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Research Technical Paper

Estimating the Structural Demand for Irish Housing

Diarmaid Addison-Smyth,

Kieran McQuinn & Gerard O'Reilly*

Central Bank and Financial Services Authority of Ireland
P.O. Box 559, Dame Street
Dublin 2
Ireland
http://www.centralbank.ie

*The views expressed in this paper are the personal responsibility of the authors. They do not necessarily reflect the opinions of the CBFSAI or the ESCB. The authors would like to acknowledge the comments of all those who participated in a CBFSAI seminar. Any errors are the sole responsibility of the authors. E-mail: diarmaid.smyth@centralbank.ie, kmcquinn@centralbank.ie & gerard.oreilly@centralbank.ie.

Abstract

After 10 years of unprecedented increases in both prices and activity levels, the Irish housing market appears to be entering a period of some uncertainty. In the early part of 2007, Irish house prices, for the first time in recent history, experienced negative growth rates - leading indicators within the housing sector would suggest that house building is already beginning to contract, with future levels expected to be somewhat below the record level of construction in 2006. The sustained increase in housing construction prompted by the rapid increase in prices has resulted in the Irish construction sector assuming a position of considerable importance within the overall economy. Arguably, any significant slowdown in housing activity could have far-reaching domestic consequences. In this paper, we use a recently developed model of the housing sector to gauge what the structural level of demand is for Irish housing.

1 Introduction

Since the latter half of 2006, the Irish housing market has finally begun to "cool off". After an unprecedented 10-year period of substantial price increases and record new housing starts, the Irish housing sector is, for the first time since the early 1990s, facing into a period of some uncertainty. Since mid 2007, price increases have all but disappeared and as a result, considerable speculation now surrounds future activity levels within the housing sector. In 2007, there were approximately 78,000 house completions down from 88,000 completions in 2006[1] in the Irish economy. This was three times the number of houses built in 1994. In an international context, the United Kingdom, in 2006, witnessed the construction of approximately 210,000 new housing completions - just over twice the Irish amount even though the population of the UK is over 14 times that of Irelands.

Inevitably, while the performance of the housing sector is of considerable interest in its own right - of more concern in recent times has been the interaction between the sector and the performance of the overall economy. The number of persons directly employed in construction has more than doubled over the past decade with 282,600 persons[2] currently employed in the sector (or about 13 per cent of the workforce). Additionally, the contribution of the buoyant housing sector to the national exchequer has become increasingly significant due to the growth in property related tax revenues. Stamp duty and capital gains taxes[3] alone accounted for just over 13 per cent of all tax revenue in 2007 (and 15 per cent in 2006), as compared with 4 per cent in 1996. Therefore, a marked slowdown in activity levels in the construction sector could, potentially, have serious implications for overall economic

[1] Officially there were 93,419 completions in 2006, however approximately 5,000 units within this were built in 2005 but not connected to the ESB network (which is how completions are measured) until 2006.

[2] There are no data available on employment in the housing or residential construction sub-sector but this is widely recognised as being the most labour intensive sub-sector within construction. Furthermore, the housing sub-sector accounts for about two thirds of the overall construction sector in investment terms.

[3] While not all of revenues arising from stamp duty and capital gains receipts are due to property related transactions, a substantial proportion are accounted for by housing. For example, it is estimated that residential property transactions account for well over one third of all stamp duty receipts. Finally, other tax revenues such as VAT and income tax are also dependent on activity levels in the housing market.

growth within the country.

Much of the present uncertainty in the housing sector is due to the slowdown in general affordability levels amongst potential house purchasers. Successive interest rate increases since the middle of 2005 on top of an already high price level coupled with a declining rate of disposable income growth has negatively affected affordability levels and, hence, demand within the market. Given this uncertainty, it would appear timely to arrive at some evaluation of the likely supply response within the construction sector to the recent slowdown in general affordability levels. In particular, what is the likely level of housing demand given current and projected macroeconomic conditions within the economy?

To address this issue, we use a recently developed model of the housing sector proposed in McQuinn and O'Reilly (2007a, 2007b). While McQuinn and O'Reilly (2007a, 2007b) focussed on the demand side of the model, in our application we estimate the implicit supply function and use this to examine what the likely implications are for housing supply of alternative paths of two of the most significant determinants of housing demand - income and interest rates. If one believes, as many do, that Irish house prices are overvalued at present, than, using the modelling framework, one can determine what the supply response for a price level, which is more reflective of fundamentals within the economy i.e. for an equilibrium price path. In turn, one can then use the model to examine the potential sensitivity of supply to different levels of incomes and interest rates.

The rest of the paper is structured as follows; Section 2 reviews the main developments in the Irish housing market over the last decade, while section 3 introduces the modelling framework. In section 4, using the results from the model, a counterfactual simulation is performed. A final section offers some concluding comments.

2 The Irish Housing Market

Over the sample period considered (1980 - 2007), the Irish economy has experienced profound economic change. Ireland, in the 1980's, witnessed negligible economic growth, an average unemployment rate of 15 per cent and high levels of personal taxation. The emergence of the so-called *Celtic Tiger* in the mid 1990s led to a sustained period of economic growth. Between 1995 and 2007, the size of the econ-

omy doubled with the total number of people employed in the country increasing by approximately 64 per cent. This sustained increase in income levels was coupled with a stable, low interest rate environment. The change in economic conditions is highlighted in Figure 1, which plots the growth rate of house prices, monthly disposable income per household and the variable mortgage interest rates over the sample period. In the first panel of Figure 1, the large increase in house price growth can clearly be seen throughout the 1990s - between 1995 and 2007 it averaged nearly 13 per cent per annum. Disposable income per household in panel 2 of Figure 1 also grew exceptionally throughout this period due to the high level of employment and income growth and reductions in personal taxation levels. By the end of the sample, monthly take home income was almost 7 times the level it had been in 1980. Panel 3 of Figure 1 illustrates the highly benign nature of the interest rate environment in recent years, when compared with the more turbulent 1980s and early 1990s.

