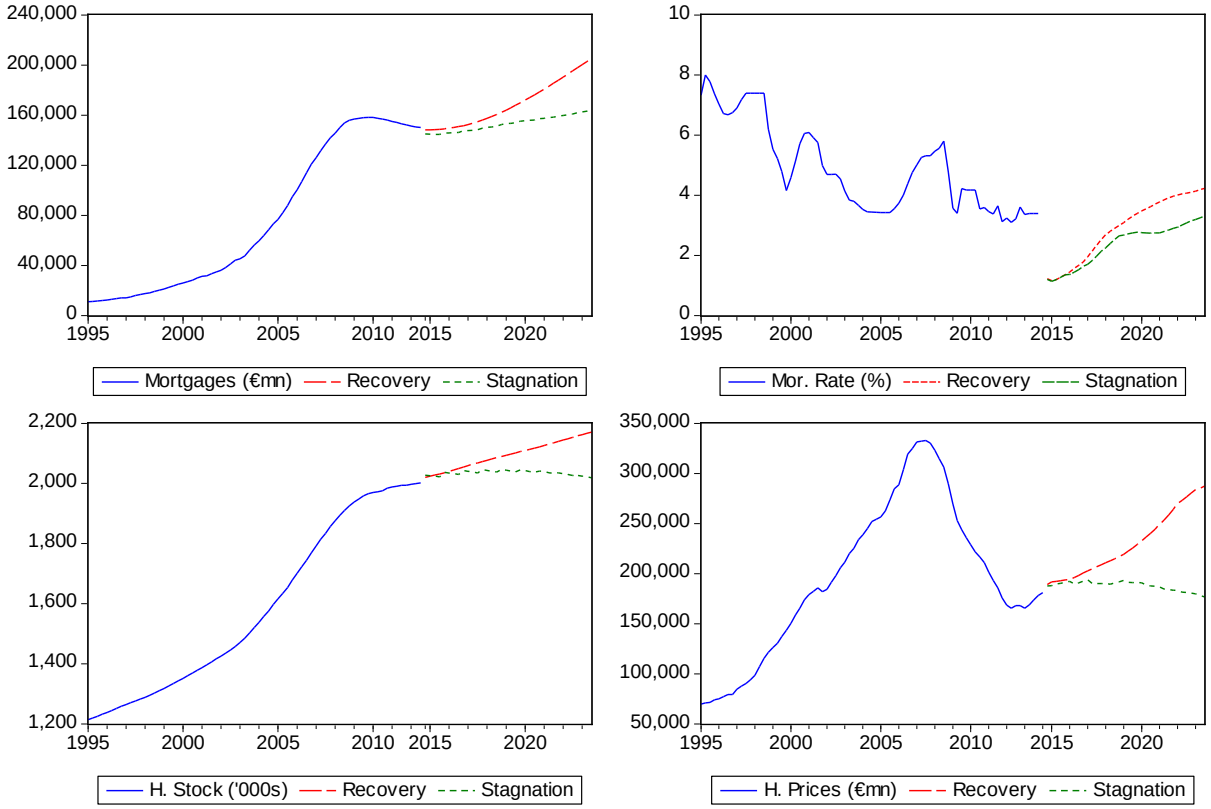
The relatively muted response of mortgage credit, together with the employment and demographic trends mentioned above, result in a much weaker demand for housing than in the *Recovery* and *Delayed Adjustment* scenarios. On the supply side, building cost inflation is approximately 0.3 percent lower in the *Stagnation* scenario than in the *Recovery* scenario until 2023.

The combined impact of these supply and demand factors on the housing stock and house prices in Figure 8 is striking. House Prices actually decline in this scenario and at 177,000 euro, are approximately 100,000 euro lower than in the *Recovery* scenario by 2023. This is mainly driven by the scenario's assumptions about demographic change, particularly the decline in the number of 25 to 34 year olds in the population. The model also implies that the equilibrium housing stock would fall by approximately 10,000 units relative to current levels due to decline in demand and, given the fall in house prices, the corresponding decline in the profitability of residential construction.

The implications for the housing and mortgage markets would therefore be quite serious were Ireland to follow the economic path depicted in *Stagnation* scenario. We should also note that our model does not incorporate the impact on banks' balance sheets of the likely increase in mortgage arrears (and perhaps strategic default of households due to negative equity) from weak economic

growth and falling house prices.[20] The contraction in mortgage credit would be more severe if this channel as banks try to increase their capital adequacy ratios via deleveraging. This would result in an even steeper decline in house prices over the next decade.

Figure 8: Comparing Mortgage volumes, Interest rates, Housing stock and House Prices in the Stagnation and Recovery Scenarios



6. Conclusions

We model equilibrium in the mortgage and housing markets in a system of simultaneous equations and isolate the impact of supply and demand factors in each market. Using a VECM to analyse the dynamics of house prices and mortgages, we find that mortgage lending becomes explosive after 2003, coinciding with a period of financial liberalisation which gave Irish banks access to cheap wholesale funding. The results of this analysis also indicate that prior to 2004, mortgage credit tends to lead house prices in the long run but that the latter have an effect on mortgage demand in the short run. Our results also suggest that mortgage demand also depends positively on disposable income and negatively on the mortgage rate.

