Central Bank &
Financial Services
Authority of Ireland

5/RT/04 October 2004

Research Technical Paper

House Prices and Mortgage Credit: Empirical Evidence for Ireland

Trevor Fitzpatrick **Kieran McQuinn** *

Economic Analysis and Research Department
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 are not necessarily held either by the CBFSAI or the ESCB. E-mail: trevor.fitzpatrick@ecb.int & kmcquinn@centralbank.ie. The authors would like to thank all those who participated in a seminar in the CBFSAI, in particular Gerard O'Reilly, Derry O'Brien, John Frain, Karl Whelan, Tom O'Connell, Maurice McGuire, Frank Browne, Rob Hamilton and Michael Casey. They would also like to thank Stefan Gerlach for comments on an earlier draft. Any errors are the sole responsibility of the authors.

Abstract

In Ireland, real property prices have increased at an average of 12 per cent per annum between 1996 and 2002 with residential mortgage credit also increasing substantially. The Irish economy provides an interesting case study of a rapidly growing economy with very low nominal interest rates experiencing a housing boom. In this paper, we empirically examine the relationship between domestic bank credit and Irish house prices. Using a number of econometric approaches, we find evidence of a long-run mutually reinforcing relationship. We use the long-run results to underpin a short-run system of the housing and credit sector and show that the short run response of house prices and credit to a one off increase in household disposable income is felt for almost three years after the initial change.

1 Introduction

A stylised fact from cross-country research in this area suggests that credit cycles tend to roughly coincide with (and may even lead) upturns (downturns) in economic activity (BIS (2001)). Favourable economic conditions are usually conducive to increased consumption and investment and, thus, may result in an increase in the demand for credit. Therefore, monetary policy analysis pays attention to developments in broader credit aggregates as well as money.

Another important reason for looking at the issue of credit growth is its potential relationship with asset prices in general and, in an Irish context, with house prices. This issue is of considerable significance in the Irish economy where property prices have risen by 12 per cent in real terms per annum between 1996 and 2002. This increase in house prices has gone hand-in-hand with a substantial increase in the level of private sector credit within the Irish economy. Inevitably, given the strong correlation noted internationally between house prices and credit growth (see Gerlach and Peng (2003) for example) some commentators, both domestic and international, have attributed the strong performance of the Irish property market to 'excessive' lending by Irish credit institutions.[1] The potentially self-reinforcing nature of credit and house prices also raises certain concerns from a financial stability perspective. It is a further stylised fact from cross-country studies that sustained credit growth tends to chronologically lead episodes of financial instability. On a more optimistic note, some countries that experienced sustained credit growth did not experience any episodes of financial instability.

Generally, higher house prices may lead to higher and longer repayment burdens. This could lead to a higher probability of default among borrowers if interest rates suddenly returned to long run averages or labour market prospects for borrowers deteriorated unexpectedly. While this is unlikely if the fundamentals of the economy remain sound, it is important to explore this issue in more detail. We explore the issue econometrically by adding a credit equation to an existing model of the Irish housing sector (McQuinn (2004)).

As mentioned earlier, the Irish economy provides an interesting case study of

[1]For example see *The Sunday Business Post* 18/06/2000, *The Irish Examiner* 31/05/2003 and an IMF article 6/08/03 available at http://www.imf.org/external/np/sec/pn/2003/pn0393.htm.

a rapidly growing economy experiencing very low nominal interest rates, and more or less simultaneous credit and housing sector boom. Given these factors, our work differs from most of the previous research into credit in three respects. Firstly, we try to empirically model the determinants of house prices and residential mortgage credit rather than just use a reduced form model. Secondly, we use a variety of estimation methods to check the robustness of our results rather than relying on one method, given that the various ways of estimating short and long run relationships have both advantages and disadvantages. Finally, we use residential property prices and residential mortgage credit unlike previous studies, which are based on broader private sector credit aggregates (that include commercial and consumer credit) and average indices of commercial and residential property prices.

The paper is organised as follows: section two briefly reviews relevant literature; section three describes the data, section four outlines the econometric methodology and discusses the results, while section five offers some concluding comments.

2 Literature

There is a significant and growing theoretical literature on the implications of asymmetric information problems for credit growth and how this may lead to effects on the real economy. For example, the credit cycle model as set out in a seminal paper by Kiyotaki and Moore (1997) shows why this may be the case. The contribution of this type of work is to show the process through which changes in credit growth may impact on the real economy and why this may lead to significant shocks to the real economy, without referring too much to the traditional interest rate channel of monetary policy transmission.

Additional empirical work by Calza, Gartner and Sousa (2001), Hoffman (2001), and Davis and Zhu (2004) seeks to explain the growth in different types of private sector credit aggregates for differing reasons such as the information content of these aggregates for monetary policy purposes and the links between commercial property price cycles and the macroeconomy.

There are, therefore, theoretical and empirical reasons for why credit may be important for the macroeconomy and the housing market in particular. To organise the discussion we review these reasons under three headings of credit demand, credit supply, and house price factors whilst recognising that, in reality, all three may be intertwined.

2.1 Credit Demand Factors

Some empirical evidence tends to suggest that the demand for credit is positively correlated with favourable economic conditions. This appears to be intuitive. For example Fase (1995) modelled both the quantity (loan demand) and the price (interest rate) for Dutch corporate loans as a simultaneous equation system. In this model, increased economic activity increases the demand for loans. Other arguments suggest a negative relationship between credit demand and economic activity. One argument suggests that, if households perceive that an expansion is temporary, households and firms may increase savings, rather than borrow more, in order to smooth consumption. A related argument is that during upturns, firms may fund additional investment from internal finance and reduce bank financed borrowing (Kashyap, Stein and Wilcox (1993)). The empirical evidence on this, however, tends to be mixed.

It might be expected that the price of credit, i.e., the interest rate, would have a negative relationship with the demand for credit. Empirically, this tends to be the case. However, there appears to be less agreement concerning the type of rates to be included in the empirical specifications. On the one hand, Calza, Gartner and Sousa (2001) include a term structure relationship (both short and long rates) in their specification, while Davis and Zhu (2004) and Hoffman (2001), use a real short-term rate as the appropriate interest rate. The relative importance of fixed and variable rate lending will influence the type of rate that is most suitable and whether the inclusion of a term structure relationship is warranted by the data. Given that the majority of Irish mortgage lending is at a variable rate, this is what we use (see section 3). It is reasonable to expect that the factors that might explain the demand for credit may be contemporaneously correlated with the state of the macro economy. As mentioned earlier this is one of the reasons why central banks pay attention to credit aggregates as part of their monetary policy analysis. Calza, Gartner and Sousa (2001) show that, for the euro area, real long run loan demand by the private sector is influenced positively by real GDP and negatively by a term structure of interest rates relationship.

