Macroprudential policy in a recovering property market: Too much too soon?

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Abstract

The aftermath of the 2007/08 financial crisis has resulted in many Central Banks and regulatory authorities examining the appropriateness of macroprudential policy as an effective and efficient policy option in preventing the emergence of future credit bubbles. Specific limits on loan-to-value (LTV) and loan-to-income (LTI) ratios have been assessed and applied in a large number of markets both in developing and developed economies as a means of ensuring greater financial stability. The Irish property and credit market were particularly affected in the crisis as the domestic housing market had, since 1995, experienced sustained price and housing supply increases. Much of the activity in the Irish market was fuelled by a sizeable credit bubble which was greatly facillitated by the emergence of international wholesale funding post 2003. After a period of pronounced declines, Irish house prices in late 2013 started to increase significantly; in early 2015, in response, the Irish Central Bank imposed new LTV and LTI limits to curb house price inflation. However, the introduction of these measures comes at a time when housing supply and mortgage lending are still at historically low levels. Therefore, in this paper we use a newly developed structural model of the Irish property and credit market to examine the implications of these measures for house prices and key activity variables in the mortgage market.

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1. Introduction

The financial crisis of 2007/08 revealed the need for a greater array of policy options in tempering housing market activity. Across countries increasing evidence emerged of property market distortions proliferating to other sectors of the real economy, thus highlighting the need for policies which target excessive and destablishing movements in lending, house prices and output levels. While elements of both fiscal and monetary policy have been considered in this regard, a growing body of opinion views macroprudential policies as the optimal policy response, particularly, in property markets, because of the preciseness of their focus and the potential flexibility of their application. Accordingly, one such series of measures - limits on loan to value (LTV) and debt to income ratios (LTI), are increasingly under scrutiny. These measures have been adopted for some time by authorities in Hong Kong, China, Korea, Singapore, and other emerging market economies, with Canada and Denmark examples of advanced countries using such limits prior to the crisis. More recently, the Hungarian, Magyar Nemezeti Bank (2010), the Norges Bank (2010), the Swedish Financial Supervisory Authority (2010) and the Bank of Finland have signalled their adoption.

In international terms, the Irish property market presents as the extreme case in terms of negative spill-overs between the housing market, the general economy and the financial sector. With both prices and activity levels increasing substantially over the previous decade, the property sector had, by 2007, assumed a disproportionate significance both on the balance sheets of Irish financial institutions and in the general economy. For example, in terms of employment, the number of persons at work in the construction sector effectively trebled from 97,000 persons in 1995 to 269,000 in 2006 and, by 2008, the sector directly accounted for one in every eight jobs in the economy.[1]

Much of the increase in the Irish housing market activity, particularly post 2000, was fuelled by a sizeable credit bubble. The Irish credit market had been liberalising over a long period of time, however, the ability of financial institutions to avail of international wholesale funding caused a significant shift in the domestic credit supply function. Thus,

[1] This is exceptional in euro area terms where the average is about one in twelve.

when the 2007/08 international financial crisis occurred, the Irish financial system was especially vulnerable. The costs to the economy of the aftermath of the property boom have been truly severe. Between 2007 and 2012, Irish house prices, in nominal terms, have fallen by almost 50 per cent. Given that nearly 40 per cent of the total stock of Irish mortgages was issued between 2004 and 2007, when prices were at their highest, the sharp subsequent decline has given rise to a significant degree of negative equity being experienced by Irish households. When coupled with the sharp increase in unemployment experienced by the Irish economy post 2008, the possibility of substantial credit risk in the mortgage books of Irish banks was one of the main reasons for the financial crisis which engulfed the Irish banking sector. Given its recent turbulent past, the Irish credit market would, therefore, appear to be an ideal candidate for the implementation of financial stability policies.[2]

In October 2014, the Central Bank of Ireland proposed the introduction of regulations which will place ceilings on the proportion of mortgage lending at high LTVs and LTIs by domestic financial institutions. The objective of these measures is to increase the resilience of the banking and household sectors to the property market and to try and reduce the risk of bank credit and housing price "spirals" from emerging in future.[3]

In this paper we present a structural model of the Irish mortgage and property market that allows us to assess the implications of these measures on the mortgage interest rate, the number of mortgages extended, house price levels and housing supply. The inextricable link between the Irish property and mortgage market, evident from Fitzpatrick and McQuinn (2007)[4], suggests that a structural model is required to achieve a comprehensive overview of the impacts of macroprudential measures.

The application, however, of the macroprudential measures comes at a critical stage in the recovery of the Irish housing and mortgage markets in the aftermath of the 2007/08

[2]Consequently, one of the major cornerstones of the 2010 program of support agreed between Ireland, the EU and the IMF was a significant commitment to deal with the degree of loan impairment on the mortgage books of Irish financial institutions.

[3]In particular, for non-first-time buyers a limit, for primary dwelling purchase, a limit of 80 per cent LTV will now exist, while lending for primary dwelling purchases above 3.5 times LTI is now restricted to no more than 20 per cent of that aggregate value. The regulations are somewhat more lenient for first-time buyers.

[4]Fitzpatrick and McQuinn (2007) found evidence of a mutually reinforcing link between mortgage credit and house prices in the Irish market over the period 1980 to 2004.

financial crisis; while Irish house prices have started to increase quite significantly since early 2013, activity variables such as housing supply and mortgage credit extension still remain at historically low levels. Therefore, there is some debate as to whether developments in the Irish property and credit market actually warrant the application of these measures *at this time*.[5]

We find that the measures will have a significant effect on the housing and mortgage markets. Even under relatively conservative assumptions concerning the potential number of borrowers displaced by such measures, our results suggest the following:

1. House prices will fall by approximately 6 per cent in the short-run due to the macroprudential measures before experiencing a 2 per cent decline over the longer-term,
2. Over the same time periods, mortgage credit extension will fall by 20 and 10 per cent respectively,
3. Finally, housing supply will be 4 per cent lower than what would be the case if the measures had not been applied.

The rest of the paper is structured as follows; in the next section we review recent developments in the Irish housing market and the role played by excess credit in the domestic mortgage market. A literature review section examines the previous applications of macroprudential rules. The following section outlines the data used in the study, while an empirical section outlines the model of the mortgage and housing market which is used to analyse the proposed macroprudential measures. A final section offers some concluding comments.

2. The Irish housing and mortgage market

2.1. Irish property market

The measures outlined by the Central Bank of Ireland are in response to recent developments in the Irish housing market. Irish house prices have varied substantially since 1995. On average from 1995 until 2007 nominal domestic house prices grew by nearly 12 per

[5]See Duffy and McQuinn (2014) for example.

cent per annum. By 2007, a growing body of opinion[6] was of the belief that Irish house prices were overvalued or subject to a "bubble" of up to 35 per cent. By bubble, we mean a situation where actual prices had deviated above the level suggested by fundamental variables in the economy. After 2007, Irish house prices continued to fall for almost seven years up to early 2013 culminating in a 50 per cent decline from peak to trough. Since then however, as the Irish economy has shown significant signs of recovery, Irish house prices have increased strongly, particularly in the Dublin area. For the 9 month period to September 2014, house prices in Dublin increased, on average, by almost 18 per cent year-on-year. This compares with a comparable national rate of 10 per cent over the same period. Given the strong price increases, some commentary has already focussed on the possibility of another bubble in Irish house prices.

Rather uniquely, during the period of substantial house price increases between 1995 and 2007, supply levels of housing escalated to such an extent that the rate of new housing supply in the domestic market was only just under half that of the United Kingdom despite the presence of a fourteenfold difference in population levels. On average, between 2005 and 2007 80,000 housing units were supplied in the Irish market. However, as with the collapse in prices post 2007, housing activity rapidly declined with just over 8,000 units being brought to the Irish market in 2012 and 2013.

