Credit conditions and the housing price ratio: evidence from Ireland's bubble and crash

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Abstract The Great Recession starting in 2007 has refocused attention on the importance of understanding housing market dynamics as contributors to macroeconomic fluctuations. While the sale-to-rent ratio of housing prices is generally regarded as a fundamental barometer of housing market health, the study of its determinants remains in its infancy. This paper examines the housing price ratio in Ireland, during an extreme housing market cycle. Using new data on first-time buyer loan-to-value ratios, a one-step error correction model of the housing price ratio in Ireland is presented for the first time. Covering the period 2000-2012, it finds clear evidence that, alongside user cost, credit conditions were central in determining equilibrium in the housing market, which saw rapid adjustment in the ratio in response to changes in its determinants. The results imply that an increase in the LTV by 10pp would have associated with a fall in the yield in 2012 from 5.6% to 5.2% in equilibrium. Overall, the results suggest that simplistic models of the housing price ratio, depending solely on user cost, are lacking. The importance of credit conditions is a finding with implications for other markets and for macro-prudential policy.

Keywords: Housing markets; housing bubbles; price-rent ratio; credit conditions; Ireland.

JEL Classification Numbers: E32; E44; E51; G12; G21; R21; R31.

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1 Introduction

The OECD housing bubble and crash of the 1990s and 2000s has reminded economists of the importance of housing. It is typically the single most important class of consumption good, making up for example 32% of the U.S. urban CPI basket, and is also the most prevalent investment asset, comprising 54% of US household wealth (Luckett 2001). Unsurprisingly, there is strong evidence of the link between housing and broader economic outcomes, not just for recent economic history (Davis & Heathcote 2005, Leamer 2007) but the entire postwar era and even predating the Industrial Revolution (e.g. Eichholtz et al. 2012, Holly & Jones 1997).

The housing bubble and crash cycle was particularly acute in Ireland. The period from the mid-1990s to 2007 was one of very strong economic growth in Ireland, initially export-led but in later years fuelled by readily available cheap credit and an unprecedented building boom. From 2007, the economic downturn was severe. Nominal GNP fell from €163bn in 2007 to €128bn in 2011, while government finances deteriorated sharply, with a fiscal deficit of 10% of output by 2010. Unemployment rose from below 5% in 2007 to almost 15% by 2011, while large inward migration flows changed to emigration. Central to the dramatic change in Ireland's economic fortunes was the end of a domestic real estate bubble, which had seen nominal house prices rise four-fold in the decade to 2007. By late 2012, prices had fallen by more than half.

The case of Ireland exemplifies the links between housing and other aspects of the economy, including financial stability, the labour market, government finances, and public service provision. Research examining its housing crash, however, remains scarce. This paper presents the first model of the ratio of sale prices to rental prices in the housing market (hereafter, simply "housing price ratio"). It builds on existing research on the housing price ratio, which stresses the importance of credit conditions, as well as the user cost. To do this, it uses error correction methods and quarterly data for the period 2000-2012, including a new series on the typical loan-to-value for Irish first-time buyers.

This paper is related to existing work on the housing price ratio. A starting point is Himmelberg et al. (2005), who show the large increase in sale prices for housing in the U.S. in the decade to 2004 (both in absolute terms and relative to rental prices) can be attributed in large part to dramatic falls in the user cost of housing. The user cost reflects interest rates (less any deductibility), expected capital gain, property taxes and maintenance costs Poterba (1984). Research by Duca et al. (2011) shows the limitations of relying solely on user cost to explain housing market outcomes: they find that the inclusion of credit conditions, as measured by the average loan-to-value for first-time buyers, notably improves models of the U.S. housing price ratio for the period 1981-2007. Compared to models without credit conditions included, the augmented specification gives better model fits, reasonable speeds of adjustment, and stable long-run relationships with sensible and more precisely estimated income and user cost coefficients. The omission of credit conditions may also affect other studies of the housing price ratio, including Ambrose et al. (2013). Their analysis

of Amsterdam sale and rental prices from 1650 to 2005 found "persistent and long-lasting deviations between housing market fundamentals and prices" and that such mispricing occurs mainly through sale prices, rather than rental prices.