The substantial surge in demand pressures in the market from the mid 1990s and the consequent increase in prices has given rise to a considerable acceleration in housing supply. Annual completions between 1970 and 2007 are plotted in the first panel of Figure 2. From 1993, there has clearly been an unprecedented increase in the rate of Irish house building. It is interesting to place this level of activity in an international context. The second panel of Figure 2, shows the number of housing completions per thousand inhabitants for a cross section of countries. A figure for Ireland is included for both 1980 and 2006 for comparison purposes. It is clear that the level of house building in Ireland has been exceptionally high, with approximately six times the number of houses built per capita than has been the case, for example, in Germany and the UK. Part of the reason for the very high level of house building in Ireland can be explained by a "catching up process" as the stock of dwellings in Ireland was traditionally low - the third panel of Figure 2. As can be seen however, even over a relatively short period of time (2003-2006), Irish stock levels rapidly converged on those of other developed economies.

This sharp rise in house building resulted in the construction sector becoming increasingly important within the Irish economy. Firstly, in terms of employment, the number of persons at work in the construction sector effectively trebled over the last decade from 97,000 persons in 1995 to 269,000 in 2006. While there is no breakdown available between residential and non-residential related employment in

construction, the former is widely recognised as being the most labour intensive sub-sector within construction. At present, the construction sector directly accounts for one in every eight jobs in the economy (see Table 1). This is exceptional in Euro area terms where the average is about one in twelve - see Figure 3. Furthermore, when account is taken of indirect effects due to house building (e.g. related employment in banking and financial services, plant hire, engineers, etc.), this weighting is even higher. These indirect employment effects have typically been estimated at 40 per cent of direct employment[4], which would account for about 100,000 additional jobs in the Irish economy. As a result, the construction sector both directly and indirectly accounts for nearly one in every five jobs in the economy.

In investment terms, house building accounted for half of all investment in the Irish economy in 2006 (Table 1) and about 15 and a half per cent of GNP (in expenditure terms). Again, this ratio is exceptionally high by international standards. In value-added terms[5], the volume of output in the building and construction sector was very high at 14.2 billion, or about 10 per cent of GNP.

Given the relative scale of investment in the Irish housing market, it is to be expected that the domestic market would eventually experience some reversion to international norms in terms of activity levels. The sector peaked in terms of house building in 2006 with a record number of house completions. The most recent house price data shows a sharp moderation in prices with prices falling in the second half of 2007.[6] This fall in price reflects a softening in demand, which can mainly be attributed to reduced affordability in the Irish market. This reduced affordability is chiefly a function of successive interest rate increases, which have impacted across the Euro area since the end of 2005. Additionally, the substantial increases in disposable income experienced during the period of the Celtic tiger are likely to give way to more modest increases in medium-term living standards. This will serve to moderate the recent rapid growth rates of personal affordability levels.

On the supply side, recent completions data (2007 quarter four) along with many forward looking indicators point to a further slowdown in house building in 2008.

[4]See 'Review of the Construction Industry 2006 and Outlook 2007-2009', DKM Economic Consultants, September 2007.

[5]Value added measures the value of output less intermediate inputs (e.g. materials used in construction).

[6]Permanent tsb/ESRI House Price Index.

These forward-looking indicators[7] include:

(1) housing starts and registrations- down 33 and 40 per cent respectively in the year to November 2007,

(2) employment - there were successive quarter-on-quarter declines in employment in the construction sector in the second and third quarters of 2007, the first time this has happened in the history of the Quarterly National Household Survey. Furthermore, over the past year, employers in the construction sector have become increasingly pessimistic regarding future employment levels,

(3) loans - the number of loans approved for house purchases in the first three quarters of 2007 was down by one quarter year-on-year,

(4) the overall rate of credit growth in the economy has been declining since June 2006, from 30.3 per cent annual growth to 17.1 per cent in November 2007,

(5) tax receipts - there was a significant undershooting in property related taxes in 2007, which became more pronounced as the year progressed. Specifically, in terms on the 1.8 billion tax shortfall in 2007, approximately 1.4 billion of this was accounted for by underperforming property related taxes.

In light of these indicators and further anecdotal evidence on turnover in the market, it seems almost certain that housing output will decline further in 2008.

At present, there is considerable uncertainty regarding the sustainable level of housing supply in Ireland in the short to medium-term. Although not always directly comparable, there are nonetheless a range of estimates on medium-term housing demand in Ireland, a selection of which is shown in Table 2. A relatively recent analysis of the construction sector by the Central Bank (FSR (2005)) estimated that the medium-term demand was somewhere in the region of 50,000 units per annum. This figure in itself was quite a significant upward revision from previous estimates. The IMF more recently estimated that the sustainable level of house completions in Ireland was between 50,000 to 70,000 units per annum. The Department of Finance

[7]Indicators from the Department of the Environment and Local Government's Housing Statistics database (http://www.environ.ie/en/). The employment expectations indicator is from the FAS-ESRI 'Monthly Vacancies and Employment Survey' (http://www.esri.ie/).

estimate that the sustainable level of residential house building is in the region of 60,000 to 70,000 units per annum. In light of these differing estimates it is timely to re-examine the structural demand for housing. Furthermore, with economic activity set to moderate in the years ahead, it would be useful to try to measure what the likely supply response of the housing sector to a slowdown in overall economic growth will actually be.

3 Modelling Approach

In this section we employ a modelling framework to quantify some of the issues raised above. Our principal questions are; what level of Irish housing demand is actually justified based on present income levels and interest rates? And given this, what is the likely supply response to this level? To examine this question, we use a recently estimated model of the housing market by McQuinn and O'Reilly (2007a, 2007b). This model suggests that the price of housing is, in the long run, related to the amount that people are able to borrow. This amount is a combination of people's disposable income levels and current mortgage interest rates.

