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A Model of Mortgage Credit

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Abstract

The emergence and proliferation of the international financial crisis since mid-2007 has, amongst other issues, refocussed attention on the interrelationship between mortgage credit availability and house prices. A growing body of opinion is now of the view that the increase in credit availability internationally was a primary contributor to the rate of house price increases witnessed in many OECD countries over the past 10 years. House price growth in the UK over this period was to the fore of that experienced across countries, while the Anglo-Saxon system of banking was characterised by a significant degree of financial innovation yielding greater credit provision. In this paper we propose a simple intuitive model, which seeks to quantify the impact of credit market disequilibrium on UK house prices over the period 1992 - 2008.

Non Technical Summary

In light of the recent financial turmoil, the interrelationship between house prices and mortgage lending is likely to be the subject of considerable attention. The proliferation of house price booms across OECD countries over the past 10 years coincided with a period of considerable innovation within the international financial sector. A growing body of opinion is of the view that the increases in house prices in some of these countries was partly fuelled by the significant increases in credit provision enabled by innovation in these countries' financial sectors. One such property market commonly identified is that of the United Kingdom.

In this paper, we propose an intuitive model for residential mortgage credit and apply it to the UK property market. We initially focus on the demand-side of the mortgage lending market, and estimate what the equilibrium or long-run level of mortgage lending should be, based on disposable incomes, interest rates and typical bank lending practices. This amount, is referred to as the *fundamental* mortgage level, which we then compare with the *actual* lending level. We refer to periods where actual lending is above fundamental lending as periods of excess credit, and where it is below, as periods of credit rationing. We then extend the analysis through modelling house prices as a function of mortgage levels so as to quantify the impact on prices in periods where we perceive there to have been either excess credit or credit rationing.

Our results suggest that there was a significant divergence between actual and fundamental mortgage lending in the UK in the post-2003 period. Specifically, we estimate that between 2004 and 2008, excessive lending in itself, resulted in house prices increasing by 11 per cent per annum on average, while towards the end of the period, this figure amounted to nearly 20 per cent. This latter period corresponds to the provisions of additional funding on the part of UK credit institutions through access to interbank markets, which we define as the "funding gap", that is, the difference between domestic credit institutions deposits and loans to the private sector. We expand our modelling framework to incorporate this additional source of funding. This variable appears to have been an increasingly important determinant of average mortgage levels in the UK in the period post-2000. We highlight its importance through a series of counterfactual exercises.

1. Introduction

In light of the financial turmoil observed since the summer of 2007, the inter-relationship between house prices and mortgage credit is certain to come under renewed scrutiny. The proliferation of house price booms across OECD countries over the past 10 years coincided with a period of considerable innovation within the international financial sector. This, along with the advent of monetary union in the Euro area and the globalisation of capital markets, greatly facillitated the ability of financial institutions to advance higher levels of credit to individual households. The period 1995 - 2007 saw considerable economic growth and a relatively benign monetary environment for most OECD countries. These factors, commonly referred to as "fundamentals" within the housing literature, would have resulted in considerable house price increases *ceterus paribus*. However, there is a growing body of opinion, which suggests that innovations within certain credit markets, in themselves, additionally fuelled the surge in prices. In particular, the capacity of credit institutions within the United Kingdom over the past 10 years to access funds abroad provided an entirely new source of lending capacity.

In this paper we propose a model for residential credit and apply the model to the United Kingdom property and credit market. Such an application would appear to be particularly appropriate. House price increases in the UK were amongst the largest for OECD countries over the past 15 years, while the Anglo-Saxon model of banking has been central to the greater liberalisation witnessed in financial markets over the same period. This liberalisation, which involved the removal of regulations and controls from financial markets, granted banks greater freedom in determining the level and allocation of credit than previously had been the case.

Initially, we focus on the demand-side of the market. In reality, the amount lent by a mortgage institution to an individual is critically dependent on current disposable income and interest rates. Based on this observation, we estimate how much a financial institution would lend an individual given plausible assumptions regarding the fraction of income that goes to mortgage repayments and the duration of the mortgage using a standard annuity formula. We refer to this mortgage level as *an amount that can be borrowed*. Over time, however, it is likely that significant differences have occurred between this mortgage level and the actual mortgage amount issued by financial instititutions. Episodes where the actual mortgage level is above the long-run level are regarded by some as instances of excess credit and periods, where it is below the long-run level as periods of credit rationing. We then express house prices as a function of average mortgage levels. As a result, we are able to quantify the impact on the housing market of episodes of perceived excess credit or credit rationing.

Our initial results suggest differences between both mortgage levels over the sample in ques-

tion, however, a significant difference does appear to have emerged between the equilibrium mortgage level and the actual level post 2003. This period corresponds to the provision of additional funding on the part of UK credit institutions through access to interbank markets. Therefore, in the second part of the paper we focus on this supply-side development and expand our empirical framework to incorporate the emergence of the *funding gap* - the difference between domestic credit institutions deposits and loans to the private sector. This gap provides an indication of the ability of UK institutions to access funding on interbank markets.

The results of the augmented model confirms the importance of both supply and demand-side factors in determining the individual level of credit extended by UK banks. The provision of additional lending capacity through access to foreign markets would appear to have been an increasingly important determinant of average mortgage levels for the period post 2000. Of interest, in light of the present upheavel in financial markets, will be the sustainability of this source of finance for credit institutions going forward. A counter factual scenario examines the implications for UK house prices if this source of lending had not been available over the last 8 years.

The literature on the role of credit and house prices is still at a somewhat nascent stage. And relatively few, if any, studies have examined the role played by greater financial innovation in the provision of credit and its related effect on house prices. Therefore, we feel our approach is of some interest. The model ultimately captures the fact that most house purchases are mortgage-financed and the amount that mortgage providers are willing to lend is ultimately a function of income and interest rates. Earlier work using a similiar type approach (McQuinn and O'Reilly (2007), (2008)) has examined the relationship between the average amount borrowable and house prices directly. However, by modelling the average mortgage level as well as house prices, the model can capture the impact on house prices, of changes in the credit channel itself.

The rest of the paper is structured as follows; in the next section we review the existing literature on some existing models of credit. We then present our model followed by some empirical results. A subsequent section traces the change in credit availability through various different market innovations and policy changes. In light of this dicussion, we expand the initial model to take account of these supply-side changes. A final section offers some concluding comments.

2. Literature Review of Credit Models

The role of credit has only recently been explored in the context of house prices. Typically, much of the emphasis was placed on the role of demand variables such as GDP, income and interest rates in determining prices. The combination of very significant house price increases, unprecedented levels of household indebtedness and financial market innovation and deregulation

in a number of developed economies, however, has led to significant interest in the interactions between house prices and credit and potential spillover effects into the real economy. Furthermore, recent developments particularly in the US, where the housing market has impacted severely on overall economic activity has refocused attention on the role played by credit and bank lending in affecting both housing markets and consumer spending.