2.2 Credit Supply

One frequently mentioned factor that falls under the credit supply rubric is the trend towards financial deregulation and improved financial engineering/information technology - both of which may have impacted on the supply or growth of credit in an Irish case. At present, financial systems in developed countries are relatively unrepressed following the trend towards deregulation of the 1980's and towards market based regulation. Improvements in the hard and soft technologies behind financial innovation have also, perhaps, latently led to these deregulatory impulses. Moreover, improved competition, possibly due to the factors mentioned above, may have also impacted positively on the supply of credit. To the extent that consumers of credit were previously liquidity constrained, and if financial liberalisation has lead to the decline in the proportion of the population that is now liquidity constrained, then these factors may have led to an increase in the amount of credit outstanding.

As the factors mentioned above take place incrementally over number of years, if not decades, it is very difficult to pick up the macroeconomic impact of these factors empirically. It is, perhaps, no surprise that the limited number of empirical studies on financial innovation tend to be case-studies and micro-oriented (Frame and White (2002) for example). However, two studies with a macroeconomic focus that try to gauge the impact of the effect of financial liberalisation on consumption are Fernandez-Corugedo and Price (2002) and Bacchetta and Gerlach (1997). The former, focussing on the UK, model financial liberalisation and the components of liberalisation policies (both are endogenous) and use the residual from the equation as a financial liberalisation measure. They find that when this financial liberalisation (FLIB) measure is used in estimating consumption expenditures, the results are not robust and do not appear to offer any better explanation of the data than traditional consumption equations. Bacchetta and Gerlach (1997) examine whether if some countries, being liquidity-constrained, experience aggregate consumption being 'excessively sensitive' to credit conditions as well as to income. Using data for the U.S., Canada, the U.K., Japan and France, they find a substantial impact of credit aggregates on consumption.

The role credit plays in the monetary transmission mechanism has been intensively researched, both for the euro area and the US. Recent insights suggest that the information asymmetries present in credit markets make the existence of financial accelerators possible. The intuition is that, owing to these information asymmetries, firm's borrowing is constrained and they can only borrow by putting up collateral, which in turn depends on their net worth (see Bernanke and Gertler, (1995) and Kiyotaki and Moore (1997)). If the value of net worth is procyclical, then the value of collateral changes over the cycle. Consequently, borrowing capacity may then increase in upturns and decrease in downturns leading to, in turn, changes in net worth. Thus, these wealth effects relating to firms may result in a propagation mechanism that may lead to abrupt changes in economic activity.

Given that residential mortgages are collateralised by the re-sale values of housing, the financial accelerator framework could potentially be applied to the housing market. In order to fully understand the structural relationships between the macroeconomy and the housing market a structural model is needed. Using a general equilibrium framework, Aoki, Proudman and Vlieghe (2002), model the interactions between house prices, consumption, and a monetary policy. The model is calibrated using UK data. One of their findings is that endogenous changes in net worth or collateral amplify shocks to the macro economy and that positive shocks to the macro economy causes a rise in housing demand, increasing house prices, and increasing borrowers net worth, decreasing the external finance premium and spilling over into consumption demand.

2.3 Property Prices

Arising from the above discussion, it is clear that property prices could have a role to play in explaining the long run evolution of credit aggregates, but this relationship could be potentially endogenous. It appears to be a stylised fact from the literature on financial instability and property price collapses, that commercial property booms have preceded banking crises in developed and emerging market economies (European Central Bank (2000) and Davis (1995)).

Through the specification and estimation of a reduced form model, Davis and Zhu (2004) find cross-country evidence to suggest that there are strong links between commercial property prices, credit, and the macroeconomy. They also find that increased commercial property prices causes increased credit expansion in some countries and that lending boosts commercial property prices in others, but that both are strongly influenced by GDP growth.

This contrasts somewhat with the results of a cross-country analysis by Hoffman (2001). He finds that the long run development of private sector credit cannot be explained in a majority of the sixteen countries considered without including an index average of residential and commercial property prices in the long run relationship. Furthermore, he finds that, in most countries, the credit-property price interaction is two-way, but does not present a full set of results to account for this (i.e., only the adjustment co-efficients for credit are shown in tables 2 and 3). It is also clear that credit may be driven by disposable income and that real GDP growth may be a crude measure of the income growth of borrowers.

Another area of the literature concentrates on the indicator value of credit growth for predicting episodes of financial instability. For example, one finding by Eichengreen and Arteta (2000) is that a 1 per cent increase in the cumulative mean growth rate of credit leads to an increase in the probability of a banking crisis in the following year by 0.056 per cent. Borio and Lowe (2002), building on Kaminsky and Reinhart (1999) framework, find, for a sample of relatively homogenous countries, that the cumulative deviation of private sector credit from its trend is a good ex-ante indicator of financial crises.

A relevant country-specific study is that of Gerlach and Peng (2003), which looks at the interactions between property prices and property related lending for Hong Kong. Similar to Ireland, Hong Kong experienced a large increase in property related lending and property prices for much of their sample period (1981:1 - 2001:4). They find that a relatively stable long-run relationship exists between credit, residential property prices, and real GDP and that bank lending appears to adjust to property prices, i.e., property prices are weakly exogenous. Their error correction models show that property prices determine bank lending, but that lending does not appear to influence the short run dynamics of property prices.

2.4 Summary

This brief review can be summarised with the following important points. Macroeconomic factors such as real GDP and interest rates are important in explaining credit growth. The nascent empirical evidence also suggests that, in some countries, property prices are potentially important in explaining the long run evolution of credit. However, the direction of this relationship is not as clear from the cross-country studies reviewed. Credit may influence property prices and vice versa. Increases in the price of credit (such as mortgage rates) may also be increasing the cost of credit to firms such as house builders, which may decrease the supply of houses pushing up prices.[2] This may also complicate the simple (negative) expected relationship between the price of credit estimated using reduced form models.

Finally, it is also apparent that, in most studies examining house prices and credit, there is a tendency to use models of the housing sector which are both highly parsimonious and reduced form in nature. Therefore, key issues identified within the Irish housing sector such as supply side influences and demographic variables, are typically omitted.[3]

3 Data

Most of the data used in the paper is that used in McQuinn (2004).[4] All data is quarterly and covers the sample period quarter 1 1980 to quarter 4 2002. The following list of variables are used in the analysis[5]

[2]It is assumed here that an increase in the mortgage rate has resulted from an increase in banks marginal costs of funds owing to an increase in rates by the central bank.

[3]See Kenny (1998), Roche (2003) and McQuinn (2004) for examples of the role played by supply-side variables in the Irish housing market.

[4]All data used is discussed in the appendix to the paper.