Given the significant increase in house prices across the OECD over the past 10 years, it is inevitable that most international studies of the housing market tend to be concerned with modelling the demand side. This is very much the case with studies of the Irish housing sector. A non-exhaustive review of the literature dealing with Irish house prices over the period of the rapid price appreciation reveals studies by Murphy (1998), Kenny (1999), Conniffe and Duffy (1999), Roche (1999, 2001 and 2003), McQuinn (2004), Duffy, Fitzgerald and Kearney (2005), Fitzpatrick and McQuinn (2007) and McQuinn and O'Reilly (2007a). Most of the empirical work estimates a fundamental house price, typically with a reduced form model. Prices are regressed on a vector of variables such as income, interest rates, demographics etc. and the fitted price from the regression is then compared with actual prices to gauge for the presence of potential over-valuation in the market.

Models of the supply side are less common. In an international context, Mayer and Somerville (1996) distingush between two different types of supply approaches. In the first, housing supply and demand functions are combined into a single reduced form equation. The response of supply to price changes is derived from the

coefficients in such models. Examples of this approach include Follain (1979), Stover (1986) and Malpezzi and Maclennan (1994). The second approach involves direct estimation of the aggregate supply function where supply is typically hypothesised as a function of house prices and cost shifters. Studies by Poterba (1984), (1991), Topel and Rosen (1988) and DiPasquale and Wheaton (1994) all estimate supply functions of the housing market directly. Using Irish data, Kenny (1999), adopting a Johansen multivariate approach, finds evidence of a long-run cointegrating relationship between the housing stock, aggregate income and interest rates. Additional work in an Irish context has focussed on the dynamics of supply response. Kenny (2003), using an aymmetric error-correction model, examines the differing costs of adjustment in the case of an expansion and a contraction of output, whereas Stevenson and Young (2007) compare the performance of three different forecasting models of Irish supply. In evaluating the results of an OLS and VAR approach, Stevenson and Young (2007) find that a simple ARIMA model provides the most accurate forecasts of supply.

Our approach is very much nested within the second type of supply studies identified. We estimate both the long and short-run housing supply function implicit within the McQuinn and O'Reilly model, and simulate both of these to gauge what the level of supply is likely to be based on the price determined by prevailing income levels and interest rates. This level is then referred to as the 'structural demand for housing' i.e. that amount which is justified by the state of relevant economic conditions within the market place.

The following variables are used in the modelling framework:

P_t = actual house prices.

B_t = amount that can be borrowed.

S_t = supply of housing.

Y_t = disposable income per household.

R_t = mortgage interest rate.

C_t = house building costs.

τ = duration of mortgage.

κ = proportion of household income going on mortgage repayments.

The data used in the study is quarterly and covers the period 1980:1 to 2007:3. Disposable income and interest rate data are obtained from a macro-economic model database created and maintained in the CBFSAI (see McGuire et al. (2002) for more details on this). The house price series used refers to new house prices and is taken from the Irish Department of the Environment's *Housing Statistics Bulletin*.[8] Data on the number of households are available from the Irish Central Statistics Office (CSO) and we interpolate this data to arrive at a series for disposable income per household at a quarterly frequency. The series for the supply of new houses along with an index of house building costs[9] are also available from the Department of the Environment's *Housing Statistics Bulletin*. Table 3 presents a summary of the relevant data over the sample period.

The McQuinn and O'Reilly (2007a) model can be summarised as follows; the demand for housing is mainly a function of the amount that prospective house purchasers can borrow from financial institutions and this, in turn, is dependent on current disposable income and the existing mortgage interest rate. The relationship between income levels, interest rates and the typical amount of a mortgage offered

[8]We use new house prices in our analysis mainly on the basis that Roche (2003) demonstrates that new Irish house prices Granger-cause second hand house prices but not the other way around.

[9]The index relates solely to labour and material costs, which should normally not exceed 65% of the total price of a house. It does not include items such as overheads, profit, interest charges, land development etc.

by a financial institution is generally based on the present value of an annuity. The annuity is the fraction of current disposable income κY_t that goes toward mortgage repayments and is discounted at the current mortgage interest rate for a horizon equal to the term of the mortgage τ. Thus, the amount that can be borrowed B_t is given by

$$B_t = \kappa Y_t \left(\frac{1 - (1 + R_t)^{-\tau}}{R_t} \right). \tag{1}$$

This mimics the reality that people seek to maximise the amount they can borrow subject to the lending criteria of mortgage lending institutions. The approach is closely related to the notion of a housing affordability index frequently used in assessments of the housing market.[10]

This expression for income and interest rates is then nested within a general model of the housing market. From this, we can then derive the corresponding supply function. Firstly, X_t is defined as the time-varying component of B_t

$$X_t = Y_t \left(\frac{1 - (1 + R_t)^{-\tau}}{R_t} \right). \tag{2}$$

Both X_t and the constant κ are then incorporated within the following inverted demand function:

$$P_t^D = \kappa X_t S^{-\mu}. \tag{3}$$

In other words, a downward sloping demand curve is assumed with the own price elasticity of demand for housing represented by the inverse of the parameter μ. This curve can be shifted due to changes in income or interest rates. The supply variable S enters negatively in this function through the own price elasticity. An inverted housing supply equation is given by the following

[10]This concept measures the ratio of an average monthly mortgage payment based on current interest rates to average family monthly income. The National Realtors Association in the United States publishes a monthly Housing Affordability Index (HAI), which is quoted frequently by the Wall Street Journal in its commentaries on the US market. See, for example, http://www.realestatejournal.com/buysell/markettrends/20051223-simon.html

$$P_t^S = \delta S^{\phi} C^{\omega}. \tag{4}$$

where δ, the intercept in the supply function, can be regarded as a standard supply side shifter, C is an index of house building costs and ω is a scaling parameter.