The specific effects of financial market innovations on housing markets are difficult to disentangle. In general, it has been argued that financial market liberalisation has resulted in procyclical lending. The key role played by credit in financial markets and the broader macro economy was stressed by Borio and Lowe (2004). They highlighted the need to identify financial imbalances, defined as periods of rapid accumulation of credit growth alongside excessive asset prices increases, because of their potentially detrimental effects on output and inflation.

An earlier study by Borio et al. (1994), examined fluctuations in asset prices and the role of credit for a large sample of developed economies in the 1970s and the 1980s. They found that the inclusion of a credit variable (specifically, private sector credit) was statistically significant in determining a composite asset price index. In the UK, the effects of the deregulatory process and competition, following the abolition of credit restrictions, were found to be very strong. The UK was one of the economies where the explanatory power of the credit variable was highest. The authors reported that the relaxation of credit constraints, following financial liberalisation played a major role in facilitating large movements in their aggregate asset price indicator.

The interrelationship between house prices and specifically mortgage lending was examined by de Greef and de Haas (2002). A strong interdependence between mortgage lending and house prices was found for the Netherlands - an economy which had been characterised by rapid increases in house prices and significant growth in the mortgage market throughout the 1990s. Dutch house prices appeared to be influenced by changes in bank lending criteria as well as standard demand and demographic variables. Similarly, Collyns and Senhadji (2002) examined lending booms and real estate bubbles across a range of Asian economies using a VAR panel data approach. They found a dual causality between credit and prices and that bank lending had significantly contributed to property price inflation. At the same time, they found that the relationship between prices and credit was asymmetric in the sense that the elasticity of the price response to credit shocks was much higher during periods of rising prices.

The relationship between prices and credit can change depending on the time-period under review. For example, a paper by Hofmann (2003) covering a sample of 20 countries (including the UK), examined the dynamic interactions between bank lending and property prices. He found multi-directional causality between lending and property prices in the short-run. In the long run, however, causality went one way from property prices to bank lending. The short run finding

is important in terms of the potential for mutually re-enforcing effects between house prices and bank credit during 'boom bust cycles' in the housing market. A further study by Hofmann (2004) examined the specific role of property prices in determining bank credit across a range of 16 developed economies using a cointegrating VAR approach between 1980 and 1998. He found that property prices were an important determinant of long-run movements in credit and in bank lending. A related study by Gerlach and Peng (2005), looking at the relationship between property prices and lending in Hong Kong, found that while there was a strong contemporaneous correlation between residential property prices and bank lending, but that the direction of causality went from prices to credit. In an Irish application Fitzpatrick and McQuinn (2007) found a mutually reinforcing relationship between house prices and mortgage credit.

A recent paper by Goodhart and Hofmann (2008) examined the links between money, house prices, credit and economic activity in a range of industrialised countries (including the UK) spanning the period 1970 to 2006 using a fixed effects VAR estimation approach. They found significant evidence of a multidirectional link between house prices and credit and the real economy. Furthermore, this relationship, specifically the link between house prices and monetary variables had become stronger in recent years, which the authors believe reflects the impact of financial market liberalisation in the 1970s and early 1980s.

In examining the UK housing market and credit in particular, Fernandez-Corugedo and Muellbauer (2006) developed a single credit conditions index indicator (CCI) through modelling 10 key indicators of credit over the period 1976-2001. The CCI effectively measures the availability of credit. They found that a number of factors can lead to a sustainable rise in the CCI, such as increased competition and structural changes within the UK credit market.

In summary, the empirical evidence although sometimes mixed, suggests a potentially important role for credit in explaining the evolution of house prices. However, it would appear that there is little consensus as to the magnitude of the credit channel in determining UK house prices.

3. A Model of House Prices and Mortgage Credit

While house price increases in the United Kingdom have moderated considerably since the midpoint of 2007, they had increased by just under 10 per cent annually over the period 1995 and 2007. The five year period between 2002 and 2007 saw very high levels of activity within the market, with a sustained increase in the number of house completions and starts from 2002 onwards. The marked supply response is reflected in investment figures, with the volume of investment in housing increasing by 3.5 per cent per annum over the past decade in the UK, which was well ahead of the EU average of 2.5 per cent and also well ahead of trends in similar developed

countries.[1] Figure 1 summarises movements in key UK housing sector variables.

Macroeconomic conditions in the United Kingdom during this period were especially conducive to house price growth. On average between 1995 and 2007, UK GDP increased by almost 3 per cent per annum, the unemployment rate averaged less than 6 per cent and disposable incomes increased on an annual basis by 2.6 per cent over the same period. Simultaneously, the UK monetary regime has, like that in the Euro area and in the United States, been particularly benign with interest rates on a long downward path since the early 1990's.

In most studies of house prices, income levels and interest rates are considered to be two of the fundamental variables determining demand. Consequently, they are central to our modelling framework. We use the following set of variables

$$
\begin{aligned}
P_t &= \text{actual house prices.} \\
M_t &= \text{average mortgage level.} \\
B_t &= \text{amount that can be borrowed.} \\
S_t &= \text{supply of housing.} \\
Y_t &= \text{disposable income per household.} \\
R_t &= \text{mortgage interest rate.} \\
F_t &= \text{UK funding gap.} \\
\kappa &= \text{percentage of income on mortgage payments.} \\
\tau &= \text{duration of mortgage.}
\end{aligned}
$$

The basic structure of the model is the following

House prices (P_t) $\leftarrow$ Average mortgage level (M_t) $\leftarrow$ Amount that can be borrowed (B_t)

Mortgage levels are assumed to be a function of the amount that can be borrowed from a financial institution based on current disposable income and the existing mortgage interest rate. The amount lent out by financial institutions to their customers is based on the present value of an annuity, where the annuity is some fraction of current disposable income discounted at the current

[1] For example, the volume of housing investment declined in Germany over the same period by 1.4 per cent per annum.

mortgage interest rate for an horizon equal to the term of the mortgage. This amount which can be borrowed is given by the following formula

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

The average mortgage level, M_t, is then a function of the amount that can be borrowed

$$M_t = f(B_t). \tag{2}$$

Clearly, an upward shift in income or downward movements in the interest rate yields an increase in the average mortgage amount available from UK credit institutions. We assume the following log-linear empirical structure for (2), where lower case denotes a variable is in logs

$$m_t = \gamma_0 + \gamma_1 b_t. \tag{3}$$

The average loan amount can then be incorporated within the following inverted demand function for housing:

$$P_t^D = \eta M_t S^{-\mu}. \tag{4}$$

The housing supply variable S enters negatively in this function through the own price elasticity of demand μ. An inverted housing supply equation is given by the following

$$P_t^S = \delta S^{\phi}. \tag{5}$$

where δ, the intercept in the supply function, can be regarded as a standard supply side shifter.