[5]We use new house prices in our analysis as Roche (2003) finds that new house prices Granger-cause second hand house prices but not the other way around.

$$\begin{aligned}
P &= \text{new house prices,} \\
R &= \text{real interest rate,} \\
S &= \text{supply of housing,} \\
I &= \text{housing investment} = \text{P}\times\text{S}, \\
H &= \text{housing stock,} \\
Y &= \text{after tax disposable income per household,} \\
D &= \text{demographic variable,} \\
B &= \text{index of builders costs,} \\
F &= \text{land costs.} \\
C &= \text{credit variable.}
\end{aligned}$$

C is calculated as the total value of loans approved by building societies, banks, other agencies and local authorities divided by the total number of loans. As such, it constitutes the average mortgage approved over time and is a narrower definition of mortgage credit than that used in comparable studies. While mortgage credit typically constitutes a substantial portion of private sector credit, it is likely to exhibit different short and long run dynamics given that it is collateralised and the original maturity is substantially longer than other consumer loans. In addition, the proportion of the stock of outstanding mortgages at fixed or variable rates is likely to influence the dynamics of the relationship between the explanatory real economy and financial variables. As mentioned earlier, in Ireland, most mortgage lending is at variable rates, therefore, we use a variable mortgage interest rate for all mortgage lenders.

Figure 1 (insert Figure 1 here) plots both C and P. From the graph, the clear increase in Irish house prices post 1996 is apparent with prices rising consistently except for a brief period in the second half of 2001.[6] The clear increase in the average

[6]This dip is usually attributed to the implementation by the Irish Government of certain aspects of the Bacon report on housing. This report highlighted measures aimed at alleviating both demand and supply side measures in the housing market. For more on this see Bacon and MacCabe (2000). The dip could also be associated with the general world-wide economic downturn at that time.

mortgage approved for the same period is also apparent. While there appeared to be some deviation between mortgage levels approved and house prices between 1998 and 2000, the gap between the two narrowed considerably throughout 2001 and 2002.[7]

Other variables included in the analysis are disposable income per household, real interest rates, a demographic variable (the number of people in the country between the ages of 24 and 36) and supply side variables such as builders' costs and land costs. While income and interest rate variables are standard variables used in both house price and credit analysis, the inclusion of a demographic variable along with supply-side cost variables reflects the findings of previous research (Roche (2003) and McQuinn (2004)) into Irish house price growth.

4 Econometric Approach

To commence our empirical examination, we test both a house price and a credit long-run relationship for co-integration.[8] The house price relationship $P = f(C, Y, H, D)$ is specified on the basis of previous research in an Irish context (see Roche (2001), Roche (2003) and McQuinn (2004) for example), while the credit relationship $C = f(P, Y, R)$ is similar to that in international studies (see Gerlach and Peng (2003) for example). In testing for co-integration we adopt the Johansen method of multivariate vector autoregressive (VAR) model (Johansen, (1988), and Johansen and Juselius, (1990)) to explicitly examine for co-integration amongst the different sets of variables. The Akaike information criterion (AIC) and LM-type tests for well-behaved residuals are used to select the optimum lag length for the VAR in levels.[9] Owing to the relatively small size of our sample, we adopt the

[7] While some observers argue that ancedotal evidence suggests that the duration of mortgages has increased in the past few years, there are no official data to support this assertion. Both the Statistics department of the Irish Central Bank and Financial Services Authority (CBFSAI) and the Irish Department of the Environment collect and publish time series on mortgage lending by resident credit institutions. Neither of these sources contain a breakdown of lending by original maturity of greater than five years.

[8] Unit root test results for the variables concerned are in Table 1 of the appendix. The variables were also checked to see if they were I(2). The results are not reported.

[9] The critical values are from Osterwald-Lenum (1991).

small sample adjustment proposed by Reimers (1992) for the trace statistic.[10] We contemplated estimating a single combined system of all seven variables together, however, the degrees of freedom limitations, in our case, associated with such an approach proved prohibitive. Tables 2 and 3 in the appendix suggest that long-run relationships exist in both the house price and credit equations.

To explore the relative significance of different variables within each long-run relationship we adopt a suite of different single-equation, time-series approaches. Firstly, we utilise the dynamic ordinary least squares (DOLS) methodology of Stock and Watson (1993). As such, the DOLS estimator falls under the single-equation Engle and Granger (1987) approach to co-integration while, crucially, allowing for endogeneity within the specified long-run relationships. We then compare our long-run results from the DOLS with those from both the Philips-Hansen (1990) fully-modified OLS (FM-OLS) and what Hyashi (2000) labels static OLS (SOLS). The FM-OLS procedure is specifically designed to allow for statistical inference in multivariate linear regressions with integrated processes. The results from these approaches are then used to specify a system of short-run equations for credit demand and the housing sector.

Of concern in the estimation of both long-run relationships for house prices and credit is the potential endogeneity between both variables. Possible endogeneity of some of the explanatory variables causes second order asymptotic bias in coefficient variables. This issue is of particular concern in the case of small samples. The Stock and Watson (1993) DOLS approach explicitly allows for potential correlation between explanatory variables and the error process. It is best explained by an example; if we take the potential long-run relationship below

$$y_t = \beta_0 + \beta_1 x_{1t} + \beta_2 x_{2t} + \epsilon_t \qquad (1)$$

where either x_{1t} or x_{2t} may be endogenous, DOLS involves adding both leads and lags of the differenced regressors to the specification to correct for correlation between the error process ϵ_t and the level regressors

[10] Note that the test statistics for the likelihood ratio test based on the maximal eigenvalue of the stochastic matrix are not reported as Johansen (1994) indicates that the statistic does not provide a coherent testing strategy.

$$y_t = \beta_0 + \beta_1 x_{1t} + \beta_2 x_{2t} + \sum_{j=-k}^{k} \theta_{1j} \bigtriangleup x_{1,t+j} + \sum_{j=-k}^{k} \theta_{2j} \bigtriangleup x_{2,t+j} + \epsilon_t \tag{2}$$

An F-test with respect to the β's has an asymptotic χ^2 distribution. The error term in (2) is liable to be serially correlated so the covariance matrix of the estimated coefficients must be adjusted accordingly. Therefore, OLS estimates of the residuals $\hat{\epsilon_t}$ are obtained as an estimator of ϵ_t and the serial correlation of ϵ_t is assumed to be approximated by the following AR(p) model

$$\epsilon_t = \psi_1 \epsilon_{t-1} + \psi_2 \epsilon_{t-2} + \ldots \psi_p \epsilon_{t-p} + \xi_t \tag{3}$$

(3) is then estimated with OLS to achieve coefficient values for ψ's. The estimated standard error of ϵ_t denoted by $\hat{\sigma}_\epsilon$ as calculated by an OLS regression of (2) is adjusted accordingly to

$$\hat{\sigma}'_\epsilon = \frac{\hat{\sigma}_\epsilon}{(1 - \hat{\psi}_1 - \hat{\psi}_2 - \hat{\psi}_3 - \ldots - \hat{\psi}_p)} \tag{4}$$

The modified covariance matrix is this $\hat{\sigma}'_\epsilon$ squared times the inverse of the second moment of the regressors of (4).