Existing work on the Irish housing market includes work in the late 1970s and early 1980s, following publication of official housing prices. Such literature (see, for example, Kenneally & McCarthy 1982, Thom 1983) typically tried to include some measure of credit constraints, a feature notably absent in the next phase of research, which dates from the late 1990s and 2000s. At this time, there was a concern among policymakers about a potential bubble in housing, reflected in the ratio of sale prices to income and in the housing price ratio. A number of papers examined Irish housing prices but, without the inclusion of credit conditions, they struggled to generate meaningful results (e.g. IMF 2003, McQuinn 2004, Murphy 2005, Rae & van den Noord 2006, Roche 2004, Stevenson 2003). The closest to a theoretically-grounded analysis of the relationship between credit conditions and housing prices is Murphy (2005), who uses an inverted demand error-correction model, including a dummy variable for financial liberalization.

The absence of credit conditions in analyses of Irish housing prices was partially addressed by Addison-Smyth et al. (2009). They present a two-equation system of average mortgage levels and house prices that builds on McQuinn & O'Reilly (2008), which relies on the mortgage repayment (affordability) and the "funding rate", the ratio of the outstanding level of mortgage lending to total domestic deposits. This is found to have considerable power in explaining average mortgage levels over the period and a plot of fundamental house prices including this factor matches price developments more closely than the more restricted model of mortgage levels.

Research on user costs for Irish housing are similarly scarce. Research by Barham (2004) found that user cost associated with owning housing in the Irish market was negative for large parts of the period from 1976 on, principally due to the favourable tax treatment afforded owner-occupancy. More recently, Browne et al. (2013) have updated this analysis, finding that the user cost is dominated by expected capital gain, where this is measured with the annual gain over the last four years. Neither paper attempts to econometrically link user cost with housing prices.

Therefore, the principal contribution of this paper lies in its presentation of the first econometric analysis of the housing price ratio in Ireland. In addition, the principal result – that, with credit conditions included, the ratio appears to adjust very swiftly to changes in its determinants – underscores the finding of Duca et al. (2011) about the importance of including some measure of credit supply, in order to accurate. Lastly, more minor contributions include the construction of a credit conditions series for Ireland during its bubble and crash and a theoretical bridge between the inverted demand and price-rent ratio approaches to modeling housing prices.

The rest of this paper is as follows. Section 2 outlines the basic economic theory involved, including a framework for connecting up inverted demand and housing price ratio approaches to modeling housing markets and Section 3 provides details on the data used in this analysis. Section

4 presents the main empirical analysis and results, while Section 5 concludes.

2 Theory

Theoretically, demand for a good depends on its prices, the income of consumers and other demand shifters. Applied to housing, suppose that in any given period t, the quantity of housing demanded, h_t, can be approximated linearly by:

$$ln(h_t) = -\alpha ln(hp_t) + \beta ln(y_t) + z_t$$

where hp_t refers to the real housing price, y_t to (real) household income and z_t to demand shifters, as discussed below. As the supply of housing is fixed in the short run, the demand function can be inverted, giving:

$$ln(hp_t) = (\beta ln(y_t) - ln(h_t) + z_t)/\alpha$$

Where the income elasticity of demand, β, is one, this simplifies further, with house prices being determined by the log income per house ($\frac{y}{h}$)and other demand shifters, z. This applies to the housing price for both sale and rental properties. Demand shifters unique to sale properties (denoted z_t^S) including user costs (described in more detail below) and credit conditions (as discussed earlier), as well as demographics, which would also affect rental prices. Demand shifters that affect both market and implicit rents can be denoted by z_t^R.

Where income, housing supply and demographics affect both sale and rental prices, this implies that dividing through by rental prices leaves, in addition to a constant, z_t^S, asset factors that affect sale properties, in particular user cost and credit conditions. This logic connects the theory outlined above, which corresponds to the inverted demand approach for modeling housing prices, to the alternative, modeling the housing price ratio, outlined below.