In the short-run, supply is assumed to be inelastic, i.e. $S = \overline{S}$. Therefore, the short-run price of housing depends on the amount that can be borrowed. To derive the long-run expression for S^{LR}, P_t^D is set equal to P_t^S and solving yields the following equilibrium condition

$$S^{LR} = \left(\frac{\kappa X_t}{C^{\omega} \delta} \right)^{\frac{1}{(\phi+\mu)}} \tag{5}$$

Taking logs of equation (5) results in, where lower case denotes a variable is in log format,

$$s^{LR} = \frac{1}{\phi+\mu} log(\kappa) - \frac{1}{\phi+\mu} log(\delta) + \frac{1}{\phi+\mu} x_t - \frac{\omega}{\phi+\mu} c_t \tag{6}$$

Grouping the constants together, we simplify this expression as

$$s_t = \gamma + \theta_1 x_t + \theta_2 c_t + \epsilon_t. \tag{7}$$

Thus, supply, in this framework, in the long run, is a function of the amount that people can borrow and a cost variable.

The approach used in the present application has the specific advantage of being integrated within a general model of the housing sector. As such, we feel, it is ideal for analysing the implications for supply of potential overvaluation in the demand-side of the market. Therefore, the model is particularly useful for scenario analysis aimed at capturing the effects of changes in income and interest rate movements on the supply response of the construction sector. Finally, the implicit model of house prices within the framework is intuitively appealing, familiar as it is to most people who have taken out a mortgage.

4 Empirical Approach and Results

We now estimate the long-run function (7). In the interest of achieving robust inferences, we adopt a number of different time-series approaches. The first such approach is the Stock and Watson (1993) dynamic OLS (DOLS) approach. DOLS explicitly allows for potential correlation between explanatory variables and the error process. This is achieved by adding both leads and lags of the differenced regressors to the specification. As a result, robust inferences can be drawn concerning the long-run results.[11] The DOLS estimates are then compared with long-run results from the fully-modified OLS (FM-OLS). The FM-OLS procedure is specifically designed to allow for statistical inference in multivariate linear regressions with integrated processes. Finally, both sets of estimates are compared with, what Hyashi (2000) labels, static OLS (SOLS) estimates. No inference concerning the estimated coefficients is possible based on static OLS (SOLS) estimation as the associated t-ratios, being dependent on nuisance parameters, are unknown. Having estimated the long-run approaches, the results are then used to underpin a short-run model of housing supply. The results of the estimation are in Table 4.

The results reveal that, as expected, housing supply is positively related to the level of affordability (x_t), while an increase in the cost of house building results in a decline in supply. T-statistics from both the DOLS and FM-OLS estimation suggest the coefficients on both the x_t and c_t variables are highly significant. Reassuringly, coefficient estimates across the three different modelling approaches are very similar. To test for the presence of a long-run relationship between the variables an Engle-Granger (Engle and Granger (1987)) cointegration test is also performed. This test is performed on the residuals from the SOLS model. As can be seen, the null of no cointegration can be rejected at the 5 per cent level.[12] Using the long-run SOLS model, we can now compare the actual level of supply with the long-run level suggested by (7). This latter level provides an estimate of the structural demand for housing given income and interest rates. This structural level along with the actual supply level is plotted in Figure 4.

[11] For more information on the use of both DOLS and FM-OLS in long-run models of the housing sector see McQuinn and Fitzpatrick (2007).

[12] Standard unit root tests performed on all of the variables suggest that they are integrated of order 1. These results are available, upon request, from the authors.

From the figure it is evident that actual supply and that level of supply justified by income and interest rates were similar up until the end of 2003. However, from 2004 onwards, a deviation has occurred between both levels. By the mid point of 2007, for example, actual housing supply on an annual basis is approximately 85,000 units, whereas the structural demand for units at that time is somewhere around 60,000 units.

4.1 Counter Factual Simulation

The significant rates of economic growth allied to reductions in personal taxation rates enjoyed during the Celtic tiger period served to increase affordability levels amongst potential house purchasers. To examine the contribution of income growth to housing demand during this period, we perform a simple counter-factual simulation. Instead of Irish disposable income levels growing at their actual rates over the period 1996:Q1 - 2007:Q3, we examine what the effect would have been on structural demand levels, if income had grown at the Euro area average over the same period. Between 1996 and 2007 Irish income levels grew at approximately 3.4 times the Euro area average. Using the long run supply function we feed the lower Euro area average income through the 'x variable' and solve for the level of supply. In Figure 5, this lower level (Cfactual) along with the structural level, which actually pertained is plotted.

For the year 2007, the simulation suggests that the relatively buoyant nature of Irish economic activity over the 1996 - 2007 period had resulted in structural demand for housing being 27,000 units greater than what would have been the case if an average income growth had been experienced.

4.2 Error Correction Model

Up to now, we have focussed on the long-run relationship between supply levels and macroeconomic conditions. However, having estimated the long-run relationship two natural questions then arise: 1) if supply levels are above the long run level suggested by market fundamentals are there equilibrating forces that will bring us back to equilibrium? 2) If this is the case, what is the speed at which actual supply levels return to their long run equilibrium? In this section we seek to answer

both these questions by estimating the short-run dynamics of housing supply. In particular, we seek to estimate the degree of error correction of the growth rate in actual housing supply to any deviation between actual supply levels and the amount suggested by current market conditions. The following short-run model is estimated

$$\begin{aligned} \triangle s_t &= \lambda\left(s_{t-1} - \gamma^{SOLS} - \theta_1^{SOLS} x_{t-1} - \theta_2^{SOLS} c_{t-1}\right) + \sum_{i=1}^{4} \psi_i \triangle s_{t-i} + \\ &\sum_{i=0}^{4} \psi_{i+5} \triangle x_{t-i} + \sum_{i=0}^{4} \psi_{i+10} \triangle c_{t-i} + u_t. \end{aligned} \tag{8}$$

where the degree of error correction within the market λ is estimated conditional on the long-run SOLS estimates presented in Table 4. The results of the short run estimation are presented in Table 5. λ, the error correction coefficient, is negative and significant suggesting that the growth rate of Irish housing supply corrects quite quickly to any deviation from the long run relationship i.e. by 19 per cent per quarter. A "general-to-specific" approach was adopted for the model and miss-specification tests, which were also performed suggest that the error process is well behaved.