Thus, having allowed for correlation between the regressors and the error process and for serial correlation, DOLS enables us to draw inferences based on the adjusted standard errors. No such inference is possible based on, what Hyashi (2000) labels, static OLS (SOLS) estimation as the associated t-ratios, being dependent on nuisance parameters, are unknown. FM-OLS estimation is concerned with allowing for statistical inference within multivariate regressions where the regressors have $I(1)$ processes. Briefly, if in (1), we assume that both x_1 and x_2 have the following first difference stationary processes

$$\begin{aligned} \bigtriangleup x_{1t} &= \mu + \nu_{1t} \\ \bigtriangleup x_{2t} &= \tau + \nu_{2t} \end{aligned} \tag{5}$$

in which μ and τ are drift parameters and ν_{1t} and ν_{2t} are $I(0)$ or stationary variables, then the computation of the FM-OLS estimator β is carried out in a multi-stage process, where, initially, y_t is corrected for the long-run interdependence of ν_t and ϵ_t.

The long-run coefficients for both the DOLS and FM-OLS approaches and the t-stats based on the adjusted standard errors are reported in Table 1 (insert Table 1 here).[11] We also include estimates of the same long-run specification with SOLS (but without the t-stats). From Table 1, a number of results are interesting. Firstly, both the credit variable in the house price equation and the house price variable in the credit equation are significant at the 1 per cent level, having allowed for potential endogeneity (in the case of DOLS). Thus, it would appear that both variables are warranted in each other's long-run relationship. All variables are significant at the 1 per cent level with the exception of interest rates in the DOLS estimate of the credit equation, which is significant at the 10 per cent level. In the house price equation all variables are correctly signed with the housing stock variable having the expected negative coefficient. In the credit equation both increases in income and house prices result in an expected increase in the demand for credit, while interest rates have a positive but very small effect. We find an almost unitary elasticity between credit and income in the long-run irrespective of the estimator used. We also find that credit appears to exercise a greater influence on house prices with a coefficient of approximately 1.32 than house prices do on credit (i.e. a coefficient of approximately 0.5) in the long-run. Coefficient estimates tend to be consistent between the DOLS, FM-OLS and SOLS estimators. This is re-assuring.

Therefore, unlike other studies that find that the interaction runs from the property market to credit, we find a two way interaction. Credit has become more affordable due to the decline in nominal and real rates and also because of the recent significant growth in household disposable income above its long term average. Arguably, this has, in turn, encouraged credit institutions to lend more and exceed their rule of thumb multiples. This interesting result is probably due to the particular confluence of a group of idiosyncratic factors in Ireland such as the

[11] In the DOLS case, we assume that the serial correlation of ϵ_t follows an AR(2) process. As a robustness check an AR(4) process was also used. There was no substantial difference in the results. Estimation of both the DOLS and FM-OLS approaches is conducted in WinRATS 5.04 for Windows.

economic boom, consequent net inward migration and, until recently, sticky supply. In a different analysis using a dynamic factor model for 13 countries, the IMF (IMF (2004)) has also noted the importance of country specific factors in explaining house prices in Ireland relative to other industrial countries.

In the next section we use the long-run models presented in Table 1 to examine the impact of increased credit to income multiples on long-run house prices.

4.1 Long-Run Simulation

A noticeable trend in the mortgage market in recent years has been the clear increase in the ratio of average mortgage levels to disposable income. To a certain extent this increase has been motivated by the reduction in the average interest burden of debt due to the persistent fall in nominal interest rates in the latter half of the 1990's. However, the full extent of this increase is clearly evident from the plot of this ratio in Figure 2 (insert Figure 2 here). Between 1980 and 1998, the ratio was an average of 1.68, while between 1999 and 2001 the average had grown to 1.96, reaching a high of 2.06 in 2001 quarter 3.

Given the long-run models presented in Table 4, we perform a simulation where we simulate what the long-run or fundamental price of houses would have been if the ratio of credit to income was kept at its 1998 quarter 4 level of 1.83. To achieve this we scale the disposable income variable in the credit equation downwards so that it is now equivalent to 55[12] per cent of the credit level post 1998 quarter 4. The resulting effect on fundamental house prices, due to the lower simulated credit variable ($\hat{C}$), can then be observed in Figure 3 (insert Figure 3 here). From the simulation exercise between 1999:1 and 2001:4 it is evident that, had the credit to income ratio been held at 1998:4 levels, long-run house prices would have followed, an increasing, but lower path. Owing to the increasing nature of the credit to income ratio, the difference between the baseline fundamental price and the simulated level is clearly increasing through time. By 2001:4, the simulated series is almost 13 per cent below the actual fundamental price. From this simulation, it would appear that the increased amount or availability of mortgage credit vis-à-vis income levels has

[12] 0.55 being the inverse of 1.83. In essence, the parameter on Y in the long-run credit equation provides an implicit loan to income ratio. By scaling down Y post 1998 quarter 4 we are imposing a certain ratio on the system.

additionally stimulated the level of fundamental house prices during the 1999-2001 time period.[13]

4.2 An Augmented Model of the Irish Housing Sector

Based on the long-run estimates of the credit and house price relationships, we revisit the McQuinn (2004) model of the Irish housing sector and augment the system to include a credit function. Briefly, the McQuinn (2004) model can be summarised as the following

$$P_t = f\left(Y_t, D_t, C_t, H_t\right) \tag{6}$$

$$S_t = f\left(P_t, P_t/B_t, F_t\right) \tag{7}$$

$$H_t = (1-\sigma)H_{t-1} + I_t \tag{8}$$

an inverted demand or price equation, a supply function and a perpetual inventory equation to 'roll-out' the housing stock based on net investment.[14] A credit relationship is now added to the model. We use the residuals from the long-run relationships from the SOLS estimation in the previous section as the error correction terms for the house price and credit equations while we use the long-run results from McQuinn (2004) to generate the ECM term for the supply equation[15]

[13] It could be argued that the ability to impose credit restrictions such as loan to income ratios is somewhat limited, in an Irish context, due to the increasingly open nature of the Irish residential mortgage market. That being said, foreign controlled institutions still only account for a relatively small proportion of the amount of domestic loans issued.

[14] Where σ is the rate of depreciation.