2.2. Irish credit market

The Irish credit market had, since the mid-1980s, been experiencing considerable financial deregulation and liberalisation, involving the removal of credit and interest-rate controls. Table (1) summarises the main developments from the mid 1980's to 2000.[7] However, the most profound development in the provision of credit, from an Irish perspective, was the increased ability of Irish banks, post euro, to attract deposits from non-residents. Given the build-up in demand side pressures in the Irish economy throughout the late 1990s, Irish financial institutions, availed substantially of the increased funding available

[6] See Honohan (2010) for more on this.

[7] An exact chronology of the control and subsequent liberalisation of the Irish credit market is discussed in detail in Kelly and Everett (2004). See, in particular, Box 1 pgs 96 and 97, which illustrates the building and dismantling of controls over the period 1973 to 1999.

within the euro area. Figure 1 presents the overall loan to deposit ratio and total external debt levels for the Irish financial sector over the period 2001 to 2010. The sharp increase in the loan to deposit ratio in the lead up to 2007 is clearly evident as is the surge in the international funding of Irish credit institutions which helped to fund the difference between lending and domestic deposit levels.

Overall, the combined effect was to increase the elasticity of the supply of credit to the household sector. The consequence of such a flatter supply curve was that financial institutions were able to increase the amount of lending to the household sector with little upward pressure on the interest rate. However, this flatter supply curve, inevitably, lead to a substantial increase in debt levels within the Irish economy. Once the financial crisis of 2007/08 occurred, Irish institutions were particularly vulnerable; given the relatively large amount of mortgage loans quickly subsiding into negative equity, international investors quickly withdrew their funding for Irish institutions. The evaporation of external funding resulted in a sizeable liquidity problem. Eventually, the fragility of the Irish financial sector was one of the main reasons for the sovereign entering a programme of support with the International Monetary Fund (IMF), European Commission (EU) and the European Central Bank (ECB) in November 2010.

2.3. A current assessment

Given the significant fluctuations in the experiences of the Irish mortgage and property markets, it is worth assessing the current state of such markets, particularly as macroprudential measures, as noted in the literature review below, can have significant impacts on housing market activity.

Using a suite of different house price models to generate a fundamental house price, McQuinn (2014) concludes that house prices are still undervalued in the Irish market. Notwithstanding the substantial increase in prices through 2013 and 2014, McQuinn (2014) estimates that the current state of key fundamental variables in the Irish economy such as income levels, interest rates, demographics and housing supply indicates that house prices at the end of 2013 were undervalued between 12 to 20 per cent.[8] As noted

[8]The main model used by McQuinn (2014) is that also applied in Kelly and McQuinn (2014) and is the

in Kennedy and McQuinn (2011) and Kennedy and McQuinn (2012), the Irish property sector followed the example of other markets, which had experienced sizeable house price bursts, in witnessing prices "overcorrecting" or falling by more than what the deterioration in market fundamentals would have suggested. Figure 2 plots an update of actual and fundamental house price from McQuinn (2014). The updated analysis indicates that prices, at end 2014, were still *undervalued* by approximately 10 per cent.

Figure 3 plots the historical levels of housing supply and credit advanced to Irish households for house purchases. As can be seen from both graphs, present levels of activity are quite below recent historical levels. In the case of mortgage credit, the total stock has been falling consistently since 2007, while the growth rates of credit have been persistently negative since 2010. While mortgage loans have been extended since this time, the significant degree of mortgage repayments over the period has consistently exceeded the draw down of new mortgages.

In the case of housing supply, along with the actual level, we also plot what we term the *equilibrium level* of 25,000 units. Duffy, Byrne and Fitzgerald (2014), based on a microeconomic analysis of tenure choice and household formation, conclude that this amount of housing units is required, on a per annum basis, over the next 15 years to meet the underlying demand in the Irish market. Clearly the present actual level of supply is significantly less than the level which pertained at the height of the property boom but it is also somewhat below the long-run equilibrium level indicated by Duffy et al. (2014). Therefore, present developments in the property and mortgage sector would suggest that the Irish market is still very much in a recovering mode from the intense crash experienced between 2007 and 2012.

3. Macroprudential policies: A brief literature review

Studies examining the potential effectiveness of macroprudential measures such as loan-to-value and debt-to-income ratios have naturally increased considerably over the past

standard inverted housing demand function commonly applied in such studies as Cameron, Muellbauer and Murphy (2006), Muellbauer and Murphy (1997), Muellbauer and Murphy (1994), Meen (1996, 2000) and Peek and Wilcox (1991).

decade. Borio, Furfine and Lowe (2001), in a relatively early review, outline the role loan-to-value limits could play in curbing pro-cyclical bank lending.[9] This is the based on the observation that procyclical bank lending is likely to be greater, the higher the average loan-to-value ratio as the higher the ratio, the higher is the marginal amount of new lending that can be granted for a given change in the value of the collateral. A significant body of work, mainly at the International Monetary Fund (IMF), has, in the aftermath of the financial crisis, explored the use of different macroprudential policies across countries.[10] A 2010 survey (Lim, Columba, Costa, Kongsamut, Otani, Saiyud, Wezel and Wu (2011)), reports that nearly 70 per cent of the 49 countries surveyed use either loan-to-value ratios or debt/loan-to-income ratios, while most of these countries use judgement almost entirely in both designing and calibrating the instruments in question. In light of this and other survey work, Caruana (2010) and Crowe, Dell'Ariccia, Igan and Rabanal (2011), conclude that limits on both loan-to-value and debt-to-income ratios are the most effective policy option, particularly, in tempering property markets.

In 1997, China introduced LTV limits and followed with debt-to-income limits in 2004 (IMF, 2011). Debt-to-income limits were introduced in Korea approximately three years after the introduction of LTV limits. Igan and Kang (2011) examine the introduction of LTV and LTI limits in Korea. Combining a regional data set and survey data they find evidence that transactions levels fall after the introduction of such limits. They find that the implementation of a LTV limit had a negative statistically-significant impact on house price growth. Although the coefficients for a debt-to-income limit were also negative they were not statistically-significant. In the three month period following a tightening of regulations, they found an average drop of 16 per cent in transaction activity in response to a tightening of LTV limits and a 21 per cent average drop in response to tightening debt-to-income regulations. In addition, using survey data they are able to model the effect of limits on property buying decisions and perceptions on the direction of house prices. The results show that both LTV and debt-to-income ratio tightening delay property-buying

[9]For a general overview of macroprudential policy see Galati and Moessner (2012) and Lim et al. (2011).

[10]This work is mainly motivated by the call from the G-20 regulatory reform agenda in February 2011 on the IMF, the Financial Stability Board (FSB) and the Bank for International Settlements (BIS) to develop a macroprudential policy framework.

decisions and push down house price expectations. Wong, Fung, Fong and Sze (2004) cite prudent lending practices guided by LTV and LTI limits in mitigating the house price boom in Hong Kong in 1994 and buffeting the financial system against the fallout from the crash in 1997.

Relatively few studies have empirically assessed the impact on both house prices and activity of these macroprudential measures. A notable exception is Almeida, Campello and Liu (2006), who, using cross-country variation in LTVs, provide evidence supporting the "financial accelerator" mechanism. In particular, they find that both house prices and new mortgage borrowings are more sensitive to aggregate shocks in countries with higher LTVs. They also find that the empirical relationship between LTVs and income sensitivities is stronger where the income constraint is less likely to be a binding factor. Therefore, households, who are constrained by the availability of collateral, have more procyclical debt capacity in the presence of higher LTVs. Crowe, Dell'Ariccia, Igan, Rabanal (2011), using a simple cross-country panel data model, estimate that a 10 percentage point increase in maximum LTV results in a 13 percent increase in nominal house prices, while for the US market, Duca, Muellbauer and Murphy (2010) report that a 10 percentage point increase in LTVs for first-time buyers results in house prices increasing between 8 to 11 percent.