This ratio is related to the concept of financial arbitrage (Poterba 1984). In an equilibrating market, sale prices will reflect the discounted future stream of rental prices: $hp_t = rent_t/\rho_t$, where ρ_t represents a discount rate. Where discount rates match interest rates r_t, and where housing is subject to costs of depreciation and maintenance (δ_t), costs of transaction and taxation (τ_t), and expected capital gains (κ_t), this means that the housing price ratio in period t (hpr_t) depends on the user cost in that period[1]:

$$hpr_t = 1/(r_t + \delta_t + \tau_t - \kappa_t)$$

In log formulation, and allowing for flexibility in relation to the relative importance with which the

[1]This is typically thought of in annual terms. For example, market participants may use a rule such as: "what multiple of annual rent is this property worth?" Equivalently, one could consider the ratio of rents to house prices as being the percentage dividend on housing as an asset.

various factors affect the ratio:

$$ln(hpr_t) = \beta_0 + \beta_1 r_t + \beta_2 \delta_t + \beta_3 \tau_t + \beta_4 \kappa_t$$

where the expectation is that β_1, β_2 and β_3 are negative and β_4 is positive (greater expected capital gains push up house prices). As mentioned above, a risk premium term, π_t, should be included in user cost, while tax relief on mortgage interest will also affect the net cost of capital.

Two other factors should affect the equilibrium ratio of prices to rents in the housing market. Firstly, as outlined in Kim (2008), if a house provides a different level of rental service to an owner-occupier than to a tenant, and houses are rented out reflecting this "rental efficiency", then the ratio of prices to rents will be positively related to rates of home ownership, θ_t. Put another way, the dividend on housing (the rent-price ratio) will be lower when home ownership is greater, due to the different level of service derived from housing by owner occupiers.

Secondly, as outlined in Duca et al. (2011), credit conditions affect the equilibrium ratio of prices to rents. Empirically, where uc_t refers to the user cost term described above, the log form allows the estimation of the long-run relationship between the various factors:

$$ln(hpr)_t = \beta_0 + \beta_1 r_t + \beta_2 \delta_t + \beta_3 \tau_t + \beta_4 \kappa_t + \beta_5 CCI_t + \beta_6 \theta_t + \beta_7 \pi_t$$

where CCI is specified such that an increase reflects an easing of credit conditions; thus the expectation is that β_4, β_5 and β_6 are positive, with all other coefficients (apart from the intercept) negative.

3 Data

The scale and nature of the private rented sector in Ireland changed substantially between the 1970s and 2000. During the 1970s, measured rents fell dramatically in real terms, at a time when homeownership was expanding rapidly. This rise in homeownership continued during the 1980s. Lastly, during the late 1990s, there were substantial reforms of the private rented sector, in particular to stimulate new supply of rented homes, in response to economic and population growth. However, for the period from 2000 on, a relatively stable rental market regime exists in Ireland, with a well-developed market-based private rented sector nationwide. This section outlines the data used in the analysis of Ireland's housing market during the period 2000-2012.

Housing Prices Two sources, the Residential Property Price Index by Ireland's Central Statistics Office (CSO, 2005-2012) and the ESRI index (which started in 1996 and was based on mortgages issued by the PTSB bank) are used to generate a hedonic index of Irish housing prices from 2000 on. In order to calculate a housing price ratio, a level of sale prices is needed: the Census-weighted

average price from the 2012Q4 Daft.ie Report was used. Information on rents comes from the Private Rents component of Ireland's Consumer Price Index, compiled by the CSO. Given the nature of this series – which is based on a small survey of landlords and lettings agents and is not mix adjusted – another rental index, produced by Daft.ie, Ireland's largest property listings website, is used for the period 2002-2012. As with sale prices, indices are converted to levels using the Census-weighted average rent according to daft.ie in 2012Q4.