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. In order to derive the long-run equilibrium price level, we set $P_t^D = P_t^S$ and solve, yielding the following equilibrium expression for S^{LR}

$$S^{LR} = \left(\frac{\eta M_t}{\delta} \right)^{\frac{1}{(\phi+\mu)}}. \tag{6}$$

The corresponding expression for the long-run price is given as

$$P^{LR} = \eta^{\frac{\phi}{(\phi+\mu)}} \delta^{\frac{\mu}{(\phi+\mu)}} M_t^{\frac{\phi}{(\phi+\mu)}}. \tag{7}$$

Taking logs of equation (7) yields the following

$$p^{LR} = \left(\frac{\phi}{\phi+\mu}\right) log(\eta) + \left(\frac{\mu}{\phi+\mu}\right) log(\delta) + \left(\frac{\phi}{\phi+\mu}\right) m_t. \tag{8}$$

Grouping the constants together, we simplify this expression to

$$p_t = \alpha + \psi m_t. \tag{9}$$

From the long-run model, we can retrieve an estimate of $[\frac{\phi}{\mu+\phi}]$ from the coefficient ψ. House prices are a function of the average loan amount and the own price elasticities of the demand and supply. The intercept α is a composite of the supply shifter δ and the parameters ϕ, μ and η. This approach is closely related to the notion of a housing affordability index frequently used in assessments of the housing market.[2]

Our estimation strategy is to obtain long-run estimates of (3) and (9). We could substitute $\gamma_0 + \gamma_1 b_t$ in for m_t in (8) and estimate the following regression

$$p^{LR} = \left(\frac{\phi}{\phi+\mu}\right) (log(\eta) + \gamma_0) + \left(\frac{\mu}{\phi+\mu}\right) log(\delta) + \left(\frac{\phi}{\phi+\mu}\right) \gamma_1 b_t. \tag{10}$$

which traces the direct impact of the affordability indicator B_t on house prices. However, our interest lies in gauging the impact of the long-run average mortgage level on house prices. This can only be done through estimating long-run regressions for both P_t and M_t.

In the next section we outline our estimation strategies for these regressions.

3.1. Data and Model Estimates

Data on house prices P_t, average mortgage levels M_t and the income of borrowers Y_t are taken from the UK Communities and Local Government website[3] The data on prices, mortgage levels and income is quarterly and starts in 1992 quarter 2, while the supply data starts in 1990 quarter 1. UK Mortgage interest rates are monthly and are taken from the Bank of England, while the CPI index used to deflate the series is taken from the National Statistics. Our estimate of the UK funding gap, which is used in subsequent sections, is the difference between monetary financial

[2]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

[3]http://www.communities.gov.uk/housing/housingresearch/housingstatistics/. In particular, data on prices, mortgage levels and income are taken from Table 514, where house prices are the average dwelling price, the average mortgage amount is the average advance and income is the average recorded income of borrowers.

institutions sterling deposits and loans to the private sector.[4] Table 1 presents summary statistics on the data used.

Table 2 reports the results for a series of unit root tests for the log of house prices p_t, the log of the average mortgage amount m_t and the log of the amount that can be borrowed b_t. In particular, we report results from two tests of the null hypothesis that each series contains a unit root. The first is the standard Augmented Dickey-Fuller t-test; the second is the DF^{GLS} test of Elliot, Rothenberg and Stock (1996) which has superior power to the ADF test. For each test, the lag length for the test regressions was chosen using Ng and Perron's Modifed AIC procedure. In both cases, the tests fail to reject the unit root hypothesis at the 5 per cent level of significance for all three variables.

In our model, we assume two long-run relationships given by (3) and (9). To investigate this empirically, we use a variety of long-run estimators. Along with the OLS estimator, we also use the dynamic ordinary least squares (DOLS) methodology of Stock and Watson (1993). The DOLS estimator falls under the single-equation Engle Granger (Engle and Granger (1987)) approach to cointegration while allowing for endogeneity within the specified long-run relationships. Single equation approaches have been used in other models of the housing market, such as Muellbauer and Murphy (1997), Fitzpatrick and McQuinn (2007), McQuinn and O'Reilly (2007) and (2008).

The Stock and Watson (1993) DOLS approach explicitly allows for potential correlation between explanatory variables and the error process. It involves adding both leads and lags of the differenced regressors to the hypothesised long-run specification to correct for correlation between the error process.[5] In our application, the error term is assumed to follow an AR(2) process, while the number of leads and lags is set equal to 2.[6] In addition to DOLS estimates, we also estimate the long-run cointegrating relationship using Philips and Hansen's (1990) fully modified ordinary least squares estimator (FM-OLS). This method corrects OLS for possible serial correlation and endogenity in the regressors that results from the existence of a cointegrationg relationship.

The final estimator used is the ARDL approach suggested by Pesaran, Shin and Smith (2001). This approach has a number of attractions as it not only allows for the long-run relationship to be estimated, it also allows for a test of cointegration along with an examination of the short-run dynamics between the different variables. As a test of cointegration, the ARDL bounds testing ap-

[4]Both series are downloaded from the Bank of England web-site. The respective series are LPQVWRB and LPQVWWV.

[5]The error term in is liable to be serially correlated so the covariance matrix of the estimated coefficients must be adjusted accordingly. This involves modifying the covariance matrix of the original regressors by specifying and estimating an AR(p) model for the error term. See Fitzpatrick and McQuinn (2007) for more on this.

[6]We experimented with alternative values of k and length of the AR() process, however, our results were not significantly changed. Parameter estimates for the leads and lags in the DOLS estimation are available, upon request, from the authors.

proach has a number of attractive features. Firstly, it is relatively straightforward when compared to other procedures such as the Johansen and Juselius approach, it allows the cointegration relationship to be estimated by OLS once the lag order of the model is identified. The procedure does not require the pre-testing of the relevant variables for unit roots unlike other approaches. The approach is applicable irrespective of whether the regressors in the model are purely I(0), purely I(1) or mutually cointegrated. Finally, the test is relatively more efficient than other estimators in small or finite sample data sizes as is the case with the sample used here. The ARDL approach is employed by specifying the following two error correction representations

$$\triangle p_t = \lambda^P \left(p_{t-1} - \alpha - \psi m_{t-1}\right) + \sum_{i=1}^{4} \beta_i \triangle p_{t-i} + \sum_{j=0}^{4} \beta_{4+j} \triangle m_{t-j} + u_t^P. \tag{11}$$

$$\triangle m_t = \lambda^M \left(m_{t-1} - \gamma_0 - \gamma_1 b_{t-1}\right) + \sum_{i=1}^{4} \omega_i \triangle m_{t-i} + \sum_{i=0}^{4} \omega_{4+j} \triangle b_{t-j} + u_t^M. \tag{12}$$

In order to arrive at the most parsimonious representation for (11) and (12), we use a general-to-specific approach based on the AIC criteria. Once the lag length is decided, the two equations are estimated jointly as a system for improved efficiency using nonlinear three-stage least squares (N3SLS). The final estimated models are presented in Table 3. In both cases, there is clear evidence of error correction. In the case of mortgage credit, any deviation between the actual and the equilibrium level is corrected by just over 7 per cent per quarter, while in the case of house prices the rate of correction is higher at nearly 12 per cent.