In a general equilibrium context, a number of studies have recently examined the stabilisation benefits of countercyclical loan-to-value rules in rational expectations models. Angelina, Neri and Panetta (2011), Christensen and Meh (2011), Lambertini, Mendicino and Punzi (2011) and Kannan, Rabanl and Scott (2012) all examine the relative merits of macroprudential (LTV rules in particular) vis-á-vis monetary policy in tempering growth in credit aggregates, while Gelain, Lansing and Mendicino (2013) find that a debt-to-income type constraint is the optimal policy response to curtail excess volatility in a model economy. Many of these approaches specify the counter-cyclical rule as some function of credit growth within a dynamic stochastic general equilibrium (DSGE) framework.

Both the loan to value and debt to income ratios naturally complement each other in dampening the cyclicality of collaterized lending, with the LTV addressing the wealth aspect and the DTI the income aspect of the same risk. Fernandez-Corugedo and Muell-

bauer (2006), for example, note the possibility of a trade-off between these concepts being offered by mortgage providers - the debt-to-income ratio could be increased when the loan-to-value ratio is reduced, thereby, keeping the overall risk exposure of the portfolio constant. Campbell and Coco (2011) argue that regulators and mortgage providers should think about combinations of these concepts rather than controlling these levers in isolation, while McCarthy and McQuinn (2013) provide evidence of differences in the usage of both credit channels by Irish credit institutions during the period 2000 to 2010.

4. A model of the Irish housing and credit markets

To show how restrictions on the loan-to-income and loan-to-value ratios affect the dynamics of both markets, we modify a model of the Irish housing and credit markets outlined in Gerlach-Kristen and McInerney (2014) to incorporate a role for the impact of macroprudential policy.

As macroprudential policy instruments such as loan-to-income and loan-to-value ratios target new mortgage lending rather than the outstanding stock, we model mortgage demand in terms of the volume of new mortgage lending rather than the total stock of mortgage credit. Following Gerlach-Kristen and McInerney (2014), the demand for real mortgage credit in our framework is a function of the real mortgage rate (*RMorRate*), the change in real house prices (*HPrices*) and personable disposable income (*Income*). However, we also consider that LTV and LTI ratios act as quantitative restrictions on the demand for mortgage credit.[11]

The LTI and LTV ratio can be interpreted as indicators of credit conditions that reflect affordability and collateral constraints. For example, higher LTI ratios allow households to obtain larger mortgages for given levels of interest rates and income and, therefore, relax the affordability constraint. Similarly, higher LTV ratios mean that the collateral that households offer as security against the mortgage is now subject to a lower "haircut" by banks and allows borrowers to obtain more credit for a given level of the price of the

[11] In this way, our specification of credit demand is similar to that Avouyi-Dovi et al. (2014) who estimate a highly parsimonious model of credit and housing markets in France. However, in their study, credit demand is a function of a composite indicator of lending criteria that includes the debt-service-to-income ratio and mortgage duration

asset.

As regulatory limits on LTVs and LTI have only recently been introduced as part of the macroprudential policy framework in Ireland, there are clear difficulties inherent in modelling the potential impact of these prudential instruments on Irish housing and credit markets. Our approach is to assume that banks' target particular LTI and LTV ratios even in the absence of regulatory restrictions and that changes in these targets have a similar impact on banks' lending behaviour to changes in prudential targets. Our rationale for adopting this approach derives from the considerable evidence that banks vary these ratios independently of cyclical conditions in order to achieve desired lending targets.[12]

In order to construct the target levels for these ratios we need to remove the impact of expectations about house price appreciation, income growth and interest rates (Fernandez-Corugedo and Muellbauer (2006)). For example, the LTV ratio may increase because banks expect house prices to increase rapidly in the next period and so there may be little change in the actual LTV once these expectations are realised. Therefore, higher LTV or LTI ratios may not necessarily correspond to lower credit standards.

We approximate house price and income expectations as a 4 quarter moving average of lagged quarterly changes in house prices and household income, respectively. Interest rate expectations are captured by the yield curve spread given by the difference between the interest rate on ten year Irish government bonds and that on 3 month treasury bills. We regress the changes in the actual LTV and LTI ratios on these variables and use the residuals to construct the target levels for each ratio. The resulting ratios, therefore, capture exogenous changes in credit conditions by banks themselves which, we argue, would have a similar impact to exogenous changes proposed by a macroprudential policymaker.

Structural break tests indicate that there is a statistical break in the relationship between new mortgage lending and its determinants in the second quarter of 2010. This period marked the beginning of the sovereign debt crisis which resulted in Ireland entering a bailout programme at the end of that year. We suggest that these events lead to a spike

[12]See McCarthy and McQuinn (2013), Fernandez-Corugedo and Muellbauer (2006), and Duca et al (2011) for evidence on how banks affected credit conditions through variation in these ratios in Ireland, the United Kingdom and the United States, respectively.

in macroeconomic uncertainty and a further contraction in credit demand for a given level of the other determinants in the model. We approximate this uncertainty with the spread *(Spread)* between the 10-year government bonds of Ireland and Germany as the latter was viewed as a safe-haven during the sovereign debt crisis (DeSantis, 2012).[13]

The demand for new mortgages, therefore, has the following form:

$$\begin{aligned} NewMortgages_t = \alpha_1 + \beta_1 NewMortgages_{t-1} + \beta_2 RMorRate_t \\ + \beta_3 \triangle Income_t + \beta_4 \triangle HPrice_{t-1} + \beta_5 LTI_t \\ + \beta_6 LTV_t + \beta_7 Spread_t + \epsilon_{1,t} \end{aligned} \quad (1)$$

All variables, except for the mortgage interest rate, are in logs.

On the supply side, the standard variable mortgage rate is modelled, in an error correction framework, as a variable markup over the cost of funds which comprise the deposit rate *(DepRate)* and the money market rate *(MMRate)*. The latter is proxied by the 3 month Euribor rate.[14]

The markup is assumed to depend on cyclical, risk and policy variables (Davis and Liadze, 2012). The riskiness of lending to the households sector should, theoretically, reflect the loss given default associated with lending as well as the repayment capacity of households. The former can be captured by the "undrawn equity" of households *(HHEquity)* given by the ratio of housing wealth to mortgage debt while we use the unemployment rate *(URate)* to capture the latter.[15]

We also allow macroprudential policy to enter the supply of credit through the constraints on the composition of funding via the loan-to-deposit *(LTD)*. Variation in the share of wholesale funding has been shown to be a significant driver of the supply of credit in the Irish case (Addison-Smyth et al, 2009; Coates and Everett, 2013). In our modelling framework, the LTD ratio effectively weights the relative cost of deposit and money market financing so that higher LTD ratios signify greater reliance on the lat-

[13]See European Commission (2012) for empirical evidence on the link between measures of uncertainty and euro area sovereign bond spreads.

[14]See ECB (2009) for evidence that Irish banks used 3 month Euribor as the base rate off which the standard variable rate was priced. The impact of monetary policy is captured by Euribor variable and therefore we assume perfect pass-through from changes in the ECB's main refinancing rate to money markets.

[15]The concept of "undrawn equity" has been shown to be a significant predictor of mortgage arrears (Whitely et al, 2004).

ter. Targets for the LTD were introduced in Ireland as part of the Financial Measure Programme following the recapitalisation of the domestic banking sector.[16]

The long-run supply of mortgage lending has the following form:

$$MorRate_t = \alpha_2 + \beta_8 HHEquity + \beta_9 URate_t + \beta_{10} DepRate_t + \beta_{12} MMRate_t + \epsilon_{2,t} \quad (2)$$

The dynamics of the mortgage rate are then modelled as adjusting to this long-run relation. In terms of the housing market, house prices are modelled using a standard inverted housing demand function which is discussed in section 2.3. In that framework, house prices are a function of the housing stock, which is used to approximate the demand for housing services, and of other variables such as population, income and the user cost of capital which shift the demand schedule for housing.