[15] The long-run equation for the supply-side is: $S = -7.275 - 0.0593 \times F - 0.267 \times B/P + 1.173 \times P$.

$$\begin{aligned}
\triangle P_t &= \alpha_0 + \alpha_1 \left(ECM_{t-1}^P \right) + \sum_{i=1}^{4} \alpha_{i+1} \triangle P_{t-i} + \sum_{i=0}^{4} \alpha_{i+6} \triangle R_{t-i} + \sum_{i=0}^{4} \alpha_{i+11} \triangle H_{t-i} \\
&\quad + \sum_{i=0}^{4} \alpha_{i+16} \triangle D_{t-i} + \sum_{i=0}^{4} \alpha_{i+21} \triangle Y_{t-i} + \sum_{i=0}^{4} \alpha_{i+26} \triangle C_{t-i} + u_t^P
\end{aligned} \tag{9}$$

$$\begin{aligned}
\triangle S_t &= \omega_0 + \omega_1 \left(ECT_{t-1}^S \right) + \sum_{i=1}^{4} \omega_{i+1} \triangle S_{t-i} + \sum_{i=0}^{4} \omega_{i+6} \triangle P_{t-i} + \\
&\quad \sum_{i=0}^{4} \omega_{i+11} \triangle \left(B_{t-i} / P_{t-i} \right) + \sum_{i=0}^{4} \omega_{i+16} \triangle F_{t-i} + u_t^S
\end{aligned} \tag{10}$$

$$\begin{aligned}
\triangle C_t &= \gamma_0 + \gamma_1 \left(ECM_{t-1}^C \right) + \sum_{i=1}^{4} \gamma_{i+1} \triangle C_{t-i} + \sum_{i=0}^{4} \gamma_{i+6} \triangle R_{t-i} + \sum_{i=0}^{4} \gamma_{i+11} \triangle P_{t-i} \\
&\quad + \sum_{i=0}^{4} \gamma_{i+16} \triangle Y_{t-i} + u_t^C
\end{aligned} \tag{11}$$

We estimate each of the equations separately in order to determine the appropriate lag length for each variable. A top-down approach is applied where a variable is dropped if its coefficient is not significant. Once we decide on the lag length, (9), (10) and (11) are estimated jointly as a system for improved efficiency.[16] The results are presented in Table 2 (insert Table 2 here).

In all three equations the error correction term is negatively signed and significant. The degree of correction is most pronounced for the house price and supply equation with coefficients of 0.243 and 0.21 on both ECM terms respectively, while the credit equation has an ECM of 0.05. 21 of the 25 coefficients estimated within the system are significant at the 5 per cent level, while the other four are significant at the 10 per cent level. The credit equation would appear to have the most explanatory power with an R^2 of 88 per cent with the house price and supply equations having R^2s of 56 per cent and 50 per cent respectively. The R^2 for the credit is quite large, particularly when compared to results from similar type studies. For example, Gerlach and Peng (2003) report an R^2 of 57 per cent for a short-run credit equation in an analysis of the Hong Kong property market. Diagnostic tests suggest

[16] Using nonlinear three-stage least squares (N3SLS).

that the error processes in all three equations are 'well-behaved' - i.e. neither serial correlation nor heteroscedasticity would appear to be an issue.

In examining both the credit and house price equation, it is apparent that the contemporaneous value of the change in credit is quite significant (at the 1 per cent level) in the house price equation, while the contemporaneous value of the house price variable does not enter into the credit equation. To investigate the possibility of potential simultaneity bias due to the presence of $\triangle C_t$ in the house price equation we follow Davidson and MacKinnon (1989) and Davidson and MacKinnon (1993) and perform a Hausman test in a single-equation context.[17] We perform a a two-stage least square estimation where, in the first stage, we regress $\triangle C_t$ on a set of purely predetermined variables. We then input the residuals from this estimation into the house price equation $\triangle P_t$. If the OLS estimates of $\triangle P_t$ are consistent, the coefficient on the residuals from the first stage should not be significantly different from zero. We obtain a p-value of 0.362.

Overall, therefore, we believe the system given by (9) - (11) offers quite a good characterisation of the short-run dynamics of the Irish property sector given the apparent simultaneous long-run relationship between Irish house prices and credit levels.

In order to explore the dynamics of the system in more detail we perform a simulation, whereby we shock the values of an exogenous variable - disposable income per household, and trace the effects on house price growth and credit growth. The variable is shocked (positively) by 1 per cent in 1995 quarter 1.[18] The evolution of the new paths for both variables is plotted in Figure 4 (insert Figure 4 here). The change in credit registers the largest initial increase with a contemporaneous increase of almost 1 per cent, house price growth, on the other hand, experiences an initial increase of almost 0.6 per cent. While the one-off increase gradually dissipates, it is evident that, almost three years later, there is still some residual effect left in the system.[19]

[17]Note Gerlach and Peng (2003) perform a similar type test in their house price/credit system.

[18]We also shocked real interest rates but the results were very marginal and so we do not report them.

[19]We also assessed the stability of the system by performing recursive estimation on the short-run equations for credit and house prices. In general, we found that the error correction terms in both equations were relatively stable throughout the 1990s.

5 Conclusions

Much popular comment has been devoted to the issue of whether there is a house prices and mortgage credit spiral in Ireland. As mortgage lending accounts for a sizeable proportion of most of the domestic credit institutions, an investigation into this issue is important from a financial stability perspective. This paper has estimated a cointegrating econometric model of mortgage credit, house prices, disposable income, real interest rates and demographic variables in order to coherently investigate the influence of credit and house prices on each other.

Adopting different time-series econometric approaches, we find fairly conclusive evidence of a mutually reinforcing long-run relationship between house prices and credit levels. This contrasts with other recent work which generally finds that this long run relationship operates in one direction or another.[20] We argue that this result is probably due to the coming together of a group of country-specific factors in Ireland such as the recent economic boom, net migration and rigidities in housing supply. Based on the long-run estimation, we augment an existing model of the Irish property sector to examine the dynamics within the system. In the short-run we find that the contemporaneous value of credit growth has a positive and significant effect on house price growth. However, house prices do not appear to influence credit contemporaneously in the short-run.

It would appear that the provision of greater levels of credit (in terms of loan to income ratios) over the past few years has also contributed to the rate of growth. Thus, while fundamental factors continue to experience favourable conditons (low interest rates, steady income growth rates etc.), the housing market is likely to continue to experience some price growth. However, in an equilibrium context, if the market is subject to, say, a significant income and/or interest rate shock and credit institutions, consequently, revise their credit to income ratios downwards this will result in any initial price declines being exacerbated.