4.3 Asymmetries in Supply?

An issue which increasingly arises in studies of housing supply is that of asymmetric adjustment costs. Does housing supply contract quicker in a downturn than it expands in a relatively buoyent market? This is particularly important in the present case, where the assumption of a linear response in both a contractionary and expansionary market may underestimate the degree of potential supply correction in the Irish property sector. A recent study by Kenny (2003) has examined this issue in some detail and finds that asymmetries, do, in fact, exist in the Irish housing market. The Kenny approach builds on earlier work by Topel and Rosen (1988) and Granger and Lee (1989) in specifying an asymmetric or non-linear error correction model. Using this approach, we test for the presence of such asymmetries in our modelling framework. In particular, we specify the following two zero/one dummies

$$D_1 = \begin{cases} 1 & \text{iff } (s_{t-1} - \gamma - \theta_1 x_{t-1} - \theta_2 c_{t-1}) > C^+ \\ 0 & \text{otherwise} \end{cases}$$

$$D_2 = \begin{cases} 1 & \text{iff } (s_{t-1} - \gamma - \theta_1 x_{t-1} - \theta_2 c_{t-1}) < C^- \\ 0 & \text{otherwise} \end{cases}$$

In this case, the inclusion of the dummies D_1 and D_2 enables output to adjust more quickly and/or asymmetrically for deviations below/above the threshold parameters C^-/C^+. We impose the value of 10 per cent for the parameter C.[13] Accordingly, we modify the short-run model (8) and estimate the following variant

$$\begin{aligned} \triangle s_t &= \lambda \left(s_{t-1} - \gamma^{SOLS} - \theta_1^{SOLS} x_{t-1} - \theta_2^{SOLS} c_{t-1} \right) + \sum_{i=1}^{4} \psi_i \triangle s_{t-i} + \\ &\quad \sum_{i=0}^{4} \psi_{i+5} \triangle x_{t-i} + \sum_{i=0}^{4} \psi_{i+10} \triangle c_{t-i} + \psi_{15} D_1 + \psi_{16} D_2 + u_t. \end{aligned} \tag{9}$$

The results of the estimation are summarised in Table 6. From the table, the estimates of the coefficients ψ_{15} and ψ_{16} suggest that positive (negative) deviations of actual supply from its long-run equilibrium result in faster (slower) adjustment of housing supply. However, in both cases neither of the coefficients are statistically significant. In Table 5, the result of an F-test conducted on the inclusion of the two dummies is also reported. We are unable to reject the null hypothesis i.e. that the explanatory power of (8) is not improved significantly by the inclusion of the two dummy variables. Thus, in this particular modelling framework, asymmetries of supply do not appear to be a major issue.

5 Concluding Comments

To date, the performance of the Irish housing market has been synonymous with the strong growth of the Irish economy. Affordability levels buoyed by exceptional economic growth and historically low interest rates have caused house prices in Ireland

[13] This follows Kenny (2003). Alternatively, one could seek to determine the threshold value endogenously through the use of a grid search procedure.

to escalate substantially over the last decade. Inevitably this resulted in a marked supply response by the construction sector. On a per capita basis, the supply of new housing units in Ireland has been exceptional. Consequently, the weighting or importance of the construction sector in the overall economy has increased significantly. Therefore, the likely supply response of the construction sector in a new, more sedate price and income environment is of considerable interest.

Using a recently developed model of house prices, this paper has sought to quantify the scale of such a slowdown. By estimating a housing supply function, a scenario was performed, which attempted to quantify the impact of increased affordability on housing demand. The results in this paper suggest that the remarkable rise in Irish living standards of the past 10 years played a key role in increasing the demand for housing. However, the present level of structural demand for housing units in the Irish economy is someway below the existing high levels of supply.

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Table 1: Relative Importance of the Irish Construction Sector 1995-2006

	1995	2000	2006
Construction Employment (000)	97	170	269
Share of Total Employment (%)	7.6	10.0	13.2
Housing Completions (000)	31	50	88
Share of Total Investment (%)	29.0	33.3	50.5
Housing Investment Share of GDP (%)	5.0	7.8	13.3

Note: The investment and GNP shares are derived from investment in hosuing at current prices (expenditure basis).

Table 2: Annual Estimates of Sustainable Irish Housing Demand

Institution	Units per Annum
Central Bank (2005)	50,000
Department of Finance	60,000 to 70,000
IMF	50,000 to 70,000
ESRI (2005)	72,000

Sources: Central Bank estimate from the 2005 Financial Stability Report; Department of Finance estimate from 'Budget 2008'; IMF estimate from 'Ireland: 2007 Article IV Consultation', September 2007; ESRI estimate from 'Medium-term Review 2005-2012'.

Table 3: Summary of Data: 1980:1 - 2007:3

Variable		Mean	Std Error	Maximum	Minimum
House Prices	P_t	115,232	85,689	331,947	32,512
Interest Rates	R_t	8.68	3.71	16.25	3.46
Income per Household	Y_t	2,674	1,365	5,784	831
Borrowing	B_t	120,528	92,493	309,678	20,521
Supply	S_t	38,629	22,420	107,796	14,364
House Building Costs	C_t	110.9	37.8	182.7	40.1

Note: All monetary variables are in Euros and nominal terms. The income figure is on a monthly basis, interest rates are in percentages, the supply figure is on an annualised basis and house building costs are in index form with 1990:3 = 100.