Equation (3) relates real house prices to the standard determinants in literature such as the housing stock *(HStock)*, household disposable income, and the user cost of capital *(User)*. We incorporate a role for demographic change in the demand for housing via new household formation by scaling the housing stock by the number of 25 to 34 year olds in the population *(Pop2534)*. The user cost of capital is calculated as the difference between the real mortgage rate and expected house prices appreciation, where the latter are approximated as a four-quarter moving average of lagged annual house price inflation (Kelly and McQuinn, 2014).

In general, interest rates are generally found to be poor indicators of credit conditions (Stiglitz and Weiss, 1981). More recent studies have highlighted the need to complement the user cost of capital with other indicators that capture shifts in the credit supply schedule such as the LTV (Duca et al, 2011). As we explicitly model mortgage lending, a more appropriate indicator of credit rationing or excess credit in our framework is the change in the quantity or stock of mortgage credit outstanding. We normalise the latter by household disposable income as changes in the relation between mortgage credit and income have been found to have the largest impact on credit conditions in the Irish case (McCarthy and McQuinn, 2013).[17]

[16] See the "Financial Measures Programme Report", Central Bank of Ireland, March 2011.

[17] We also considered other normalisations such as by population, the number of households and total

The long-run demand for housing has the following form:

$$HPrices_t = \alpha_3 + \beta_{13}(HStock_t/Pop2534_t) + \beta_{14}Income_t + \beta_{15}User_t + \beta_{16}(MorStock_t/Income_t) + \epsilon_{3,t} \quad (3)$$

We estimate the dynamics of house prices in an error-correction framework and allow changes in the unemployment rate to have an impact in the short run.

The second credit channel in the housing market enters via the housing completions *(HCompl)* equation (4). As with the housing demand equation, the impact of credit has both an interest rate and non-interest rate channel. The interest rate on credit to non-financial corporations *(NFCRate)* is used to capture the cost of credit, while the change in the stock of construction loans *(ConstLoans)* is used to capture credit conditions facing construction firms.

New housing units are also a function of Tobin's Q and cyclical factors which affect construction activity. Our measure of Tobin's Q relates the value of housing investment to its replacement cost (Poterba, 1984). This is approximated by the ratio of house prices to building costs *(BCost)*, which has also been used to proxy for the "normal profit" of housing construction therefore determining the level of new housing units in the long run (Kenny, 1999).

Housing investment tends to be pro-cyclical and can be subject to uncertainty about the future profitability of construction due to the high fixed costs and, thus, the irreversibility of investment (Davis and Heathcote, 2005; Miles, 2009). The rise in uncertainty can be associated with an increase in the real option value of waiting which leads to a reduction in current investment (Bloom, 2009).

As uncertainty also tends to be countercyclical (Bloom, 2014), we include a measure of the output gap *(Gap)* of the Irish economy in the housing completions equation to capture changes in the perceived distribution of future house prices. However, as the construction of the output gap is particularly difficult in the Irish case[18], we also include the corporate insolvency rate *(Insolv)* to capture changes in uncertainty.

deposits but the results do not change significantly.

[18]Owing to the small open nature of the economy and the historical linkages between the Irish and UK labour markets.

$$HCompl_t = \alpha_4 + \beta_{17} HCompl_{t-1} + \beta_{18}(HPrice_t/Cost_t) + \beta_{19} NFCRate_t + \beta_{20} \triangle ConstLoans_t + \beta 21 Gap_t + \beta_{22} Insolv_t + \epsilon_{4,t} \quad (4)$$

The final equation (5) relates housing investment to the housing stock using the perpetual inventory method where the current housing stock depends on the depreciated housing stock from the previous period and current level of housing completions. We assume the housing stock depreciates at a rate (σ) of 0.4 percent per quarter.[19]

$$HStock_t = (1 - \sigma) HStock_{t-1} + HCompl_t. \quad (5)$$

4.1. Data

The volume of new mortgage lending is constructed using data on mortgage approvals from the Banking and Payments Federation Ireland (BPFI) and Department of Environment, Community and Local Government (DoECLG). To construct average loan-to-value and loan-to-income ratio we use the BPFI data on mortgages for the purchase of primary dwelling houses from Q1 2005 and then backcast these ratios using the DoECLG data on average loan size across all mortgage lending. The mortgage interest rate is the standard variable rate (SVR) and refers to the mid-point of the representative mortgage rate from the Central Bank of Ireland's *Quarterly Bulletin* and to the average mortgage rate on new lending from the Central Statistics Office.

The deposit rate, the volume of deposits, the (3 month) money market rate, the interest rate on loans to non-financial corporations and the volume of construction lending are also taken from the *Quarterly Bulletin*. Quarterly data on personal disposable income, GDP and the consumer expenditure deflator are obtained from the National Institute's NiGEM database for Ireland. The real variables used in the econometric analysis below have been deflated using the latter.

Our house price series is constructed using data from the DoECLG, CSO and the ESRI-Permanent TSB house price index.[20] The annual housing stock is obtained from the

[19] This is consistent with the annual rate depreciation on dwellings assumed by the Central Statistics Office (CSO) in Ireland.

[20] See Gerlach-Kristen and McInerney (2014) for details.

DoECLG and is interpolated using quarterly estimates of new housing completions, also from the DoECLG. In our econometric analysis, the rate of corporate insolvencies is used to reflect the macroeconomic environment facing construction firms. This is calculated using data on corporate insolvencies and company registrations from the Department of Jobs, Enterprise and Innovation (DJEI). Finally, all data are seasonally adjusted where necessary using the Census Bureau's X13 seasonal adjustment program.

4.2. Results

Equations (1) to (4) are jointly estimated by 3 Stage Least Squares (3SLS) over the period Q1 1988 to Q4 2013 subject to the constraint in (5). Potentially endogenous variables are instrumented using lags of the endogenous variable and other exogenous variables.

Figure 4 compares the actual values of new mortgage lending, the mortgage rate, housing completions and house prices with those predicted by the model over the sample period. In general, our model fits the data quite well, although there are periods of over- and underprediction. Andrews-Ploberger tests for structural breaks do not indicate any significant problems with parameter instability.

Table (2) presents the estimates of supply and demand in the mortgage market.[21] In terms of mortgage demand, new mortgage lending exhibits a moderate degree of persistence with a coefficient of 0.67 on the first lag.[22] In addition, the cost of credit, given by the real standard variable mortgage rate, has a negative and significant effect on mortgage demand.

Real household disposable income has the largest effect on mortgage demand in both the short and the long run, thus emphasising the impact of affordability constraints or repayment capacity on the ability to obtain larger mortgages. The long-run elasticity of new mortgage lending with respect to changes in income is over 2. Collateral constraints are also important. Higher house prices, therefore, allow households to borrow more for a given LTV. This highlights the suitability of implementing LTV targets that are counter-cyclical for addressing excessive credit growth.

[21] We discuss the results for the mortgage and housing markets separately for ease of exposition, although the equations are estimated jointly.

[22] Additional lags were found to be insignificant.

Importantly, given the focus of this paper, we find that the expectations-adjusted LTV and LTI ratios have positive and significant effects on the demand for mortgage credit. Interestingly, we find that the demand elasticity of the LTV is almost twice that of the LTI. In the long-run, a one percent increase in the LTV ratio raises the volume of new mortgage lending by over 2 percent, whereas, a one percent increase in the LTI ratio raises new mortgage lending by just over 1 percent.[23] These results suggest that prudential policy, by targeting these ratios, can have a significant impact on restraining credit growth.

Finally, the spread between the Irish and German bond rates has a negative and significant effect on new mortgages. As mentioned previously, this variable is mainly intended to capture the spike in macroeconomic uncertainty that arose from the sovereign debt crisis and which may have led to potential mortgage borrowers postponing the house purchase decision.