In terms of mortgage supply, we find that prior to 2004 the volume of credit that banks were willing to lend was strongly correlated with the level of retail deposits in the banking sector. Although, banks became heavily dependent on wholesale funding during the period in which mortgage lending

[20] Data on mortgage arrears are only available since 2009.

became explosive, the developments in money markets since the onset of the crisis, along with the likely evolution of macroprudential policy, indicate that banks will become increasing dependent on deposits as the marginal source of funding in the future. Therefore, this specification of mortgage supply is likely to be a more realistic description of future lending behaviour than the benchmark specification in the literature which models the mortgage rate as a spread over the policy rate.

We also find that mortgages, unemployment and in particular, demographics are significant determinants of mortgage demand, while housing supply is mainly a function of the profitability of housing construction.

The future evolution of mortgage credit and Irish house prices has implications for a wide variety of economic actors including policy makers, banks and households. The scenarios that we consider should not be interpreted as characterising a narrow range of paths that represent upper or lower bounds on the level of mortgage credit or the level of average house prices. Although the recovery scenario may currently appear to be a more realistic benchmark for how the economy will develop, these scenarios should be viewed simply as providing an indication of the sensitivity of our forecasts to the underlying macroeconomic assumptions.

In any case, an interesting result of this forecasting exercise is that house prices are still below their pre-crisis peak by 2023 in the recovery scenario. This highlights the extent to which house prices deviated from their fundamental level in the pre-crisis bubble period. In addition, the dynamics of the mortgage and housing markets in the delayed adjustment scenario highlight the importance of domestic financial policy, in terms of alleviating credit constraints at the household and firm level.

Appendix

Table A1: Testing for long- and short-run relationships between the Housing stock (per capita) and the Mortgage volume (per capita)

	ΔHStock	ΔMorVol
ECM_{t-1}	-0.031 [-2.6]	0.103 [0.5]
$\Delta HStock_{t-1}$	0.350 [3.1	-2.305 [-1.2]
$\Delta HStock_{t-2}$	0.128 [1.1]	-0.593 [-0.3]
$\Delta HStock_{t-3}$	0.064 [0.6]	2.268 [1.3]
$\Delta HStock_{t-4}$	0.515 [4.9]	2.703 [1.5]
$\Delta HStock_{t-5}$	-0.260 [-2.2]	-0.047 [-0.1]
$\Delta HStock_{t-6}$	-0.090 [-0.8]	-2.525 [-1.3]
$\Delta MorVol_{t-1}$	0.008 [1.2]	0.302 [2.6]
$\Delta MorVol_{t-2}$	0.004 [0.5]	0.216 [1.7]
$\Delta MorVol_{t-3}$	0.008 [1.1]	-0.004 [-0.1]
$\Delta MorVol_{t-4}$	-0.001 [-0.1]	0.234 [1.9]
$\Delta MorVol_{t-5}$	-0.010 [-1.3]	-0.120 [-1.0]
$\Delta MorVol_{t-6}$	-0.012 [-1.6]	0.012 [0.1]
Constant	0.001 [2.2]	0.014 [1.8]
R^2	0.55	0.31
Cointegrating Equation		
$HStock_{t-1}$	1	
$MorVol_{t-1}$	-0.088 [-26.5]	
Constant	7.491	

Note: Sample period 1980Q1 to 2003Q2. *t*-statistics are in brackets. ECM is the error correction term.

References

Almeida, Heitor, Murillo Campello, and Crocker Liu. (2006). "The Financial Accelerator: Evidence from International Housing Markets," *Review of Finance,* Vol.19, pp.1-32.

Addison-Smyth, Diarmuid, Kieran McQuinn and Gerard O'Reilly. (2009). "Modelling Credit in the Irish Mortgage Market", The Economic and Social Review, vol. 40(4),pages 371-392.

Allen, Franklin and Douglas Gale. (1999). "Bubbles, Crises, and Policy", Oxford Review of Economic Policy, 15(3), 9-18

Beck, Thorsten. (2014). "Ireland's Banking System-Looking Forward*". Future Directions for the Irish Economy* conference organised by IIIS and European Commission, Dublin.

Bernanke , Ben and Mark Gertler. (1989). "Agency Costs, Net Worth, and Business Fluctuations", The American Economic Review, 79 (1), 14-31

Brissimis, Sophocles N. and Thomas Vlassopoulos. (2008). "The Interaction between Mortgage Financing and Housing Prices in Greece," The Journal of Real Estate Finance and Economics, 39 (2), 146-164.Finance and Economics

Browne, Frank, Thomas Conefrey and Gerard Kennedy. (2013). "Understanding Irish house price movements- a user cost of capital approach". Research Technical Papers 04/RT/13, Central Bank of Ireland.