On the basis of this work, what are the implications for the stability of the domestic financial sector? A greater level of credit availability means that, *ceterus paribus*, mortgage-holders have outstanding loans that are greater than what they otherwise would have been if availability had been curtailed. At the moment, banks

[20] The exception is Hoffman (2001).

have a ‘haircut’ on the market value of the housing assets through the loan to value ratio and the fact that this lending is collateralised. However, if an increasing proportion of their loans are to borrowers with a higher loan to value ratios, then they will have less of a comfort margin in the event of a decline in residential property prices.

References

Aoki, K., Proudman, J. and Vlieghe, G.: 2002, House prices, consumption, and monetary policy: A financial accelerator approach, *Working Paper 169*, Bank of England.

Bacchetta, P. and Gerlach, S.: 1997, Consumption and credit constraints: International evidence, *Journal of Monetary Economics* **40**, 207–38.

Bacon, P. and MacCabe, F.: 2000, The housing market in Ireland: An economic evaluation of trends and prospects, Government of Ireland Publication.

Bernanke, B. and Gertler, M.: 1995, Inside the blackbox: The credit channel of monetary policy transmission, *Working Paper 5146*, NBER.

BIS: 2001, 71st annual report, Bank for International Settlements (BIS) Press and Communications.

Borio, C. and Lowe, P.: 2002, Asset prices, financial and monetary stability: exploring the nexus, *Working Paper 114*, Bank of International Settlements, BIS, Basle.

Breusch, T.: 1978, Testing for autocorrelation in dynamic linear models, *Australian Economics Papers* **17**, 334–355.

Calza, A., Gartner, C. and Sousa, J.: 2001, Modelling the demand for loans to the private sector in the euro area, *Working Paper 55*, ECB.

Davidson, R. and MacKinnon, J.: 1989, Testing for consistency using artificial regressions, *Econometric Theory* **5**, 363–84.

Davidson, R. and MacKinnon, J.: 1993, *Estimation and inference in econometrics*, Oxford University Press, Oxford.

Davis, E.: 1995, *Debt, Financial Fragility and Systemic Risk*, Oxford University Press, Oxford, UK.

Davis, E. and Zhu, H.: 2004, Bank lending and commercial property cycles: Some cross-country evidence, *Technical Report 150*, BIS.

Eichengreen, B. and Arteta, C.: 2000, Banking crises in emerging markets: Presumptions and evidence, *Working Paper 115*, Center for International and Development Economics.

Engle, R.: 1982, Autoregessive conditional heteroscedasticity with estimates of the variance of United Kingdom inflation, *Econometrica* **50**, 987–1008.

Engle, R. and Granger, C.: 1987, Cointegration and error-correction: Representation, estimation and testing, *Econometrica* **55**, 251–76.

European Central Bank: 2000, Asset prices and banking stability, ECB.

Fase, M.: 1995, The demand for commercial bank loans and the lending rate, *European Economic Review* **39**, 99–115.

Fernandez-Corugedo, E. and Price, S.: 2002, Financial liberalisation and consumers expenditure: FLIB re-examined, *Working Paper 157*, Bank of England.

Frame, W. and White, L.: 2002, Empirical studies of financial innovation: Lots of talk little action, *Working Paper 212*, Federal Reserve Bank of Atlanta.

Gerlach, S. and Peng, W.: 2003, Bank lending and property prices in Hong Kong, *Hong Kong Institute for Monetary Research Working Paper 12*.

Godfrey, L.: 1978, Testing against general autoregressive and moving average error models when the regressors include lagged dependent variables, *Econometrica* **46**, 1293–1302.

Hoffman, B.: 2001, The determinants of private sector credit in industrialised countries: Do property prices matter?, *Working Paper 108*, BIS.

Hyashi, F.: 2000, *Econometrics*, Princeton University Press, Princeton, New Jersey.

IMF: 2004, The global house price boom, *World Economic Outlook*, International Monetary Fund, Washington, pp. 71 –136.

Johansen, S.: 1988, Statistical analysis of cointegration vectors, *Journal of Economic Dynamics and Control* **12**, 231–254.

Johansen, S.: 1994, The role of the constant and linear terms in cointegrating analysis of non-stationary variables, *Econometric Reviews* **13**, 205–29.

Johansen, S. and Juselius, K.: 1990, The full inofrmation maximum likelihood procedure for inference on cointegration with applications to the demand for money, *Oxford Bulletin of Economics and Statistics* **52**, 169–210.

Kaminsky, G. and Reinhart, C.: 1999, The twin crises: The causes of banking and balance of payments problems, *American Economic Review* **89**, 473–500.

Kashyap, A., Stein, J. and Wilcox, D.: 1993, Monetary policy and credit conditions: Evidence from the composition of external finance, *American Economic Review* **83**, 8–98.

Kenny, G.: 1998, The housing market and the macroeconomy: Evidence from Ireland, *Working paper 1/RT/98*, Central Bank of Ireland, Dublin, Ireland.

Kiyotaki, N. and Moore, J.: 1997, Credit cycles, *Journal of Political Economy* **105**, 211–48.

McGuire, M., O'Donnell, N. and Ryan, M.: 2002, Interpolation of quarterly data for ECB/NCB multicountry modelling exercise - Data update to 1999q4, *Research paper*, Central Bank of Ireland, Dame Street, Dublin 2.

McQuinn, K.: 2003, Alternative models of the Irish supply side, *Technical paper 2/RT/03*, Central Bank of Ireland, Dublin, Ireland.

McQuinn, K.: 2004, A model of the Irish housing sector, *Technical paper 1/RT/04*, Central Bank of Ireland, Dublin, Ireland.

Osterwald-Lenum, M.: 1991, A note on the quantiles of the asymptotic distribution of the maximum likelihood cointegration rank test statistic, *Oxford Bulletin of Economics and Statistics* **50**, 461–72.

Phillips, P. and Hansen, B.: 1990, Statistical inference in instrumental variables regression with I(1) processes, *Review of Economic Studies* **57**, 99–125.

Reimers, H.: 1992, Comparisons of tests for multivariate cointegration, *Statistical Papers* **33**, 335–59.

Roche, M.: 2001, The rise in Dublin city house prices: Fad or just fundamentals, *Economic Modelling* **18**, 281–95.

Roche, M.: 2003, Will there be a crash in Irish house prices?, *ESRI Quarterly Economic Commentary* **Autumn**, 57–72.

Stock, J. and Watson, M.: 1993, A simple estimator of cointegrating vectors in higher order integrated systems, *Econometrica* **61**, 783–820.