On the supply side, the nominal standard variable rate adjusts to its long-run equilibrium at a rate of over 50 percent per quarter. In addition, the mortgage rate is positively affected by higher funding costs and greater levels of household-specific lending risk. Both the deposit and the money market rate have a significant effect on the mortgage rate. The long-run elasticity of the mortgage rate with respect to the 3-month euribor, our benchmark money market rate, is 0.79, while the elasticity with respect to the deposit rate is 0.25.[24] The results also suggest that banks reduce mortgage interest rates when then have relatively greater access to wholesale funding.

As mentioned in the previous section, both "undrawn equity" and unemployment are used to approximate the level of risk associated with secured lending to households. The coefficient on the household equity variable suggests that a 1 percent increase in the ratio of house prices to mortgage debt per household reduces the standard variable rate by approximately one-tenth of a percentage point. Similarly, a 1 percent increase in the (log) unemployment rate raises the standard variable rate by approximately 7.5 basis points in

[23]The long-run elasticity is calculated as the short-run coefficient divided by (1-0.67), where 0.67 is the coefficient on the lagged dependent variable.

[24]The long-run elasticity in an error-correction model is obtained by dividing the variable's short-run coefficient by the error-correction term.

the long-run.

We now turn to the estimates of the supply and demand equations for the housing market, shown in Table 3. The house price equation is estimated in error-correction form with house prices adjusting to a long-run relation consisting of the demand for housing services, the cost of capital, disposable income and mortgage credit. The error-correction terms suggests that house prices adjust to their long-run equilibrium at a rate of 22 percent per quarter. The long-run elasticities for both the user cost and income are consistent with previous estimates for Ireland (see Murphy, 2004).[25]

Similar to Kelly and McQuinn (2014) and Gerlach-Kristen and McInerney (2014), the demand for housing services has a large impact on house prices. A one percent rise in the ratio of the housing stock to the population of 25 to 34 year olds raises house prices by over 1 percent in the long run. Our measure of credit conditions is also positive and significant indicating the importance of allowing for a non-interest rate credit channel in the determination of Irish house prices. In the short run, house price dynamics are also affected by changes in income, credit conditions and unemployment.

On the supply side, housing completions exhibit a high degree of persistence with a coefficient on the level of the previous period of 0.75. The results indicate that a Tobin's Q view of residential investment is consistent with housing construction in Ireland, while we also find that the impact of credit on the residential construction sector operates via both prices (interest rates) and quantities.

Finally, our indicators of the macroeconomic environment appear to be important. The output gap is negative and highly significant and may reflect pessimistic expectations about the future demand for housing.[26] Similarly, the corporate insolvency rate is also negative and significant. Importantly, both the output gap and the corporate insolvency rate are insignificant if we exclude the period since the onset of the financial crisis from our sample. In addition, structural break tests indicate a statistical break in the relation

[25]The user cost coefficient does not change significantly when we consider that house price expectations may adapt more slowly than suggested by a 4 quarter moving-average of lagged house price inflation.

[26]We considered three alternative measures of the "output gap": the gap derived from a production function taken from the OECD's Economic Outlook, the difference between actual and potential output where the latter is constructed using a Hodrick-Prescott filtered trend, and a measure of detrended output where GDP is regressed on a linear and quadratic trend. The results reported above refer to the latter but do not change significantly when the alternative measures are used.

between completions and profitability and credit variables since mid 2007 that is absent when the output gap and insolvency rate are included.

We now apply our model to assess the likely impact of the regulatory limits on LTV and LTI that have recently been introduced in Ireland.

5. Simulating the impact of LTV and LTI restrictions

The Central Bank of Ireland, as the Irish macroprudential authority, has recently introduced regulatory limits on the share of high LTV and LTI lending by Irish mortgage lenders. Specifically, banks must restrict lending for primary dwelling purchase above 80 per cent loan-to-value (LTV) to no more than 15 per cent of the aggregate flow of all housing loans for principal dwelling purposes and for primary dwelling purchase above 3.5 times loan-to-income (LTI) to no more than 20 per cent of that aggregate value (CBI, 2015).[27] The mortgage demand equation outlined above models new mortgage lending as a function of average LTVs and LTIs. In order to simulate the impact of these restrictions, we calculate how the proposed restrictions would affect the average values of the LTV and LTI ratios.

Table 1 from CBI (2014) shows the distribution of lending according to different LTV and LTI ratios. The share of lending over an LTV of 80 percent was 44 percent in 2013, while the share of lending with an LTI of over 3.5 was 23 percent.[28] In the following simulations we, therefore, consider how the new mortgage restrictions would change the weighted-average LTV and LTI using this data.[29] The weighted-average LTV and LTI

[27] The restrictions do allow for some relief for first time buyers who can avail of LTV ratios up to 90 percent of the purchase price for primary dwellings under 220,000 euro in value. We do not consider this relief in our simulations.

[28] It is important to note these data only pertain to a subset of Irish owned banks. As the newly introduced regulatory limits will affect all retail banks operating in the Irish market, a more relevant data set for considering the impact of the measures on the housing market is maintained by the CSO. As Duffy and Hanlon (2014) show, the share of lending with an LTV of over 80 percent in that data set was 60.4 percent in 2012, which is significantly higher than the share from the CBI dataset for 2013. Unfortunately, as the share of lending at each LTV and LTI is unavailable from the CSO dataset for 2013, we confine our analysis to the CBI data. See Lydon and O'Hanlon (2012) for a discussion of the differences between the two datasets.

[29] CBI (2014) presents the share of lending for LTVs and LTIs in particular ranges. In calculating the weighted averages, we take the midpoint of the range. For lending at LTVs over 100 percent and LTIs over 4.5, (as no maximum values are given) we assume that the ranges are 100 to 110 percent and 4.5 to 5, respectively, and use the midpoints of these ranges.

using these data are 83.75 percent and 3.66, respectively.

In order to estimate how the proposed restrictions would affect the average LTV and LTI we make a number of assumptions:

1. First, we assume that banks would distribute the 15 percent of lending over the LTV cap and 20 percent over the LTI cap in a similar way to the distribution observed in the most recent year for which data is available.

2. Secondly, we make certain assumptions about the number of potential high-LTV and high-LTI borrower who would be affected by the new regulations. Clearly, some borrowers could obtain the higher deposit requirement from savings, from parents, through personal loans or loans from non-mortgage financial institutions. These borrowers could then obtain mortgages with a LTV ratio at the maximum level of 80 percent rather than having to exit the mortgage market.

3. Therefore, we consider different assumptions about the proportion of these potential mortgagors that will be unable to obtain the higher deposit. We refer to these as the percent of borrowers "displaced" by the regulatory restrictions. In the first case, we assume that 25 percent of potential high-LTV mortgagors exit the mortgage market, which reduces the weighted-average LTV and LTI by 8 percentage points and 0.04, respectively. Our more extreme scenario supposes that 50 percent of such borrowers exit the market, thereby reducing the average LTV and LTI by 14 percentage points and 0.07, respectively.

Figure 5 illustrates the impact of the lending restrictions on new mortgage lending in terms of percent deviation from the baseline level of no mortgage restrictions. When we assume that only 25 percent of borrowers who would have obtained mortgages with LTVs above 80 percent now obtain them at the new LTV limit, mortgage lending reaches a peak decline of 20 percent relative to the baseline after 8 quarters and remains 10 percent below baseline in the long-run. The impact assuming a 50 percent displacement is clearly twice as large.

Our model indicates that the decline in mortgage lending would lead to lower house prices. However, it is important to note that the model contains a mechanism that

ameliorates the effect of lower LTVs on house prices. Although, the direct impact of lower LTVs is to reduce new mortgage borrowing at a given interest rate, there is an indirect channel that supports credit demand via lower interest rates.