To apply the bounds cointegration test, we calculate an F-test for the joint restriction that the coefficients on p_{t-1} and m_{t-1} are zero in the case of (11) and on the test that the coefficients on m_{t-1} and b_{t-1} are zero in the case of (12). The cointegration results are also presented in Table 3. The F-test results for the cointegration test suggests that the two assumed long-run relationships are indeed cointegrated.

The long-run estimates are all presented in Table 4. From the Table, it is evident that all estimators report similiar results for the long-run relationship in question. The results for the coefficient sizes are much the same, while the t-stats for the OLS, DOLS, FM-OLS and ARDL estimates are all highly significant. In the next section, we examine the implications of these long-run models for the UK mortgage market.

3.2. Long-Run Simulations

In Figure 2 the actual mortgage level M_t is compared with the solution (fitted value) from the long-run (OLS) model. This provides a comparison between the actual mortgage level issued in the market and the long-run level based on the combination of income levels and interest rates. We refer to the long-run level as the "fundamental" level. From the graph, it is evident that while a long-run relationship does exist between the two series, there are periods where deviations occur. For example, from the late 1990's until the end of 2003, the *fundamental* mortgage level is somewhat in excess of the actual amount suggesting a degree of credit rationing. Credit institutions were lending out less than what would have been expected, given the state of macroeconomic fundamentals within the UK economy. However, in recent times, the opposite is the case - actual loan amounts issued were considerably in excess of what prevalent income and interest rates suggest they should be.

Two graphs are presented in Figure 3. In the first graph we plot actual house prices with the solution from the long-run house price equation (9). From the graph it is evident that both prices are very similiar with little or no difference apparent. This suggests that actual mortgage levels are a very good determinant of house prices. In the second graph of Figure 3, we trace through to UK house prices the implication of the difference between actual mortgage levels and the fundamental levels (i.e. we solve equation (9) with the fitted value from (3)). In Figure 4 we plot the difference between both prices. From the graphs, it is evident that house prices in the UK, from 2004 onwards, were significantly in excess of what the level would have been if mortgage lending had been at equilibrium levels (the "Scenario" level). From this, one can conlude that the relaxation of credit conditions in the UK financial system contributed significantly to house price growth over the period.

On average, from 2004 - 2008, the difference between the actual house price and the price associated with equilibrium credit conditions was 11 per cent, while towards the end of 2007 and start of 2008, the difference was almost 20 per cent. A tightening of monetary policy by the Bank of England throughout the early part of 2006 did cause actual prices and the scenario level to be briefly re-aligned, however, by 2008 the difference between both prices was at its largest for the entire sample.

3.3. Financial Market Innovation

The growth in the UK housing market is reflected in the effective trebling in the value of loans for house purchases and home improvements between 2000 and 2007 from just under £120 billion to

£360 billion in 2007 - see Table 5 for details. In net terms,[7] the increase was ever sharper with net advances increasing from just over £15 billion in 1995 to approximately £110 billion in 2007. The number of mortgages outstanding increased by well over a million between 1995 and 2007, with the average mortgage advance trebling over the same period from just over £48,000 in 1995 to £150,500 by 2007 indicative of very high levels of activity and lending within the housing market. Consequently, the UK is characterised by particularly high levels of residential indebtedness. In 2006 for example, the ratio of residential debt to GDP stood at 86 per cent, compared with the EU average of 50 per cent.

The UK mortgage market has evolved considerably over the past 30 years and is recognised as one of one of the most flexible and developed financial markets globally, according to the IMF. Furthermore, the UK is one of a group of countries that experienced robust innovation within the mortgage sector. In particular, the abolition of credit controls in the mortgage market, the globalisation of capital markets and lower world interest rates facilitated more competition within the sector. In terms of the latter, increasing competition resulted in a sharp increase in the supply of credit to UK households and facilitated double-digit rates of growth during the peak years of the housing market. In particular, UK lenders greatly increased their lending and exposure to the household sector from 2000 onwards.

The sharp increase in lending to the household sector was facilitated by innovation within the financial markets. Credit institutions' total domestic deposit liabilities traditionally has been the main funding source for mortgage supply. An additional source of funding, which has become available following financial market liberalisation is cross-border funding in the form of inter-bank borrowing and debt issuance. This can be approximated by the funding gap defined as the difference between the total loan portfolio of domestic UK banks and their total domestic deposit supply. In 2001 UK customer lending was comparable to customer deposits, however, by 2008, the surplus of lending over deposits was £700 billion.[8] The emergence of this alternative source of funding for UK banks, and its subsequent growth rate, has clearly had significant implications for the UK mortgage and housing markets.

3.4. Incorporating Supply-Side Changes

To empirically address this supply-side development in the credit market, we re-estimate (3) incorporating the UK funding gap in the specification i.e.

[7] Net of repayments of principal and for local authorities housing association grants.

[8] Much of this funding was sourced from the United States, which acting as an intermediary, attracted capital inflows from the rest of the world and exporting these funds to other countries.

$$m_t = \gamma_0 + \gamma_1 b_t + \gamma_2 f_t. \tag{13}$$

A variety of estimators (OLS, DOLS and FM-OLS) are again used to estimate this specification. The results, which are presented in Table 6, demonstrate the importance of the funding gap. While the coefficient on the affordability variable is still somewhat larger than that of the funding gap - estimates for the DOLS and FM-OLS approaches would suggest that the affordability variable has twice the impact, all three estimators report significant t-statistics for both variables.

Using the results from Table 6, in Figure 5, we graph the actual loan amount with the original fundamental level (fundamental 1) and the new fundamental level (fundamental 2) from equation (13). Clearly, the inclusion of the funding gap variable results in the new fitted value being more closely aligned with actual mortgage levels. In a similiar fashion to the second graph in Figure 3, in Figure 6, we also trace through the impact of this new fundamental mortgage level to house prices. We call this new price level scenario 2 and compare it with the original scenario level (scenario 1). It is evident from the graph that the inclusion of the funding gap variable, again, reduces, significantly, the degree of variation between the scenario and actual price levels post 2003.

Given the increase in the scale of the funding gap variable, we conduct a counter-factual simulation to illustrate the growing relevance of this source of funds. We hold the funding gap at its 2000 level and trace through the impact to the housing market. The results are presented in Figure 7. The graph illustrates, again, the significant impact that credit market innovation post 2000 has had on both the UK mortage and house price markets.

4. Conclusions

One of the major sources of the recent financial instability has been the decline in house prices across a number of countries. The resultant fall in the book value of property-related loans observed by many commercial banks was a contributory factor to the serious erosion of confidence within the international financial system prompting the complete stalling of the inter-bank credit markets through 2008. A growing consensus has now emerged, which believes that the overvaluation in international property markets was itself a function of over exhuberent lending, particularly, to prospective mortgage holders in the residential property sector.