Interest Rates Mortgage market interest rates are taken from official sources. For the period from 2003, the quarterly average of the annual percentage rate of charge (APRC) reported by the ECB is used. Prior to this, the figures are are the CSO's "representative Building Society mortgage rate". These are variable rates, as these represent the vast majority of mortgages in Ireland; according to Kennedy & McIndoe-Calder (2011), just 15% of the loan-book of the four major Irish lending institutions at the end of 2010 was based on fixed-rate mortgages. These series form the gross nominal mortgage rate rm^{GN}, where rm stands for mortgage rate (as opposed to deposit rate or some combination), G for gross and N for nominal. The net nominal mortgage rate, rm^{NN}, is calculated by deducting the marginal rate of mortgage interest relief.

Expected Capital Gain Gross interest rates are only part of the cost of home ownership. An offsetting component of user cost is the expected capital gain: if interest costs are 5% per year but nominal house prices are expected to grow by 10% per year, assuming no other costs to ownership, the real user cost would be perceived as negative. Unfortunately, there are no consistent data on expected capital gains in residential housing for the whole period under analysis. However, surveys covering the period 2003-2007 and 2012 on suggest a strong adaptive component to expectations, i.e. that housing market participants look at the recent history of the market as their best guide regarding the future direction of prices. For example, in early 2007, a year when nominal house prices were at best stable, participants expected strong price growth, as had been the case in recent years. Similarly, in early 2012, consumers expected prices to fall 10%, the average rate over the previous four years; prices actually fell by 4% in 2012. The existing literature suggests that for other countries, the four-year average and one-year rates of change in nominal house prices often perform well as measures of expected capital gains based on adaptive or extrapolative expectations (Muellbauer 2012). Therefore, both are used here in explaining the housing price ratio. This is denoted in the suffix to the net interest rate, where rm^{NR4} indicates an interest rate net of expected capital gains, based on four-year appreciation.

Other Costs User cost includes property taxes, maintenance and depreciation. Ireland did not have an annual property tax for the period under analysis, relying instead on stamp duties, i.e. transaction taxes. The percentage rate that applied was subject to certain bands, but for a first-time buyer of a house of average value, the rate was 0% throughout most of the 2000s. The CSO

Household Budget Survey 2010 gives an estimate of the amount spent on maintenance; based on spending and housing prices in 2010, households spend on average about 0.5% of the value of their dwelling on maintenance. However, setting a fixed proportional cost of maintenance means that this does not vary over the period and thus is irrelevant for a dynamic model of changes in house prices over time. A similar point can be made fo financial and psychological costs of moving.

Credit Conditions Aggregate statistics on the volume of lending and the average house price, collected by Ireland's Department of the Environment give a figure that can be interpreted as the average loan-to-value for property purchases in a given year. However, this is not the same as the marginal LTV ratio and may be skewed by positive equity during periods of rising prices. Instead, a loan-level Central Bank of Ireland (CBI) dataset, described in Kennedy & McIndoe-Calder (2011), can be used to calculate the mean and median loan-to-value for first-time buyers across four Irish-owned financial institutions (all subsequently recapitalized by the Irish state), for the period 2000-2011. The series is based on over 100,000 loans on the books of the four institutions as at end-2011.[2]

An alternative measure of credit conditions is also used, the ratio of mortgage credit to domestic deposits. Credit conditions may vary with trends in financial liberalization or due to cyclical appetite among financial institutions for mortgage assets; i.e. they may be due to technology or preferences. Both will be reflected in the ratio of credit to deposits. For the period 2003-2012, Central Bank of Ireland data on the outstanding amounts (including securitized loans) of loans for house purchase were used, as were total deposits from Irish private households. This series was extended back using quarterly data from the IMF *International Financial Statistics* on demand and other deposits, and on domestic credit. Having been below 80% for the entire pre-Eurozone period, the ratio of credit to deposit more than doubled by 2007 to 180%, reflecting banks borrowing from international capital markets.