Consider equation (2) which describes how banks set the mortgage rate in the model. As the LTV falls, the household equity variable in that equation must rise. Banks, therefore, lower interest rates in response to the lower risk associated with secured lending to households. This is shown in Figure 5, again by the number of potential borrowers displaced.[30]

Lower interest rates both raise the quantity of new mortgage lending but also lower the user cost of housing. Both of these credit effects will act to offset the effect on house prices of the decline in credit that directly results from the lower LTV. Figure 5 shows how house prices would be affected by the mortgage restrictions.

If we assume that 25 percent of those borrowers who would have obtained mortgages at LTVs above 80 percent now exit the market due to the higher deposit requirement, house prices reach their peak decline after 4 years, approximately, 6 percent down relative to the baseline and, approximately, 2 percent below the baseline in the long-run.

The impact on housing completions mirrors that of house prices. Housing construction is a function of the profitability of building new units, given by the ratio of house prices to building costs. As building costs are assumed to remain unchanged in this scenario, the decline in house prices also leads to a decline in the construction of new housing units.

With a quarter of potential borrowers displaced, housing completions fall by 4 percent relative to baseline after 5 years, thus lagging the peak decline in house prices by approximately 4 quarters. Finally, the long-run effect of the mortgage restrictions, given this level of displacement, is a housing stock that is almost 1 percent lower than in the baseline case of no change in policy. In the more extreme scenario of 50 percent displacement, this impact results in a 2 percent decline.

[30] Note that the deviation of the mortgage rate from the baseline level are in percentage points rather than percent.

6. Concluding comments

The calamitous effects of the banking and property sector crash in the Irish economy have had many profound implications for the citizens of the Irish state. As of the end of 2014, over 14 per cent of Irish mortgage holders were in some form of mortgage arrears, with hundreds of thousands of households still experiencing negative equity. Sizeable increases in personal taxation have been necessary to correct the public finances as substantial amounts of revenue were required to cover the property-related shortfall in the balance sheets of Irish financial institutions. The mere fact that the solvency of the state was significantly jeopardised by the nexus between the property market and the banking system ensures that Ireland, as a small open economy in a heavily integrated financial world, needs an effective and timely macroprudential system to avoid the mistakes of the past.

However, the timing of the application of such a system is crucial. At present, the Irish property and credit market would still appear to be gradually emerging from the complete market failure which pertained between 2007 and 2012. Housing supply is somewhat below fundamental levels, based on underlying structural demand, while growth rates in mortgage lending are still negative. Furthermore, while house prices have increased significantly since early 2013, this is against the backdrop of a 50 per cent fall in prices between 2007 and 2012, which, almost inevitably, saw actual prices fall below the level the state of fundamental variables in the economy would suggest they should be. Thus, price increases in the market at this time would appear to be a function of prices returning to their long-run equilibrium path along with the current low levels of housing supply.

The results in this paper indicate that, while the macroprudential measures proposed will more than likely result in house prices being lower than what they otherwise would be, they may also result in fewer houses being supplied to the market and fewer mortgage loans being issued than a "baseline" or no policy change scenario. As a result, as noted by Whelan (2014), the measures may well end up curbing house price inflation but at the cost of generating a sub-optimal equilibrium in the housing market, where the measures result in restricted demand for new houses, while the supply-side response in the housing market is impaired by credit and other regulatory restrictions.

In that context, it is regrettable the macroprudential measures were not implemented on an explicit rules basis, which incorporated a counter-cyclical component. This would have enabled cyclical considerations in the housing market to be taken into account in framing any such measures. Borio and Shim (2007), Goodhart (2004), Galati and Moessner (2012) and Aikman, Haldane and Nelson (2014) amongst others, have highlighted the importance of rules (or built in stabilisers) as opposed to discretion in calibrating macroprudential policy with the latter noting the necessity of rules for accountability, transparency and efficacy of policy implementation.

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Figure 1: Irish Banking Sector Data 2001-2010