This paper proposes a simple intuitive-based model of the mortgage market. Initially, the average level of mortgage credit is modelled solely as a function of affordability, where affordability is a combination of people's disposable income and mortgage interest rates. House prices are then

estimated as a function of the average mortgage amount. The model is applied to the property market in the United Kingdom. Over the last twenty years, the UK has experienced two profound episodes of house price overvaluation. Simultaneously, during this period, the UK banking sector has been to the forefront of innovations in the provision of credit. Consequently, the UK mortgage market is a logical case study for this empirical model.

Our application reveals that, firstly, for a given income level and interest rate, the loans extended by UK credit institutions varied, at times, quite significantly over the period 1992 to 2008. This was especially the case since 2004, where increases in the loan amount issued relative to its equilibrium level, in itself caused UK house prices to increase, on average, by 11 per cent per annum. Given the changes in the UK mortgage markets over this period, the model was then augmented to take account of the additional supply of funds within the mortgage industry. Through a counterfactual simulation, the resulting model is used to quantify the contribution to mortgage levels from this source. This result is of some interest given the future uncertainty concerning this source of institutional funding.

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Table 1: Descriptive Statistics of Model Variables

Variable	Pneumonic	Mean	Std. Deviation	Unit
House Prices	P	88,939	41,349	£ sterling
Income	Y	27,448	8,179	£ sterling
Deflator	D	0.93	0.07	2005 = 1.00
Mortage Interest Rate	R	7.36	1.45	%
Affordability Level	B	96,739	34,573	£ sterling
Average Mortgage Amount	M	71,796	31,902	£ sterling
UK funding gap	F	139,954	72,778	£ millions sterling

Note: N = 65, 1992:2 - 2008:3.

Table 2: Unit Root Tests

	Unit Root Tests				
	p_t	m_t	b_t	f_t	5%
Test					
ADF t-test	0.355	-0.510	-1.655	-0.139	-2.89
ADF^{GLS}	0.238	-0.597	-3.345	-0.205	-13.7

Note: p_t is the log of the actual house prices, m_t is the log of the average mortgage amount, b_t is the log of the amount that can be borrowed and f_t is the log of the UK funding gap. The sample period runs from 1992:2-2008:3.

Table 3: Short-Run and Cointegration Estimates of House Prices and Mortgage Levels 1992:2-2008:3

Dependent Variable	$\triangle m_t$	$\triangle p_t$
Constant	-4.979	-0.711
	(-2.856)	(-1.168)
ECT_{t-1}	-0.074	-0.119
	(-2.909)	(-2.273)
b_{t-1}	1.417	
	(9.205)	
m_{t-1}		1.079
		(19.777)
$\triangle m_t$		1.117
		(14.339)
$\triangle m_{t-2}$	-0.228	
	(-2.131)	
$\triangle m_{t-4}$	0.256	
	(2.594)	
$\triangle b_t$	0.310	
	(4.734)	
$\triangle p_{t-1}$		0.125
		(2.066)
Cointegration - ARDL Bounds tests		
Variables	*F-Test*	
p and m	3.262	
m and b	4.653	

Note: ECT = error correction term, t-statistics are in parenthesis.

Table 4: Long-Run Estimates

$Dependent\ Variable$	p_t			
	OLS	ARDL	DOLS	FM-OLS
ψ	1.088	1.064	1.072	1.048
T-Stat	20.421	18.096	21.780	14.816
$Dependent\ Variable$	m_t			
	OLS	ARDL	DOLS	FM-OLS
γ_1	1.092	1.416	1.196	1.155
T-Stat		8.891	7.098	9.933

Note: N = 65.

Table 5: Summary UK Mortgage Lending Statistics

Variable	Unit	1990	1995	2000	2005	2007
Gross Advances	£billion	69.8	57.3	119.8	288.3	363.7
Net Advances	£billion	33.3	15.2	40.8	91.2	107.7
Average Advance	£	41,018	48,338	70,606	122,049	150,405
Number of Mortgages	(000's)	1,113	859	1,045	987	992

Note: The loan figures are for house purchase, improvement and topping-up loans. The net figure refers to "Net of repayments of principal and for local authorities housing association grant".

Table 6: Alternative Long-Run Mortgage Credit Regression

$Dependent\ Variable$	m_t		
	OLS	DOLS	FM-OLS
γ_1	0.558	0.709	0.757
	(7.929)	(2.861)	(3.239)
γ_2	0.405	0.325	0.320
	(8.821)	(2.200)	(2.191)

Note: T-stats are in paratheses.