Table 4: Long-Run Supply Model Estimates

Variable	Parameter	DOLS Estimate	FM-OLS Estimate	SOLS Estimate
constant	γ	1.206	1.681	1.868
		(2.884)	(4.251)	
x	θ_1	1.561	1.487	1.454
		(5.054)	(12.037)	
c	θ_2	-2.159	-2.068	-2.024
		(-2.690)	(-7.729)	
		Cointegration Test		
Engle-Granger		-4.44		
1 %		-4.45		
5 %		-3.93		

Note: Figures in parenthesis refer to t statistics. Lower case denotes the variable in question is in logs and can consequently be interpreted as an elasticity. The cointegration is conducted on the residuals from the SOLS model.

Table 5: Supply-Side Error Correction Model

Variable	Parameter	Estimate
ECT_{t-1}	λ	-0.194
		(-4.058)
$\triangle s_{t-1}$	ψ_1	-0.289
		(-3.314)
$\triangle s_{t-2}$	ψ_2	-0.188
		(-2.059)
$\triangle s_{t-3}$	ψ_3	-0.176
		(-1.959)
$\triangle s_{t-4}$	ψ_4	0.493
		(5.938)
$\triangle c_{t-2}$	ψ_{11}	1.672
		(2.786)
$\triangle c_{t-3}$	ψ_{12}	-1.089
		(-1.850)
$\overline{R}^2$		0.60
$AR(1)$		0.242
$AR(4)$		0.086
$ARCH(1)$		0.492
$ARCH(4)$		0.697

Note: Figures in parenthesis refer to t statistics. The results for the short-run model are after a general-to-specific procedure has eliminated insignficant lagged terms. Results are presented only for the parameters of interest. P-values are reported for the AR (Godfrey (1978) and Breusch (1978)) tests and ARCH (Engle (1982)) tests.

Table 6: Asymmetric Supply-Side Error Correction Model

Variable	Parameter	Estimate
ECT_{t-1}	λ	-0.197
		(-2.153)
$\triangle s_{t-1}$	ψ_1	-0.270
		(-3.007)
$\triangle s_{t-2}$	ψ_2	-0.167
		(-1.771)
$\triangle s_{t-3}$	ψ_3	-0.150
		(-1.613)
$\triangle s_{t-4}$	ψ_4	0.505
		(5.990)
$\triangle c_{t-2}$	ψ_{11}	1.922
		(2.940)
$\triangle c_{t-3}$	ψ_{12}	-0.918
		(-1.473)
D_1	ψ_{15}	-0.019
		(-0.616)
D_2	ψ_{16}	-0.017
		(-0.475)
$\overline{R}^2$		0.59
P-Value of D_1 *and* D_2		
0.593		

Note: Figures in parenthesis refer to t statistics. The results for the short-run model are after a general-to-specific procedure has eliminated insignficant lagged terms. Results are presented only for the parameters of interest.