Table 1: Long-Run Single Equations for House Prices and Credit (1981-1999)

D. Variable:	House Prices (P)			Credit (C)		
	DOLS	SOLS	FM-OLS	DOLS	SOLS	FM-OLS
Y	0.914	0.745	0.838	1.04	1.02	1.05
	(5.911)		(4.618)	(2.924)		(6.323)
R				0.007	0.009	0.009
				(1.771)		(4.025)
C	1.327	1.328	1.315			
	(13.954)		(11.416)			
P				0.514	0.519	0.497
				(2.656)		(4.710)
H	-1.245	-1.219	-1.209			
	(-14.071)		(-12.332)			
D	2.011	2.188	2.229			
	(6.628)		(6.125)			

Note: N=73. T-statistics are in parenthesis. All variables except the real mortgage rate are in logs.

Table 2: Estimates of Short-Run House Prices, Credit and Housing Supply (1981-1999)

Dependent Variable:	House Prices (P)	Housing Supply (S)	Credit (C)
ECM_{t-1}	-0.249	-0.208	-0.055
	(-3.545)	(-2.721)	(-1.969)
$\triangle Y_t$			0.097
			(2.906)
$\triangle R_t$			0.001
			(2.613)
$\triangle R_{t-1}$			-0.001
			(-2.127)
$\triangle R_{t-2}$			-0.001
			(-2.127)
$\triangle S_{t-1}$		-0.183	
		(-1.937)	
$\triangle S_{t-4}$		0.461	
		(5.439)	
$\triangle C_t$	0.607		
	(3.271)		
$\triangle C_{t-1}$			0.399
			(5.221)
$\triangle C_{t-2}$			0.321
			(3.988)
$\triangle P_{t-1}$		1.479	1.441
		(1.631)	(1.619)
$\triangle P_{t-2}$		2.297	2.273
		(2.634)	(3.192)
$\triangle P_{t-3}$	0.207		
	(1.971)		
$\triangle P_{t-4}$			0.118
			(2.644)
$\triangle \frac{B_{t-1}}{P_{t-1}}$		1.454	
		(2.419)	

continued on next page

Table 2: Short-Run Models (continued)

	House Prices (P)	Housing Supply (S)	Credit (C)
$\triangle \frac{B_{t-2}}{P_{t-2}}$		1.162	
		(2.047)	
$\triangle H_{t-3}$	1.703		
	(2.992)		
$\triangle D_t$	-2.537		
	(-2.196)		
R^2	0.56	0.50	0.88
AR(1)	0.588	0.202	0.275
AR(4)	0.521	0.246	0.473
ARCH(1)	0.514	0.839	0.673
ARCH(4)	0.876	0.054	0.284

Note: N=73. ECM = error correction term, T-statistics are in parenthesis. P-values are reported for AR and ARCH tests. AR tests are the Godfrey (1978) and Breusch (1978) tests for serial correlation and the ARCH tests are the Engle (1982) tests for heteroscedastic errors. All variables except the real mortgage rate are in logs.

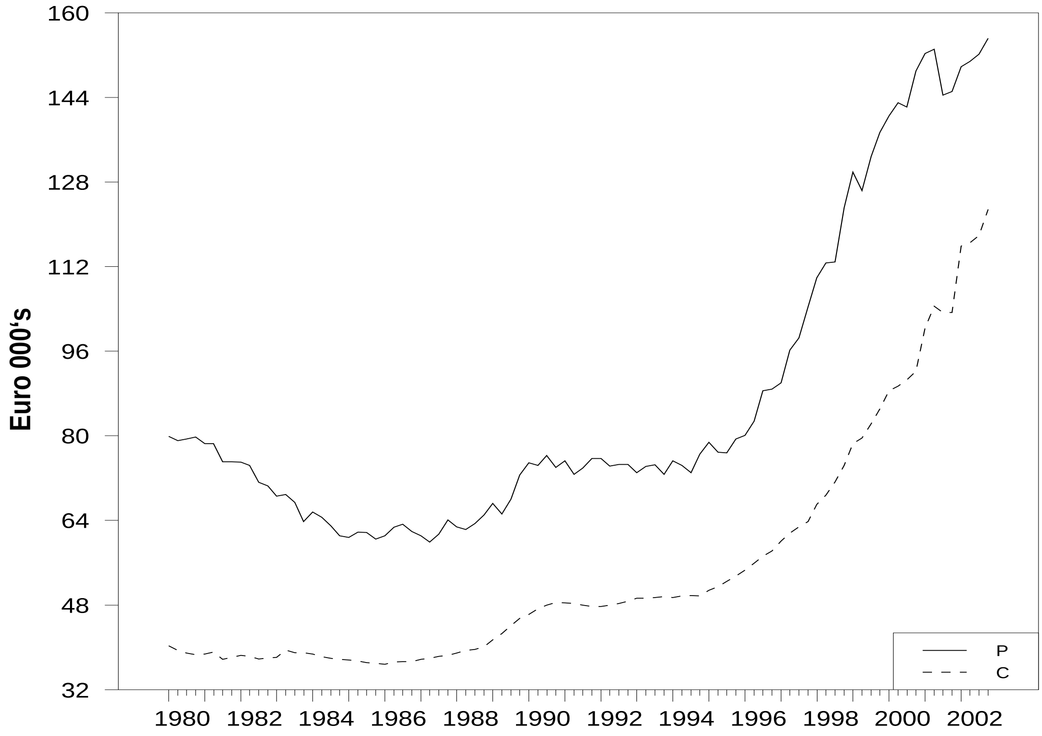

Figure 1: Plot of New House Prices (P) and Average Mortgages Approved (C): 1980-2002