Figure 1: UK Housing Market

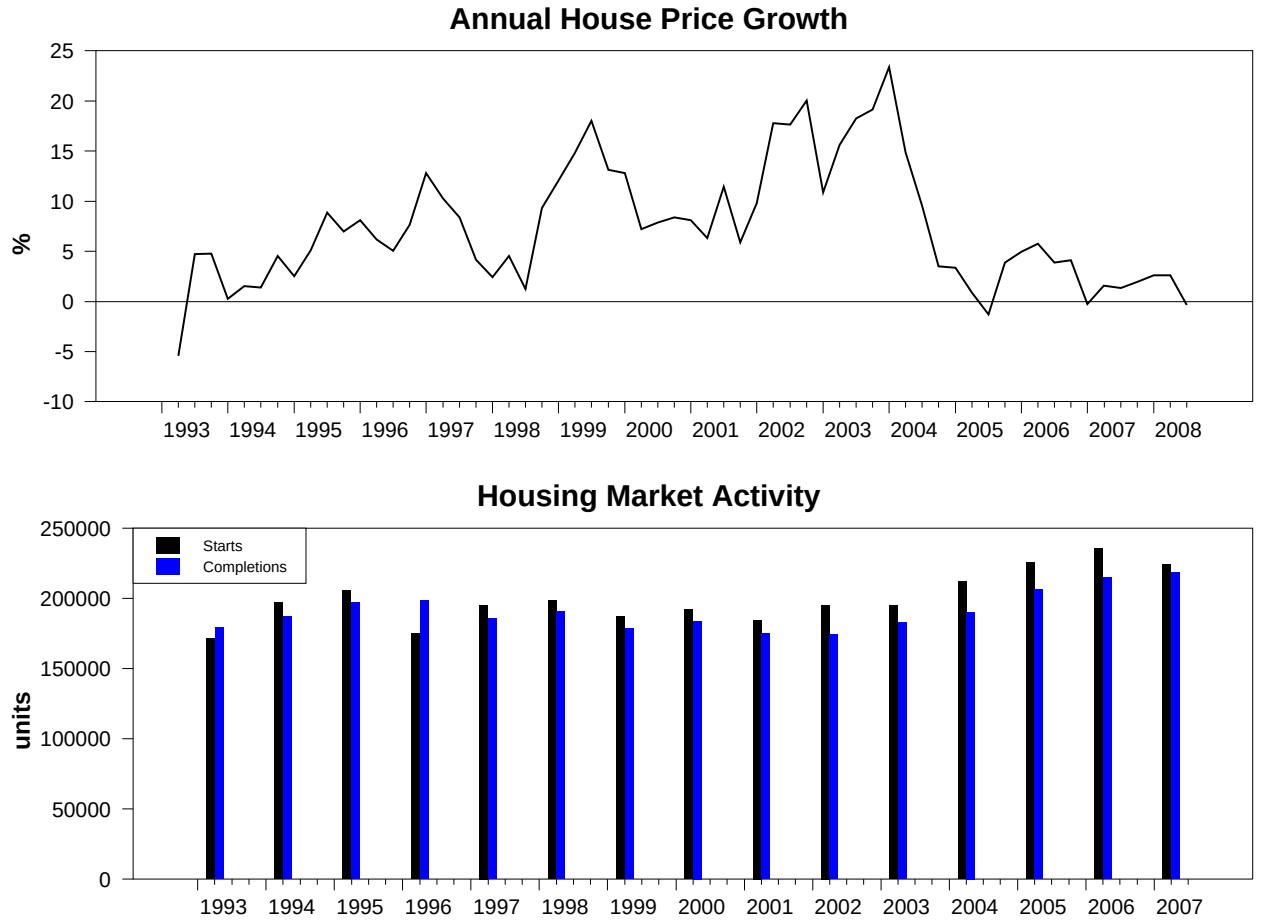

Figure 2: UK Mortgage Market - Loan Amounts

Actual and Fundamental

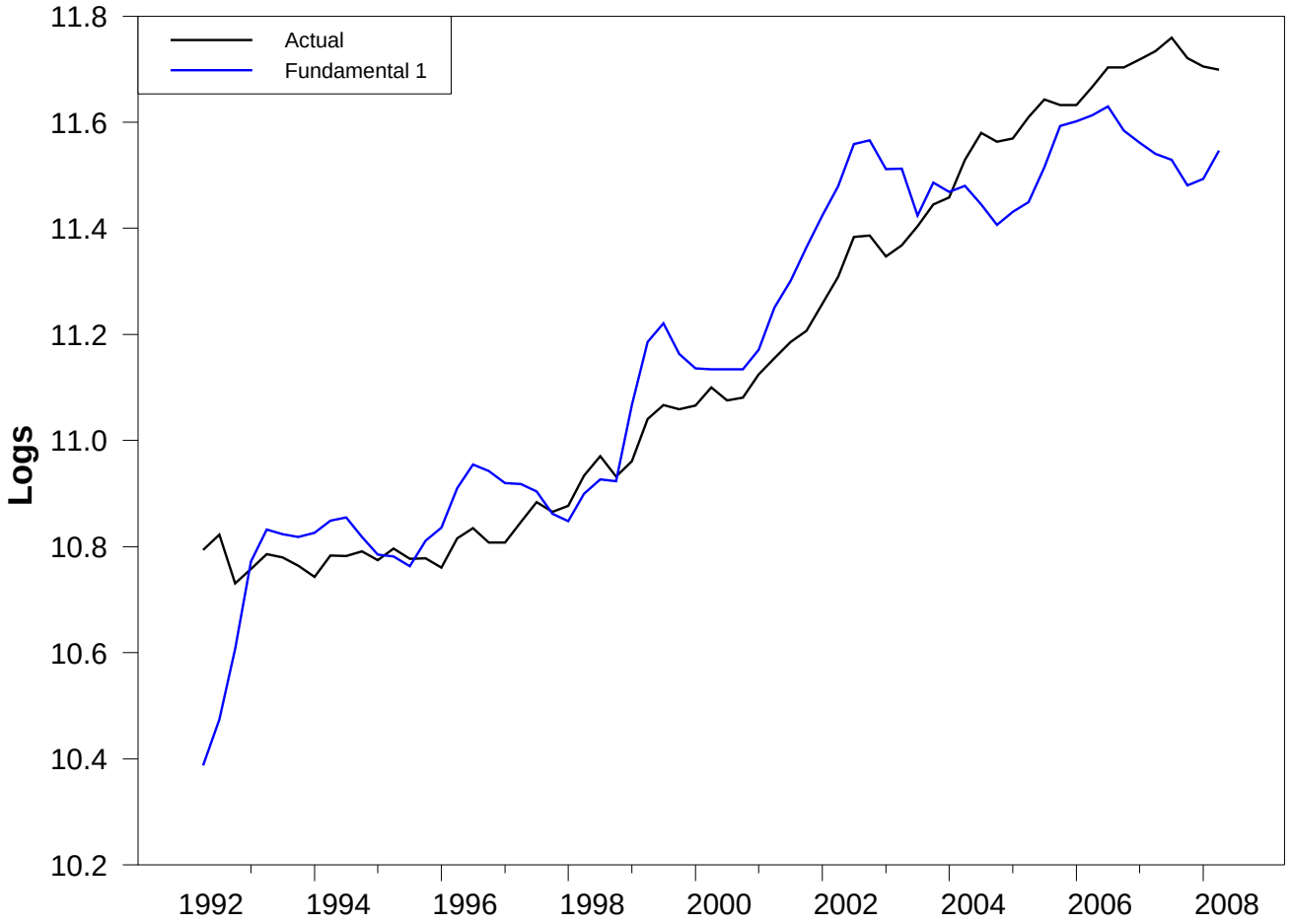

Figure 3: UK Housing and Mortgage Market