Figure 1: House Prices, Income and Interest Rates

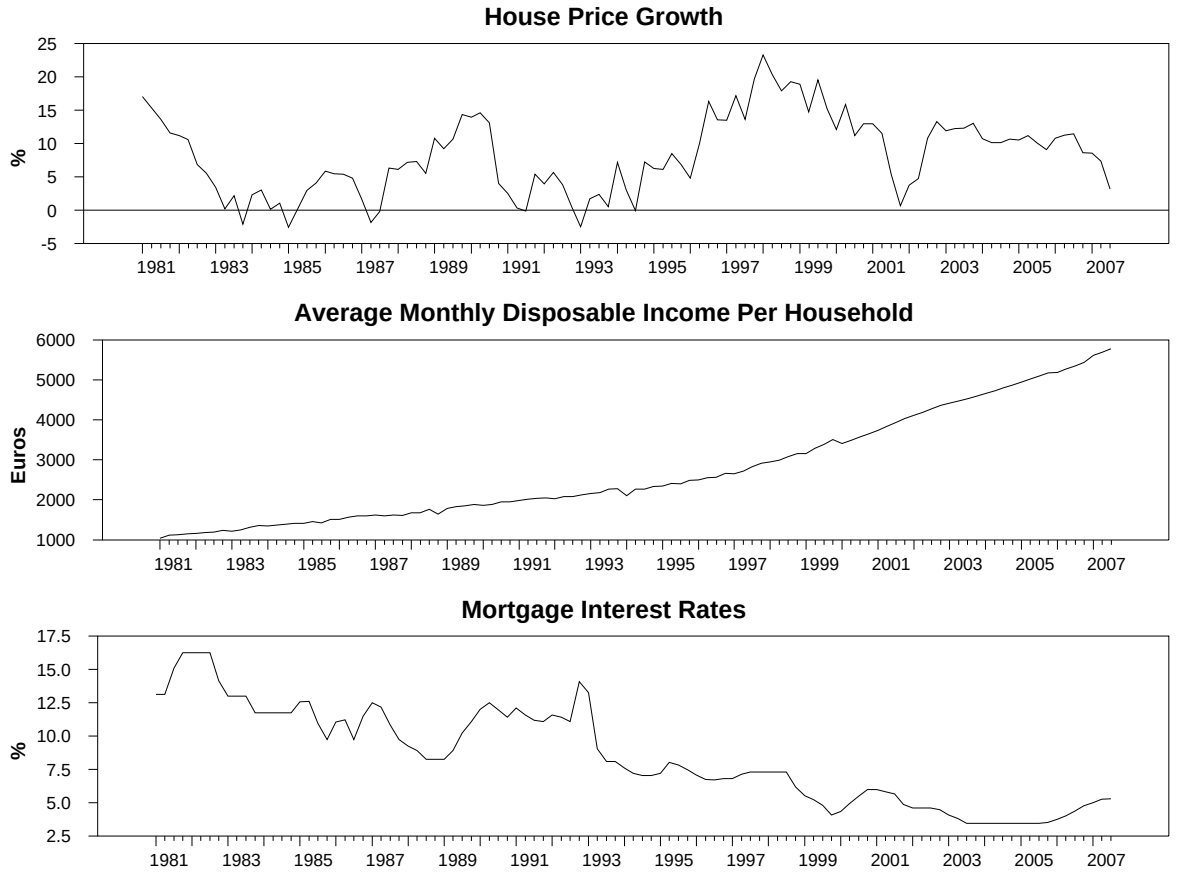

Figure 2: Housing Supply

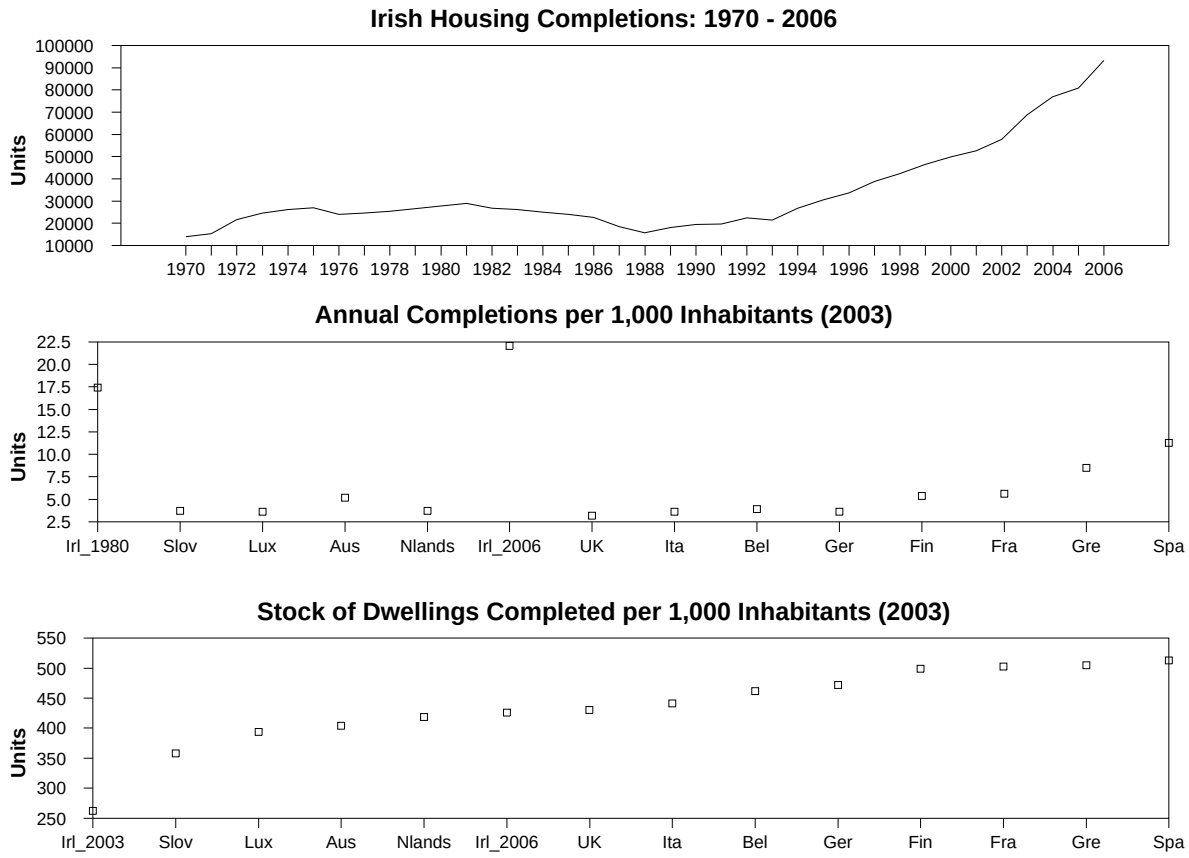

Figure 3: Share of Employment in Construction Sector (2003)