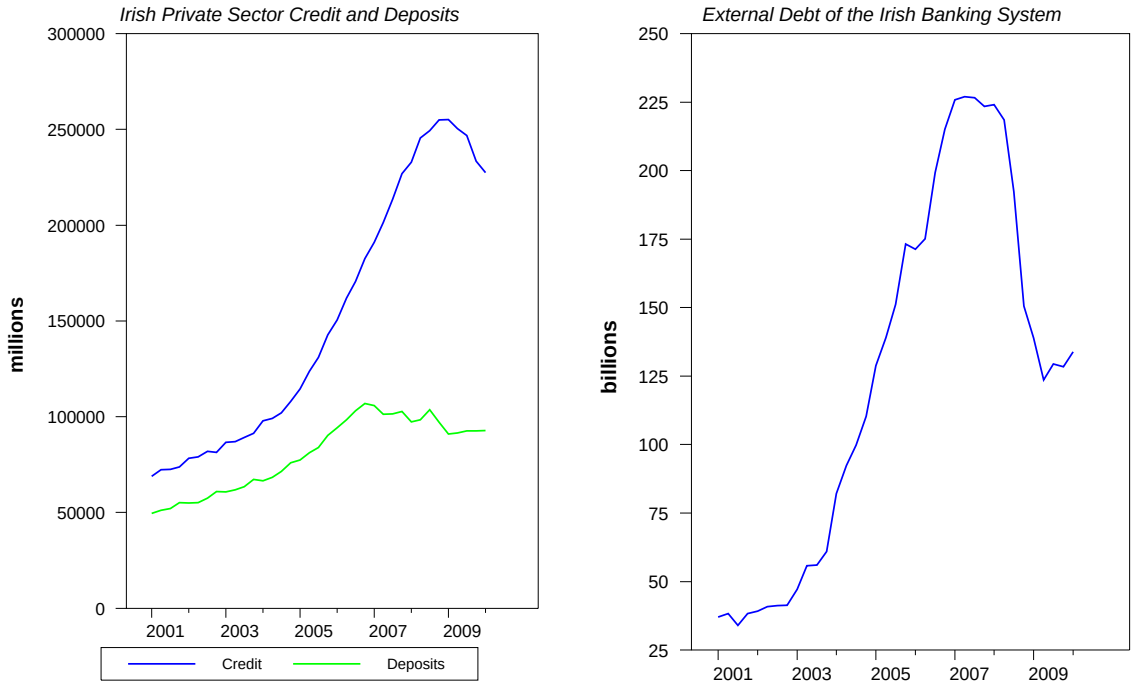


Figure 2: Results of Irish House Price Model 2000:1 - 2014:4

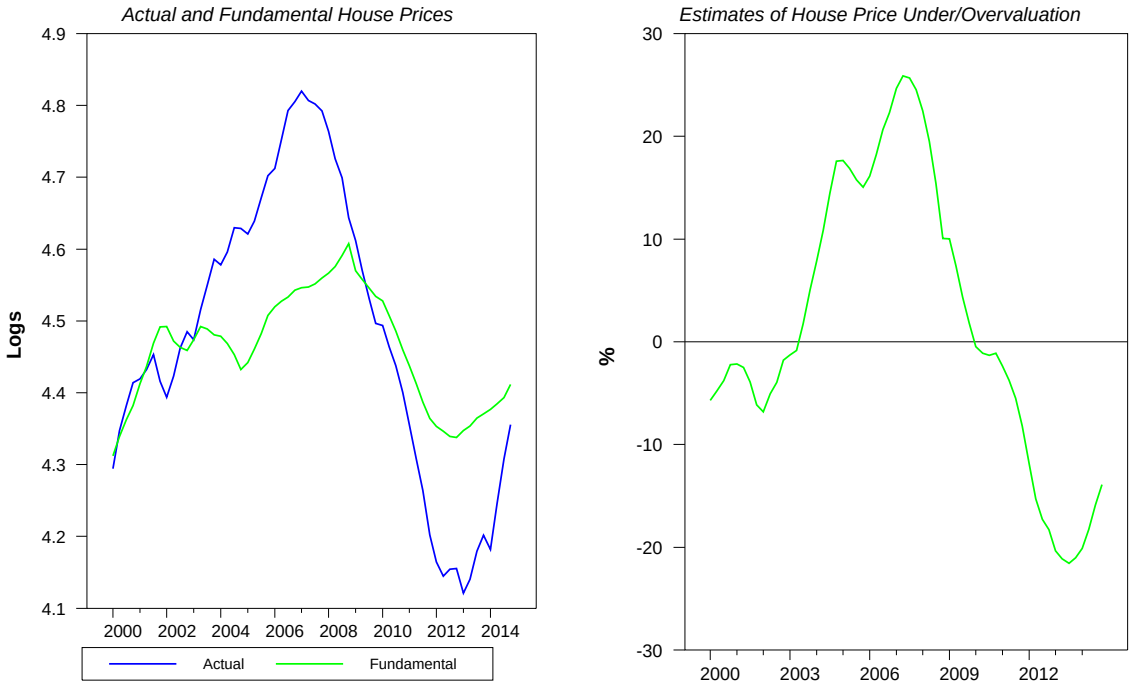
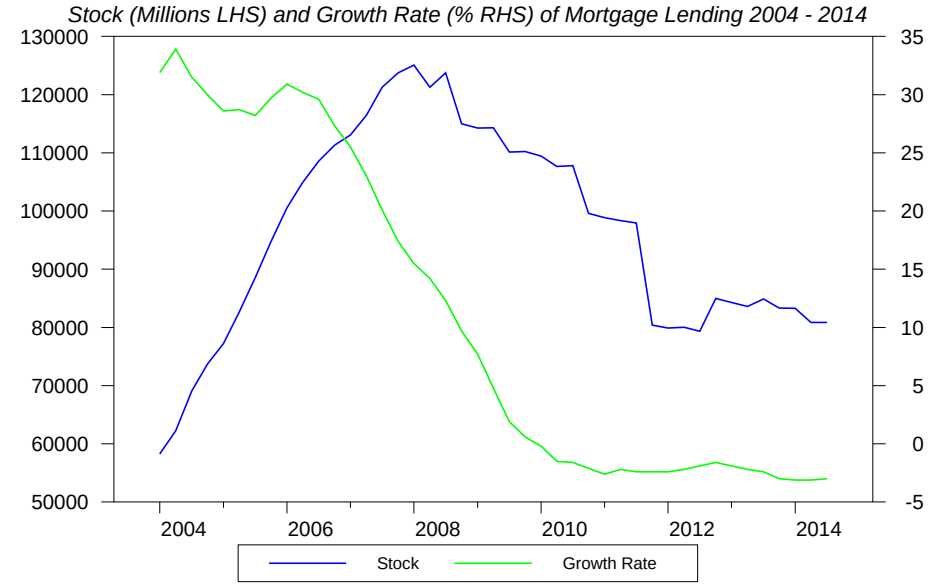


Figure 3: Irish Mortgage Credit and Housing Supply



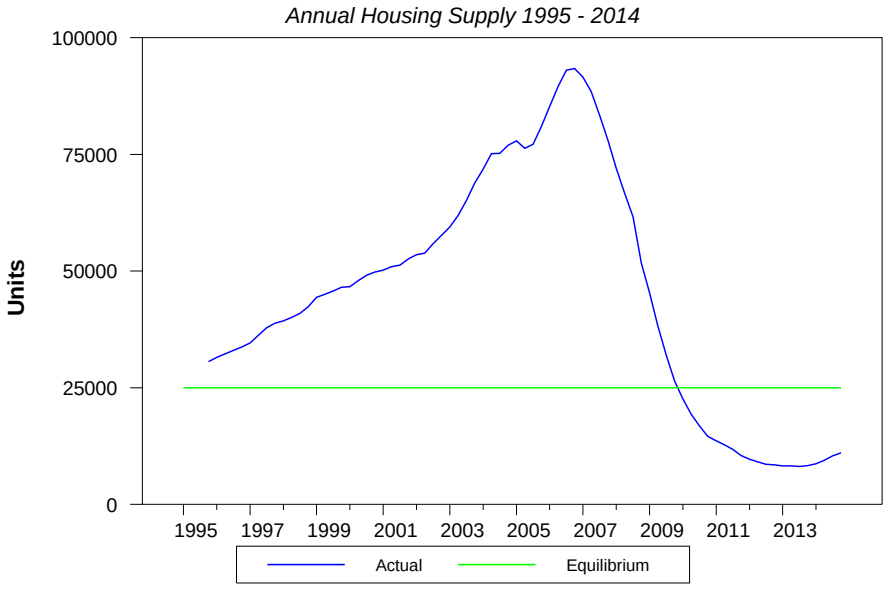
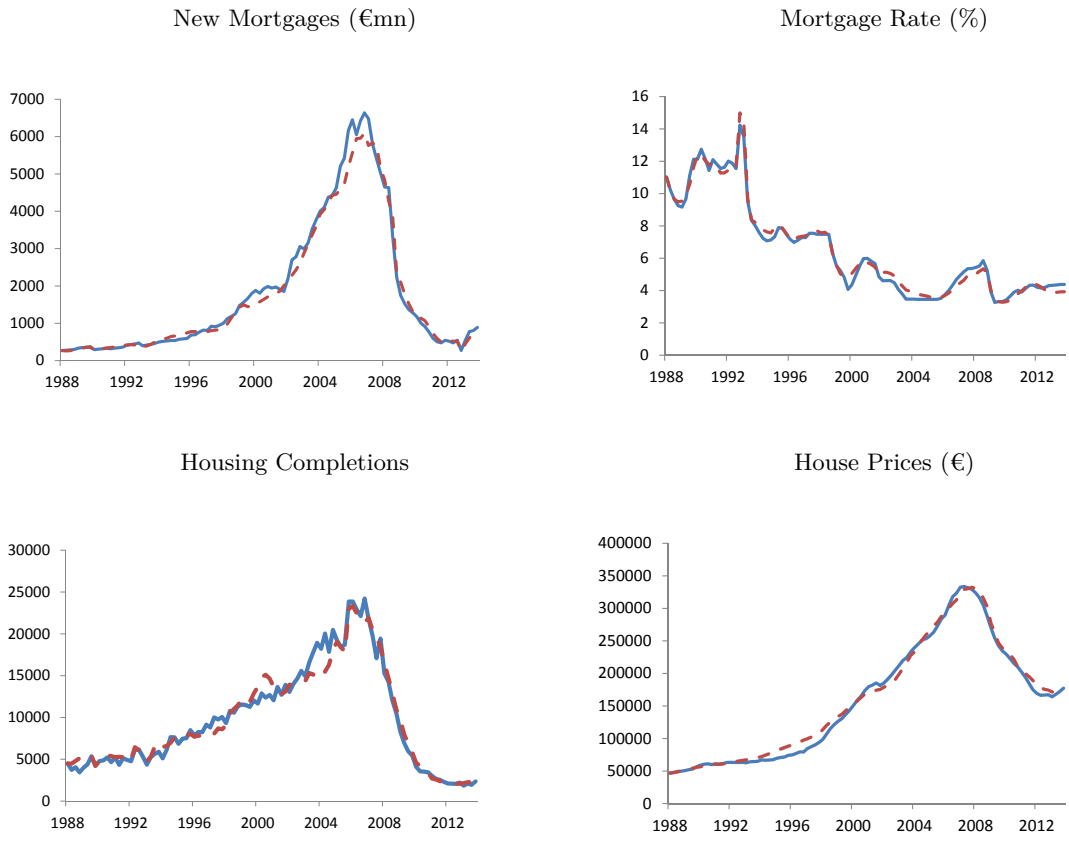
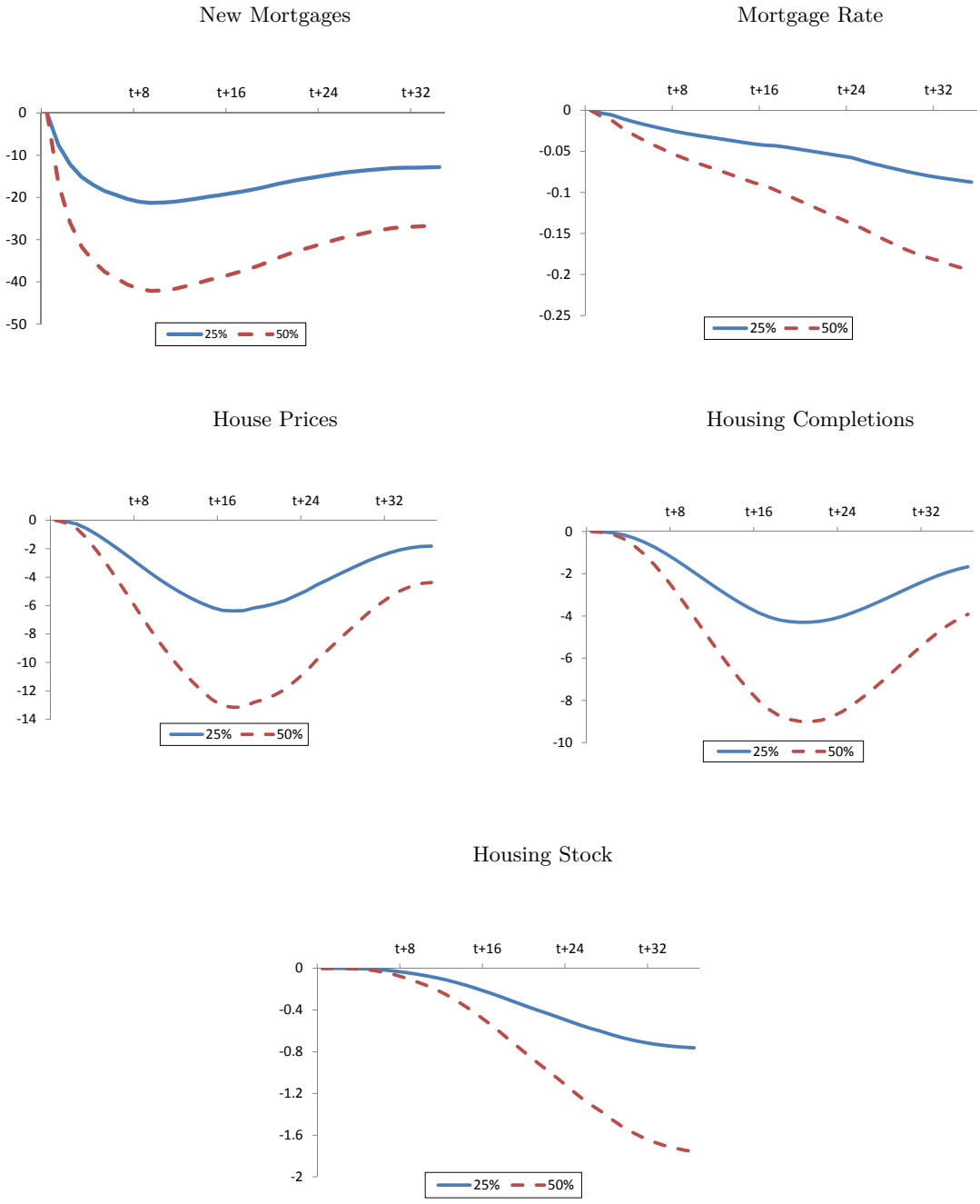