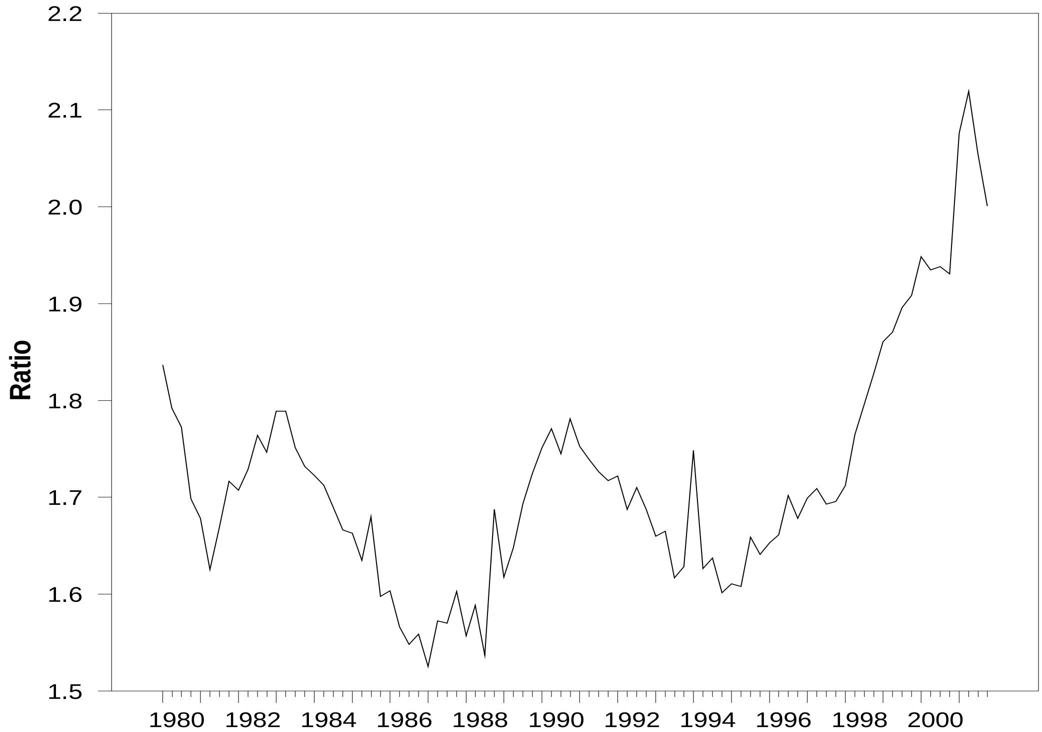

Figure 2: Ratio of Average Mortgages Approved to Disposable Income: 1980-2001

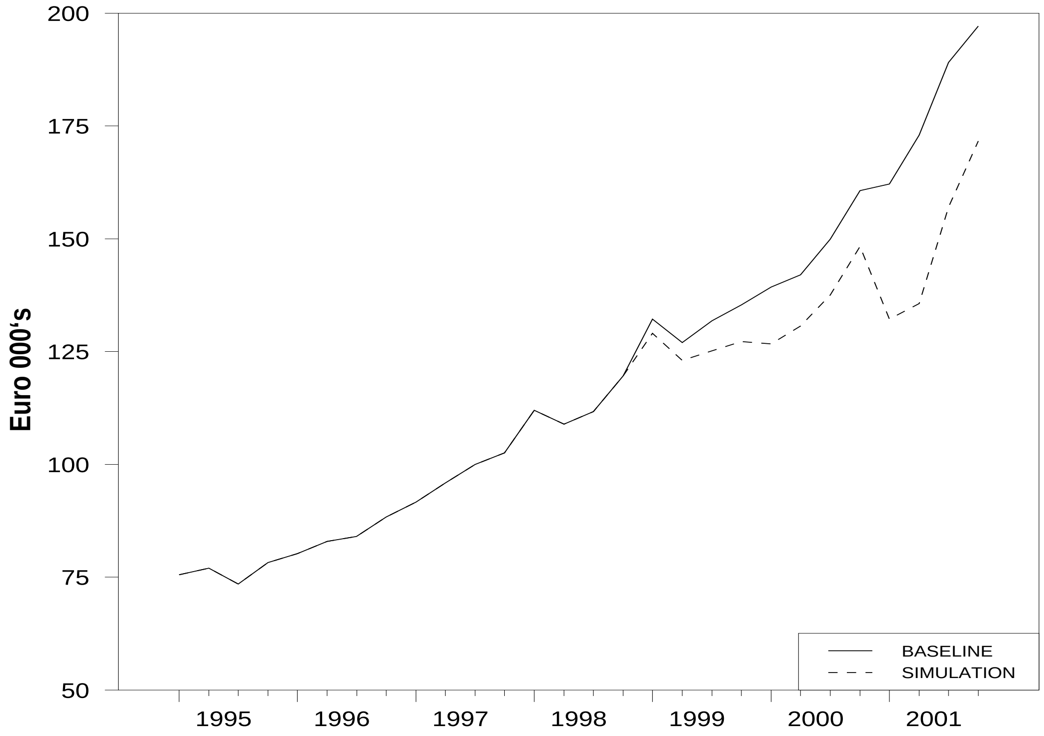

Figure 3: Baseline and Simulation Long-Run House Prices: 1995:1-2001:4

Figure 4: Short-Run Response of Change in House Prices (DP) and Credit (DC) to a 1 per cent increase in Disposable Income: 1995:1-1998:4

Appendix A

The house prices used in this study are the new house price series from various 'Housing Statistics Bulletins' of the Department of the Environment and Local Government. Housing supply is the total number of housing completions (both private and local authority). This is also available in the Housing Statistics Bulletin as is the index of builders costs and the credit series used. The demographic variable is available on an annual basis from the Central Statistics Office (CSO) and is interpolated for quarterly observations. The income variable and the deflator used are from the Irish macro-model database created and maintained in the Economic, Analysis Research and Publications Department (EARP) in the Central Bank. Details of the database and interpolation procedures used to compile it are available in McGuire, O'Donnell and Ryan (2002). The housing stock is derived both from the model database and a series of non-residential housing stock used in McQuinn (2003). Data on the level of land costs is kindly provided by Dr. Maurice Roche (NUI Maynooth).

Table 1: Augmented Dickey Fuller (ADF)
Test Statistics Results for Housing Model Variables

		Critical Value	
Variable	Test Statistic	1%	5%
P	1.571	-3.51	-3.17
S	0.276	-3.51	-3.17
YC	2.112	-3.51	-3.17
D	-0.789	-3.51	-3.17
B/P	-3.245	-3.51	-3.17
F	0.256	-3.51	-3.17
H	0.469	-3.51	-3.17
C	-1.16	-3.51	-3.17
R	-1.602	-3.51	-3.17

Note: N = 73. These variables were also tested for I(2) processes.

Table 2: Cointegration Likelihood Ratio Tests for Long-Run Credit Relationship (Unrestricted Intercept: No Trend)

Null	Alternative	λ_{trace}	λ_{trace} adjusted	Critical Value 95%	90%
a) VAR(C, P, Y, R)p=3					
r = 0	r > = 1	64.28	50.84	53.48	49.95
r<= 1	r > = 2	35.61	27.80	34.87	31.93
r<= 2	r > = 3	17.71	14.07	20.18	17.88
r<= 3	r > = 4	6.86	5.45	9.16	7.53

Table 3: Cointegration Likelihood Ratio Tests for Long-Run House Price Relationship (Unrestricted Intercept: No Trend)

Null	Alternative	λ_{trace}	λ_{trace} adjusted	Critical Value 95%	90%
a) VAR(P, C, Y, H, D)p=5					
r = 0	r > = 1	103.97	67.72	70.49	66.32
r<= 1	r > = 2	64.73	42.80	48.88	45.70
r<= 2	r > = 3	32.50	21.04	31.54	27.78
r<= 3	r > = 4	7.14	4.86	17.86	15.75
r<= 3	r > = 4	7.14	0.41	17.86	15.75