4 Analysis and Results

To understand housing price ratios in Ireland during the period 2000-2012, a one-step error-correction framework is employed, combining both long-run fundamental determinants of the housing price ratio (elements of the user cost and measurements of credit conditions) as well as short-run dynamics. Three dynamic terms are included: the lagged value of *dlhpr*, capturing any memory; the contemporaneous change in rents, capturing the extent to which changes in the ratio reflect changes in the denominator; and the contemporaneous change in credit conditions. The long-run equilibrium relationship includes the following fundamentals: the rate of interest (either nominal,

[2]Due to lack of data, and justified by more descriptive analyses of Irish mortgage lending in 2012, the median LTV for 2011Q4 was extended to apply to 2012. As this is an equilibrium term, excluding these points does not have a significant impact on the results, although it does have a meaningful impact on sample size.

and thus expected capital gains terms would also be required, or real) and credit conditions.

Two other terms may matter for the ratio of prices to rents. Firstly, it may be the case that, in comparing mortgage payments with equivalent rents, non-linearities exist. Thus, where a combined real rates of interest term is included, the log of the nominal net interest rate can be included to capture any such effects. Second, as suggested by Kim (2008), the percentage of renters may be inversely related to price-rent ratio in equilibrium, reflecting the differential return from real estate derived by owner-occupiers compared to tenants and landlords.[3]

Results for three specifications are presented in Table 1, for both measures of credit conditions (MCDR and LTV). The first separately includes the net nominal interest rate, and 1- and 4-year (annualized) house price inflation to reflect extrapolative expectations. For both measures of credit conditions, the results show an order of magnitude difference between the interest rate and expectations terms, suggesting non-linearities are important. Thus, the second specification includes one term for the real net rate of interest, with a weight of 0.6 on 4-year inflation and 0.4 on 1-year (as suggested by their relative coefficients), as well as the log of the net nominal interest rate. In both cases, this improves the fit of the model, although in the *ltv* specification, the coefficient on the log rate is at best marginally significant. The final specification adds the percentage in rented accommodation. For the specification using *mcdr*, this term is significant. However, for the specification using *ltv* to measure credit conditions, this variable is not statistically significant and indeed has the wrong sign. It also worsens the fit of the model.

The diagnostic results are strong. The models explain between 80% and 85% of variation observed in changes in the price-rent ratio. The speed of adjustment implied by the coefficient on the lagged level of the price-rent ratio is between 25% and 30% for models using *mcdr* and roughly 18% for models using *ltv*. Across all three specifications, however, the fit of the model using loan-to-value information was substantively better than the fit using the credit-to-deposit ratio (as measured by sigma, the root mean squared error). Thus, while the ratio of mortgage credit to deposits can act as a good proxy for credit conditions, it does not perform as well in explaining changes in the housing price ratio as the loan-to-value for the typical first-time buyer.

The specification using the median loan-to-value for first-time buyers is thus chosen to estimate the long-run relationship; actual and fitted values are plotted in Figure 1. It suggests one important dynamic relationship also: the coefficient on the contemporaneous change in the loan-to-value of 0.26 is statistically significant and implies that as credit conditions are being loosened, the price-rent ratio rises beyond just what is suggested by the long-run coefficient. This is consistent with shifting a fraction of the population from renters to owner-occupiers, creating a temporary boost to demand. The implied long-run relationship from this model is as follows, where Φ represents

[3] A limitation to use of this variable is its interpolated nature and thus the failure to reject the null of the annual change in the percentage renting being I(1).