Coates, Dermot and Mary Everett. (2013). "Profiling the cross-border funding of the Irish banking system", Economic Letters 04/EL/13, Central Bank of Ireland.

Davis, Philip and Iana Liadze. (2012). "Modelling and Simulating the banking sectors of the US, Germany and the UK", NIESR Discussion Paper 396, NIESR: London.

Duca, John, John N. Muellbauer, and Anthony Murphy. (2011). "House Prices and Credit Constraints: Making Sense of the US Experience," The Economic Journal, 2011, 121 (May), 533-551.

Duffy, David. (2012). "Irish Housing: A Role for Loan-to-Value Limits?", *Renewal Series* Paper 7, ESRI: Dublin.

Duffy, David, David Byrne and John Fitzgerald. (2014). "Alternative Scenarios for New Household Formation in Ireland", special article in *Quarterly Economic Commentary, Spring.*

ESRI. (2013). *Medium-Term Review: 2013-2020.* Edited by John Fitz Gerald and Ide Kearney. ESRI: Dublin.

Fitzpatrick, Trevor and Kieran Mcquinn. (2007). "House Prices And Mortgage Credit: Empirical Evidence For Ireland," Manchester School, University of Manchester, vol. 75(1), pages 82-103, 01.

Gerlach, Stefan and Wensheng Peng. (2005). "Bank Lending and Property Prices in Hong Kong," Journal of Banking and Finance, 29 (2), 461-481.

Gimeno, Ricardo and Carmen Martinez-Carrascal. (2010). "The Relationship between House Prices and House Purchase Loans: The Spanish Case," Journal of Banking and Finance, 34, 1849-1855.

Hofmann, Boris. (2004). “The Determinants of Bank Credit in Industrialized Countries: Do Property Prices Matter?," International Finance, 7 (2), 203{234.

Kiyotaki, Nobuhiro and John Moore. (1997). “Credit Cycles”, Journal of Political Economy, 105 (2), 211-248.

Lindner, Fabian. (2014). “The interaction of mortgage credit and housing prices in the US”, IMK Working Paper 133, Duesseldorf.

McQuinn, Kieran and Gerard O’Reilly. (2006). “Assessing the role of income and interest rates in determining house prices”. Research Technical Papers 15/RT/06, Central Bank of Ireland.

McCarthy, Yvonne and Kieran McQuinn. (2013). “Credit conditions in a boom and bust property market,” Research Technical Papers 08/RT/13, Central Bank of Ireland.

McInerney, Niall. (2014). “A structural model of the Irish banking sector”. mimeo.

Murphy, Anthony. (2004). “Housing and National Competitiveness”, a report for the National Competitiveness Council.

Nobili, Andrea and Francesco Zollino. (2012). “A structural model for the housing and credit markets in Italy”. Working Paper number 887, Banca D’Italia.

Oikarinen, Elias. (2009). “Interaction Between Housing Prices and Household Borrowing: The Finnish Case," Journal of Banking and Finance, 33 (4), 747-756.

Pazarbasioglu, C. (1996). “A Credit Crunch? A Case Study of Finland in the Aftermath of the Banking Crisis”. IMF Working Papers, International Monetary Fund.

Rae, D and Paul van den Noord. (2006). “Ireland’s housing boom: What has driven it and have prices overshot?” OECD Economic Department Working Papers (492).

Year	Number	Title/Author(s) ESRI Authors/Co-authors *Italicised*
2014		
	494	The Effects of Wind Generation Capacity on Electricity Prices and Generation Costs: a Monte Carlo Analysis, Muireann Lynch, John Curtis
	493	The Effect of Wind on Electricity CO2 Emissions: The Case of Ireland, Valeria di Cosmo, Laura Malaguzzi Valeri
	492	Financial Structure and Diversification of European Firms, Martina Lawless, Brian O'Connell and Conor O'Toole
	491	SME Recovery Following a Financial Crisis: Does Debt Overhang Matter? Martina Lawless, Brian O'Connell and Conor O'Toole
	490	Examining the Relationship between employee Resistance to changes in job conditions and Wider Organisational Change: Evidence from Ireland Hugh Cronin and Seamus McGuinness
	489	Estimating Building Energy Ratings for the Residential Building Stock: Location and Occupancy John Curtis, Niamh Devitt, Adele Whelan
	488	Gaming in the Irish Single Electricity Market and Potential Effects on Wholesale Prices Darragh Walsh and Laura Malaguzzi Valeri
	487	Household Formation and Tenure Choice: Did the great Irish housing bust alter consumer behaviour? David Byrne, David Duffy and John FitzGerald
	486	Changing Time: Possible Effects on Peak Electricity Generation Sara Crowley (UCC), John FitzGerald and Laura Malaguzzi Valeri
	485	Changes in Labour Market Transitions in Ireland over the Great Recession Adele Bergin, Elish Kelly, Seamus McGuinness