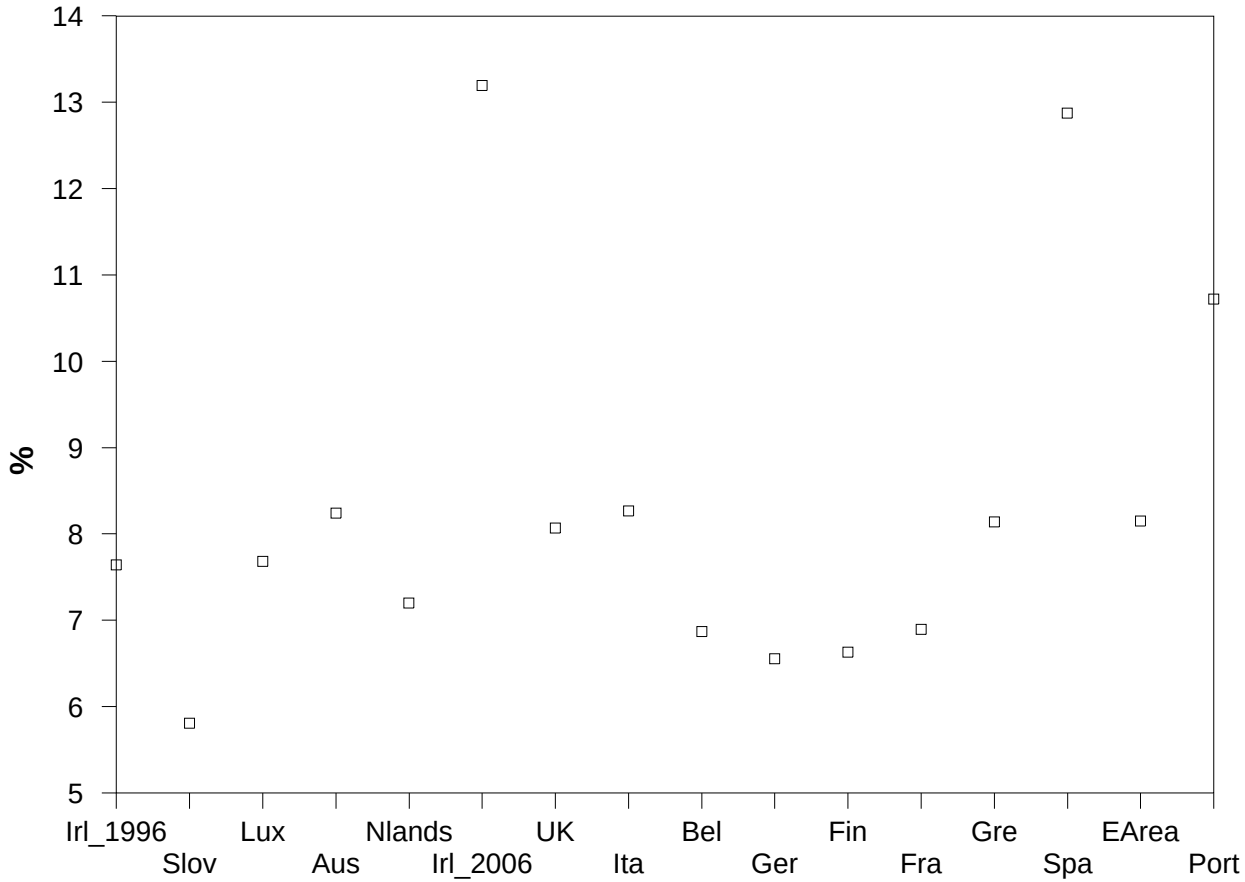

Figure 4: Actual Supply and Structural Demand

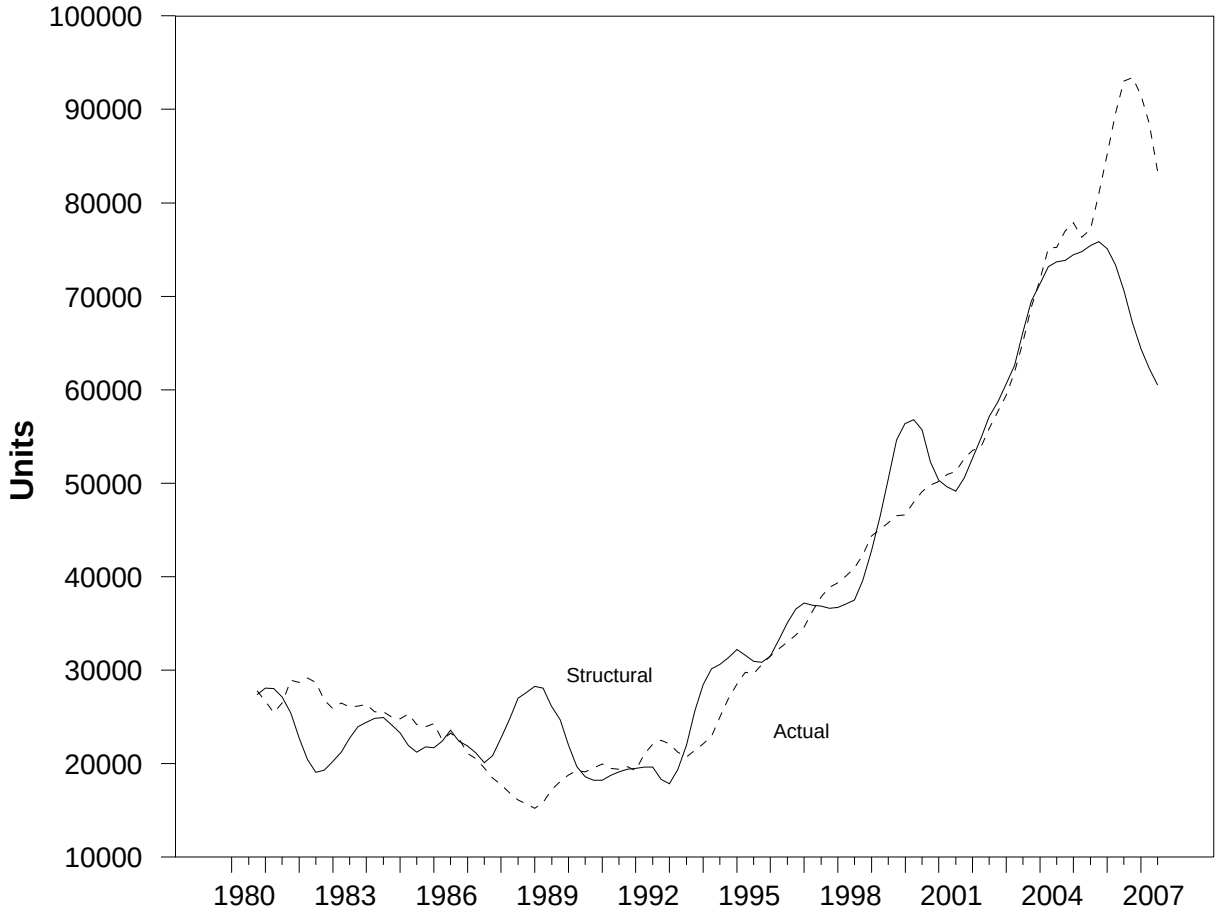

Figure 5: Structural Demand and Counterfactual Simulation