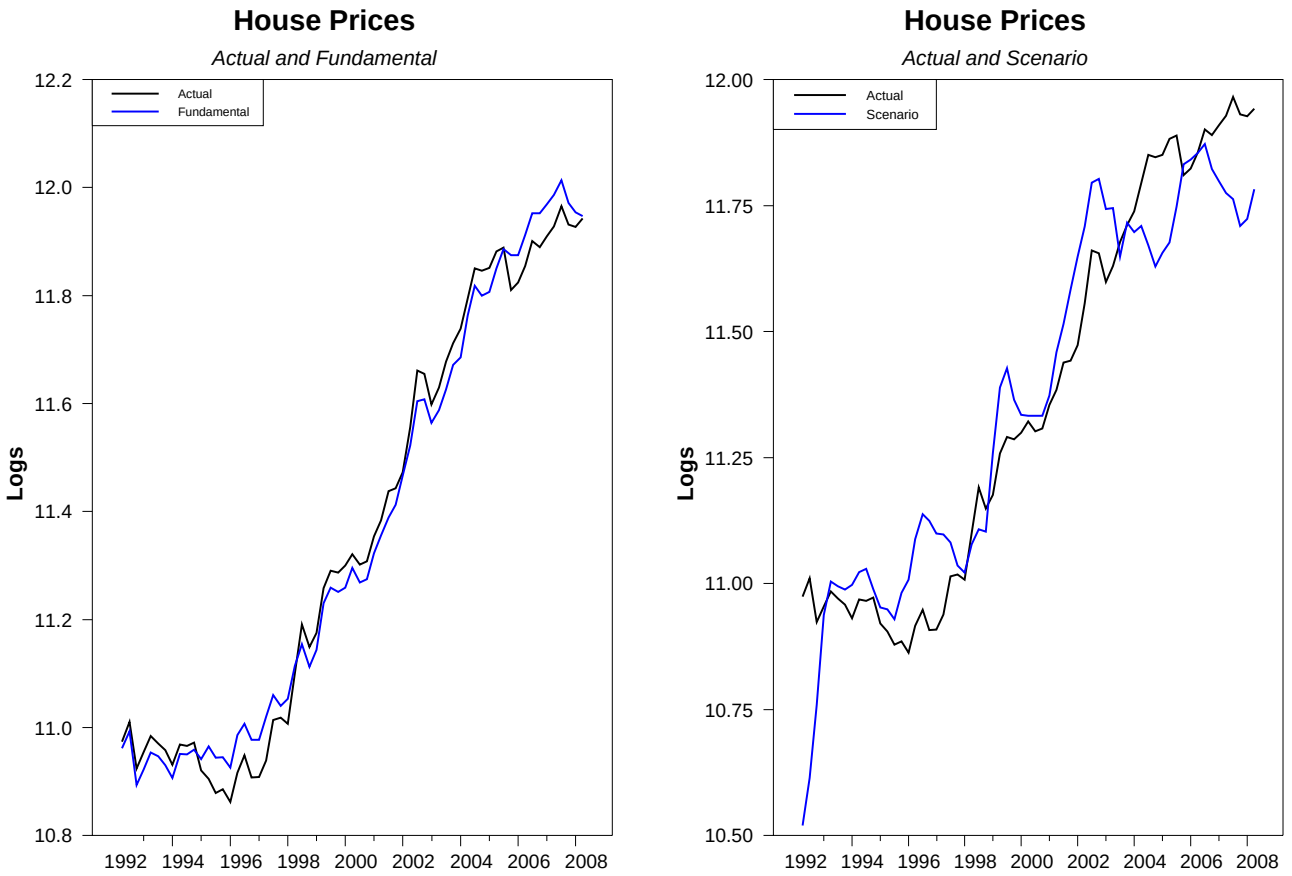

Figure 4

Under/overvaluation in UK house prices due to credit market disequilibrium

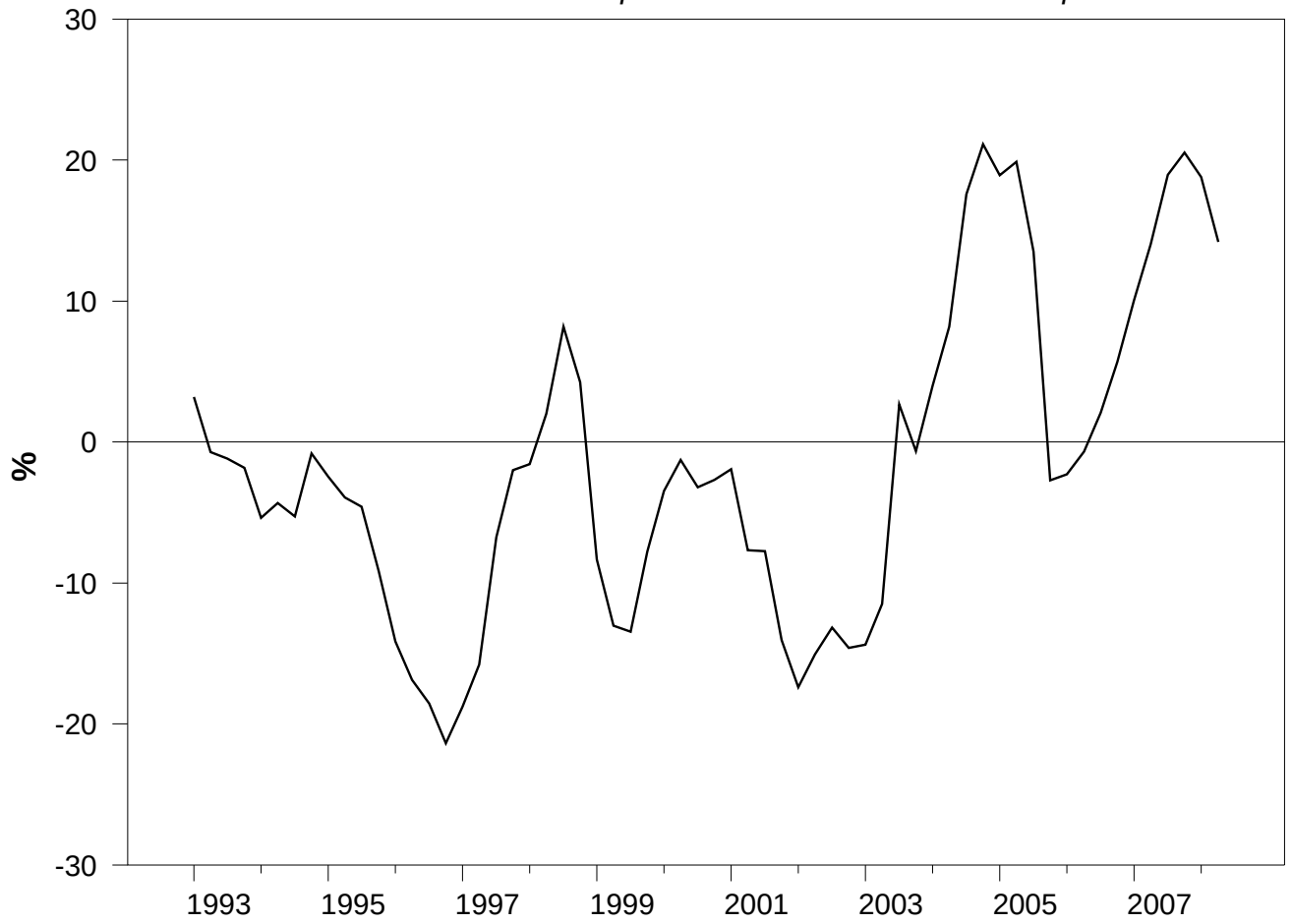

Figure 5: UK Mortgage Market - Augmented Model