Figure 4: Actual and Predicted Values of Housing and Credit Market Variables 1988-2013



Note: the solid and dashed lines represent the historical and simulated series, respectively.

Figure 5: Simulating the Impact of Mortgage Market Restrictions



Note: the solid and dashed lines represent the impact of the LTV and LTI measures assuming that 25 and 50 percent of potential high-LTV and high-LTI are displaced, respectively. All graphs show the percent deviation from a baseline of no policy change except for the mortgage rate, which is the deviation in percentage points.

Table 1: Taxonomy of factors influencing Irish credit supply

1988 - 1999	2000 - present
Major relaxation of exchange controls.	Introduction of 100 per cent loan to value ratio (LTV) mortgages (2005).
Formal trigger mechanism for changes in retail interest rates suspended.	Introduction of tracker mortgages into the Irish market (1999/2000).
Limitations on FX borrowing by residents and IEP borrowing by non-residents removed.	Growing use of derivatives to manage risk.
Fixed-rate mortgages introduced by some banks for first time.	Mortgage securitisation.
Secondary liquidity requirement abolished.	Equity withdrawal and loan consolidation.
Reduction in primary liquidity ratio 8 to 2 per cent.	

Table 2: Demand and Supply in the Irish Mortgage Market

Mortgage Demand $NewMortgages_t$		Mortgage Supply $\triangle MorRate_t$	
$NewMortgages_{t-1}$	0.672	$MorRate_{t-1}$	-0.544
	(-19.5)		(-6.7)
$RMorRate_t$	-0.025	$HHEquity_{t-1}$	-0.541
	(-7.2)		(-4.1)
$\triangle Income_t$	0.782	$URate_{t-1}$	0.423
	(-2.9)		(-8.1)
$\triangle HP_{t-1}$	0.534	$DepRate_{t-1}$	0.136
	(-3.5)		(-5.8)
LTV_t	0.749	$MMRate_{t-1}$	0.429
	(-4.5)		(-21.5)
LTI_t	0.371	LTD_{t-1}	-0.906
	(-6.0)		(-8.2)
$Spread_t$	-0.063	$\triangle MMRate_t$	0.45
	(-6.1)		(-9.2)
$Constant$	7.048	$\triangle DepRate_{t-1}$	0.128
	(-9.8)		(-2.9)
		$Constant$	-0.013
			(-0.6)
Adj. R^2	0.991		0.891

Note: The mortgage supply and demand equations are estimated by Three-Stage Least Squares (3SLS) over the period Q1 1988 to Q4 2013. Potentially endogenous variables are instrumented using own lags and the other regressors. t-statistics are in parenthesis.

Table 3: Demand and Supply in the Irish Housing Market

Housing Demand $\triangle HPrices_t$		Housing Supply $HCompl_t$	
$HPrices_{t-1}$	-0.223	$HCompl_{t-1}$	0.754
	(-4.5)		(-15.2)
$(HStock_{t-1}/Pop2534_{t-1})$	-0.27	$(HPrices_t/BCost_t)$	0.177
	(-20.5)		(-3.0)
$User_{t-1}$	-0.002	$NFCRate_t$	-0.022
	(-13.5)		(-2.4)
$Income_{t-1}$	0.206	$Insolv_t$	-0.094
	(-13.4)		(-5.4)
$(MorStock_{t-1}/Income_{t-1})$	0.096	Gap_t	-1.302
	(-16.0)		(-4.4)
$\triangle Income_{t-1}$	0.173	$\triangle ConstLoans_{t-1}$	0.509
	(-2.5)		(-2.8)
$\triangle(MorStock_{t-1}/Income_{t-1})$	0.205	Constant	1.248
	(-2.2)		(-5.8)
$\triangle URate_t$	-0.098		
	(-2.3)		
$\triangle URate_{t-1}$	-0.097		
	(-2.2)		
$Constant$	-0.007		
	(-2.8)		
Adj. R^2	0.783		0.984

Note: The housing supply and demand equations are estimated by Three-Stage Least Squares (3SLS) over the period Q1 1988 to Q4 2013. Potentially endogenous variables are instrumented using own lags and the other regressors. t-statistics are in parenthesis.