Table 1: *Modelling changes in the price-rent ratio (dlhpr), 2000-2012*

	MCDR		MCDR (non-lin)		MCDR (%rent)		LTV		LTV (non-lin)		LTV (%rent)	
	Coeff	p-value	Coeff	p-value	Coeff	p-value	Coeff	p-value	Coeff	p-value	Coeff	p-value
Constant	1.296	0.000	1.333	0.000	1.766	0.000	0.732	0.000	0.731	0.000	0.751	0.000
$lhpr_{t-1}$	-0.249	0.001	-0.255	0.000	-0.305	0.000	-0.177	0.000	-0.175	0.000	-0.185	0.000
cci_{t-1}	0.131	0.007	0.134	0.005	0.219	0.000	0.361	0.000	0.36	0.000	0.362	0.000
rm_{t-1}^{NN}	-3.001	0.000					-1.036	0.04				
$d16lhp\_ann_{t-1}$	0.343	0.002					0.211	0.000				
$d4lhp_{t-1}$	0.24	0.001					0.126	0.004				
rrm_{t-1}^{NN41}			-0.581	0.000	-0.409	0.013			-0.34	0.000	-0.402	0.012
$l(rm_{t-1}^{NN})$			-0.078	0.000	-0.081	0.000			-0.024	0.122	-0.026	0.116
pc_rent_{t-1}					-1.244	0.025					0.175	0.667
$dlhpr_{t-1}$	0.21	0.099	0.228	0.058	0.29	0.015	0.192	0.109	0.186	0.105	0.174	0.141
$dlrent$	-0.707	0.000	-0.685	0.000	-0.519	0.001	-0.72	0.000	-0.741	0.000	-0.782	0.000
$dcci$	0.389	0.057	0.466	0.014	0.458	0.012	0.257	0.016	0.261	0.012	0.271	0.012
sigma	0.01377		0.01372		0.01307		0.01287		0.0127		0.01283	
R2	0.819		0.816		0.837		0.842		0.842		0.843	
Test failures	Hetero		None		None		None		None		None	

the unobserved intercept term:

$$ln(hpr_t) = \Phi + 2.05ltv_t - 1.94rm_t^{RN*} - 0.13ln(rm_t^{NN}) \quad (1)$$

Credit conditions Credit conditions have a long-run impact on the price-rent ratio, with the coefficient of 2.05 indicating that an increase of ten percentage points in the loan-to-value of the typical first-time buyer was associated with an increase in ratio of prices to rents of 20.5%. Assuming static rents, this translates into a 20.5% increase in house prices. Put another way, suppose average house prices are €170,000 and the average monthly rent is €800; thus the average gross yield (annual rent relative to prices) is 5.6%. An increase in the LTV by 10pp is associated with a fall in the yield from 5.6% to 5.2% in equilibrium. (There would also be a dynamic effect on the price-rent ratio, as outlined above, in this example of 2.6%, pushing the yield down to 5.0%.)

Duca et al. (2011) use the log form of the loan-to-value for first-time buyers and report a long-run elasticity of prices with respect to LTV of 1.4. Here, a model with level of LTV/downpayment ($\sigma = 0.01270$) has better fit than one with log LTV ($\sigma = 0.01282$), and also performs better than one with log down-payment, which will have different non-linearities ($\sigma = 0.01278$). For reference, the implied long-run elasticity of prices with respect to LTV for Ireland 2000-2012 was roughly 1.6, compared to 1.4 in the case of the USA, 1980-2007.)

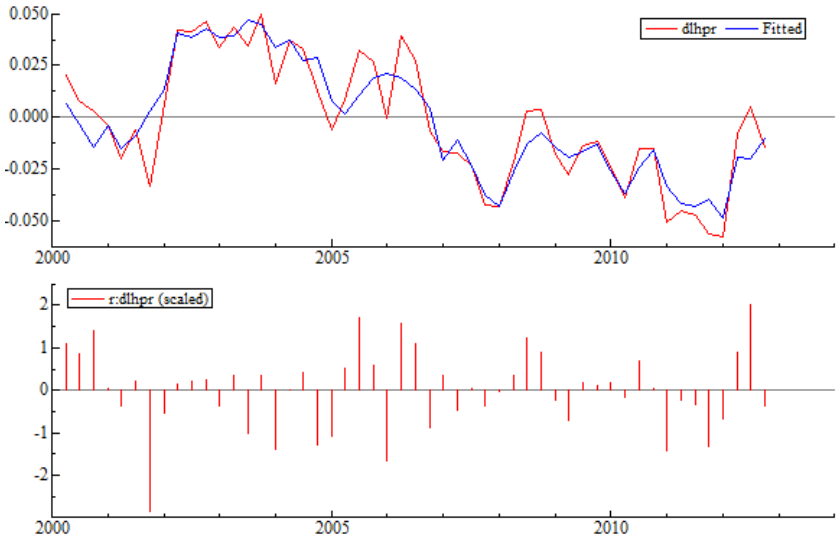
Real interest rates Real interest rates for housing – as measured by the difference between nominal rates after tax reliefs and the expected capital gain (based on 4-year and 1-year inflation) – are associated with a lower price-rent ratio, as expected. The coefficient of 1.94 indicates that an increase in real interest rates of 1 percentage point is associated with an increase in equilibrium price-rent ratio of 1.94%. This is somewhat larger than the coefficient in the inverted demand model