Loan Amounts Actual and Fundamental

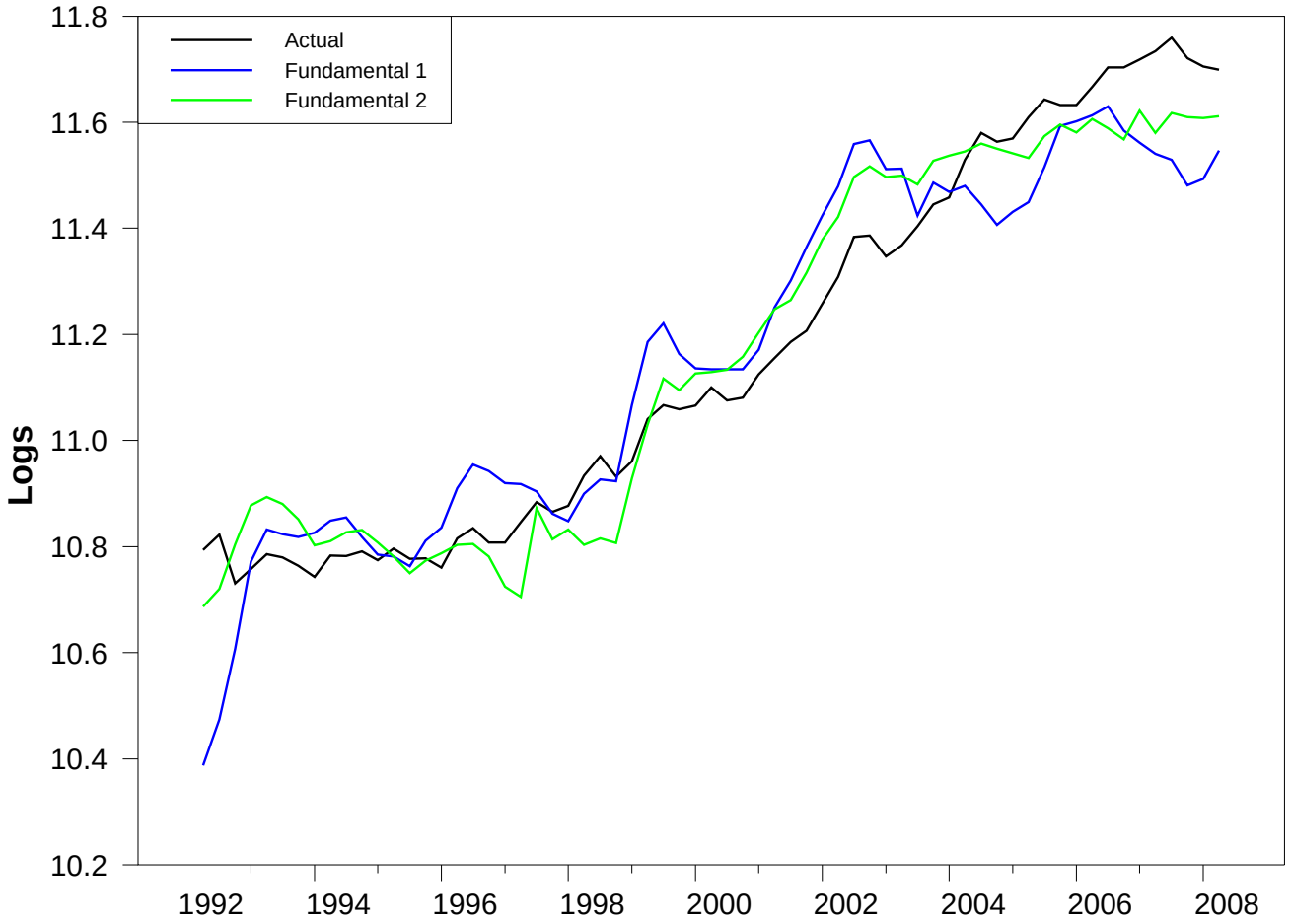

Figure 6: UK Housing and Mortgage Market - Augmented Model

House Prices Actual and Scenario

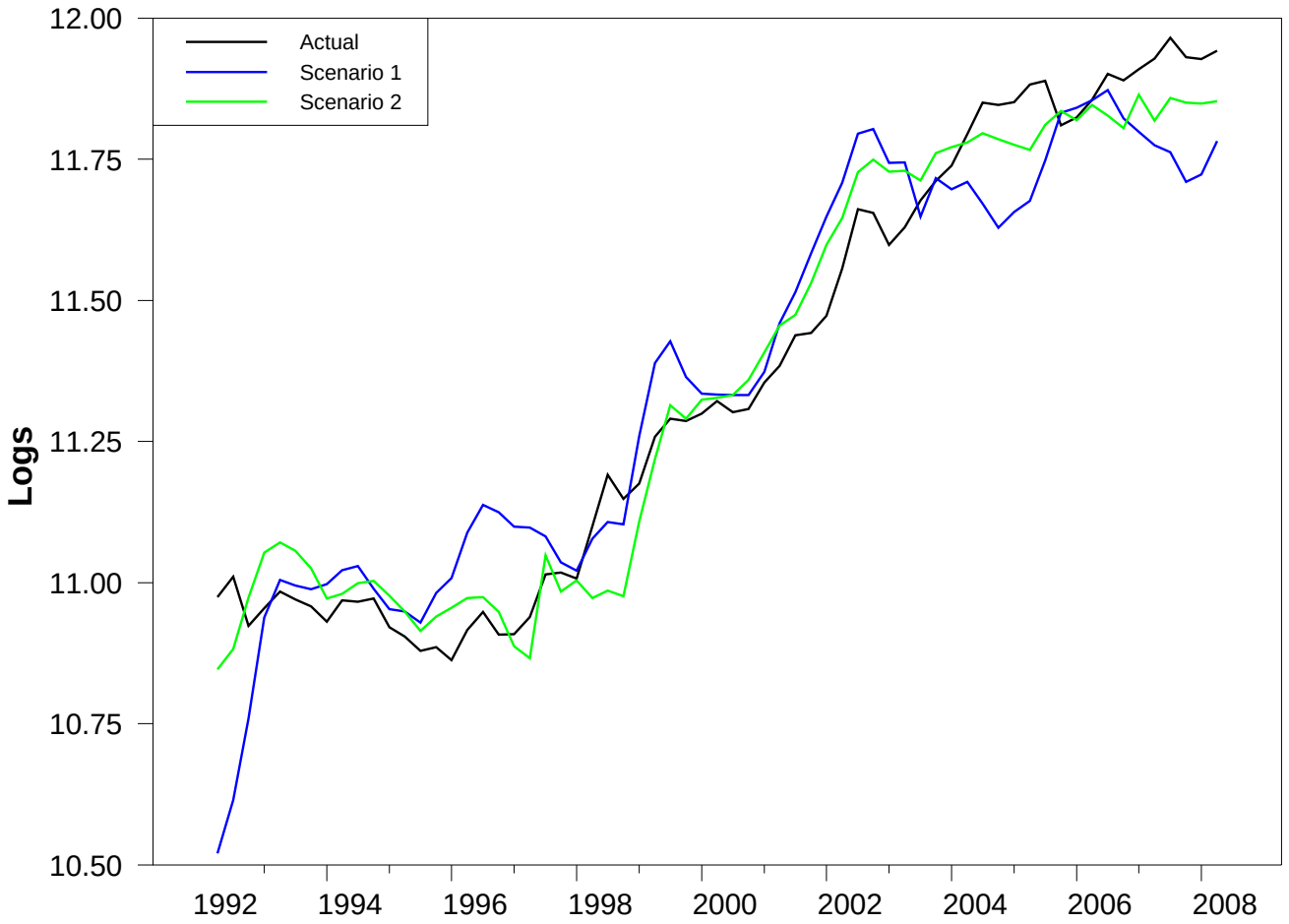

Figure 7: Counterfactual Scenario