(1.53) and suggests that a relationship between interest rates and inflation to a much greater degree than between interest rates and rents.

Nominal interest rates In addition to real interest rates for housing, the nominal rate may also matter, although its statistical significance is marginal (potentially a product of the small sample size). A 10% reduction in the nominal after-tax mortgage rate is associated with a 1.3% rise in the price-rent ratio. This may reflect the cash-flow constraints and the direct choice faced by would-be first-time buyers of a particular rent or nominal net mortgage payment.

Robustness & Sensitivity Overall, these results are sensitive to series chosen, due to the small period for which the model is computed. Nonetheless, largely similar results are obtained if an alternate series for rents (from property website daft.ie) is used for the period 2002-2012. Adding other dynamics does not improve model fit, while using loan-to-income information contained in the same CBI data is not preferred. Using the DOE series on LTVs for new dwellings results in a significantly poorer model fit, with neither house price appreciation term statistically significant and the nominal rate only marginally significant.

Figure 1: *Actual and fitted values of dlhpr, 2000-2012*



5 Conclusion

This paper has examined the housing price ratio in Ireland during its recent housing bubble and crash. Following a growing literature that focuses on the role of credit conditions, in particular

Duca et al. (2011), the ratio of sale to renting prices for Irish housing was placed in an error-correction framework, where the key long-term determinants related to the user cost and credit conditions. This involved the construction of a new series of the typical loan-to-value paid by first-time buyers in Ireland, from 2000 on, using Central Bank of Ireland micro-data. Credit conditions were also measured at an aggregate level, using the system-wide ratio of mortgage credit to household deposits. While both measures capture significant variation in the sample, the LTV measure performs better, reflecting the importance of including the change in the credit-deposit ratio, as well as the level. The key time-varying terms in the estimated user cost are the net interest rate less a combination of 1-year and 4-year inflation, with potential non-linearities applying in relation to the nominal rate of interest.

In the parsimonious long-run relationship that emerges between sale and rental prices, credit conditions matter, both for the long-run solution and for short-run dynamics. An increase of ten percentage points in the typical first-time buyer LTV was associated with an increase in the long-run price-rent ratio of 20.5%, as well as a short-run effect of 2.6%. This suggests that previous studies of the Irish housing market have suffered from omitted variable bias, attempting to model prices but without accounting for credit conditions. Taking 2012 values, which imply an average gross yield (annual rent relative to prices) of 5.6%, an increase in the typical LTV offered to first-time buyers by 10pp would be associated with a fall in the yield from 5.6% to 5.2% in equilibrium.

Of note is the speed with which housing prices in Ireland during this period adjusted to a new equilibrium. The preferred specification, using the typical LTV for first-time buyers, suggests that almost two thirds of the gap between the actual ratio and the equilibrium ratio was closed every year. In this sense, Ireland's bubble was not an irrational bubble in the housing market, marked by prices deviating significantly from their determinants. Rather, the analysis here suggests that Ireland's bubble was one step further up: it was the determinants themselves – in particular credit conditions and expectations – that had deviated from sustainable levels. The extrapolative nature of these expectations generates a natural mechanism for house price to overshoot on both upside and downside. How policy can prevent this recurring, for example tracking expectations with regular surveys to warn about future problems, should be an active topic of future research and policy analysis. Another suggested avenue for research is the extension of the period studied here, in order to capture the effect of previous and subsequent episodes of macro-prudential regulation and of rent control.

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