Cyclical and structural change in the UK housing market

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Abstract

Purpose – This paper aims to examine factors affecting house prices separating cyclical and structural influences. In addition to considering the role of income and interest rates, it examines whether access to a key source of liquidity, mortgage finance, could affect the long-term behaviour of the market rather than being a short run impact. In addition, the paper considers whether the effects of mortgage funding and the financial crisis affect all regions equally or whether there exist particular differences across regions of the UK.

Design/methodology/approach – Using quarterly time series data from 1983q1 to 2011q2, the paper employs a Johansen cointegration approach to identify the long-run (permanent) and short-run (transitory) factors affecting house prices both at national and regional levels. It identifies whether there is a separate influence for mortgage lending from interest rates and general money market liquidity, as captured by money supply M3, and whether these effects are permanent or temporary. The paper employs impulse response functions to examine house price evolution due to innovations in mortgage lending and quantifies these effects with and without the financial crisis.

Findings – The findings indicate that real personal disposable income, mortgage market liquidity, interest rates and money supply as well as housing stock supply impact house prices permanently with the expected signs. The findings are broadly consistent at national and regional level, although there are some significant regional variations in results. The mean reversion of the housing markets is captured via the error correction term which is significant at the national level and in all but three regions. Impulse response functions show how house prices respond to shocks in mortgage lending and how this varies with and without a financial crisis.

Research limitations/implications – The importance of mortgage lending to the housing market is a clear result from the research in addition to income, interest rate and money supply effects. One implication is that factors affecting mortgage lending supply can impact the housing market in both the short and long run.

Practical implications – Given the significance of mortgage finance for house price evolution, the paper discusses how the Help-to-Buy policy may help to overcome the limitations created by the reaction of the mortgage lending sector to the financial crisis.

Social implications – Access to homeownership has been limited by greater downpayment constraints introduced by lenders since 2008/2009. Policies that reduce these constraints may enable households to change to the type of tenure they prefer.

Originality/value – The paper identifies the importance of mortgage lending for the housing market both nationally and regionally using an econometric approach that quantifies the role of fundamentals in both the long and short run.

Keywords House prices, Housing policy, Long and short run factors

Paper type Research paper

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1. Introduction

The recent history of house price evolution reveals a market that exhibits substantial price volatility with annualised percentage price changes greatly exceeding that of the change in gross domestic product (GDP) and household incomes. In addition, there is evidence of clear persistence of price change over consecutive time periods, in many cases, lasting a number of years. This can be clearly seen in the UK where the variance of real house prices is more than 11 times greater than that of gross value added (GVA) over the period from 1991 to 2009. This period also saw house price growth being persistently less than GVA growth between 1991 and 1996, but significantly above GVA growth from 2001 to 2007. Between 2008 and 2010, house prices fell significantly in real terms across the UK. By the beginning of 2014, they remained below their 2007 peak despite more recent price rises.

Such phenomena are not unique to the UK. Many countries experienced significantly high rates of house price appreciation in the run up to the Global Financial Crisis (GFC) accompanied by high growth rates in credit and liquidity (see Goodhard and Hofmann, 2008). Prolonged periods of real house price inflation make housing an increasingly attractive investment asset. Combined with financial deregulation that permits equity withdrawal based upon accrued housing wealth (capital appreciation) and the creation of buy-to-let mortgages (where investors can benefit from both potential capital appreciation and an income return component), housing can increase consumption expenditure (see Wood and Nygaard, 2010) via housing wealth and collateral effects, and via investment income.

Using US data, Iacoviello and Neri (2010) argue that monetary variables (shocks) impact on house prices that also impact on consumption expenditures. Demary (2010) finds the existence of a housing wealth effect and links between interest rates and house prices. Wilson *et al.* (2011), however, suggest that the impact of interest rates on house prices does not exist in the long run but only in the short run.

Interest rates have been included in models of housing demand reflecting mortgage costs. Mortgage lending has usually not been included as a separate variable. However, mortgage liquidity saw significant increases during the period prior to the GFC. In the UK, nominal gross mortgage lending more than doubled between 2001 and 2004 and was more than 2.5 times its 2001 average by 2007 at the market peak. By 2011, gross mortgage lending had fallen to values below those recorded in 1983. These changes correlate positively and significantly with house price movements. Taltavull de La Paz and White (2012) argue that mortgage finance should be included in housing models for a number of different reasons. They note that most house purchase is debt financed, making mortgage credit critical for effective demand in the market. The supply of mortgage finance may be exogenous to the housing market or endogenous, as mortgage finance increases when house prices rise. The latter may be related to price expectations and lead to bubbles. These may generate larger wealth effects and impact the macroeconomy (Case *et al.*, 2003).

Mishkin (1995) identifies different channels through which financial (mortgage) flows impact the housing market. He suggests that there is a "bank lending" channel and a "balance sheet" channel. Changes in monetary policy affect the availability of household debt that impacts asset prices though the balance sheet channel.

The macroeconomic impact of mortgage market behaviour has been evidenced by Leece (2004), Tsatsaronis and Zhu (2004) and Miles (2005). Researchers have also argued

that housing market volatility is correlated with aggregate fluctuations in GDP that correspond to periods of either stagnation or a drop in house prices, contributing to wider economic contractions (Hall, 2011; Meen, 2011). In periods of economic contraction, falling consumer confidence negatively affects household expenditure (Whitehead and Williams, 2011). The negative consumer sentiment, as a consequence of more restrictive mortgage lending conditions post GFC, promotes fluctuations in house prices and can make the economy persist with negative or near zero economic growth (Duca *et al.*, 2010; Debelle, 2004; Dell'Ariccia *et al.*, 2012).

The role of expectations has been discussed extensively in the literature. Attanasio and Weber (1994) consider the role of housing wealth and income expectations (relating to productivity) on consumption. They considered whether wealth effects from house price appreciation could lead to a boom in consumption. They also suggested that these effects would be strongest for those older age groups who were already homeowners in contrast to younger households who were more likely to be in rented accommodation. For the younger age groups, they suggested that higher economic growth linked to higher productivity would increase expected future (i.e. permanent) income. Using disaggregated data, the authors showed that consumption by younger households was stronger than expected, suggesting that the impact of revisions to permanent income were significant in driving their consumers' expenditure. In relation to the current Help-to-Buy policy, higher economic growth would be expected to feed into permanent incomes (at some point) and, therefore, cause current consumption to rise relative to current observed income. This should be most apparent for younger households who have longer to benefit from higher economic growth.

Wealth effects on consumption have been identified by Case *et al.* (2003), Ludwig and Slock (2004) and Campbell and Cocco (2007). Attanasio *et al.* (2009), however, provide different results. Using micro data, they suggest that there exists a 'common causality hypothesis. This they argue is the alternative explanation to wealth and collateral effects of house prices on consumption. "The [common causality hypothesis] also encompasses the possibility that there may be shocks to house prices that do not affect expectations, and thus consumption." (Op. Cit, p. 23) The common causality hypotheses implies that regions that have the strongest gains in productivity "[…] will be those where both house price growth and consumption growth of the groups that benefit most from productivity gains are highest." (Op. Cit, p28).

In this paper, the role of mortgage market liquidity is tested as a separate influence on the housing market from the effect of, the more traditional, interest rate channel. We would expect there to be a negative relationship between house prices and interest rates, a priori, and a positive relation between house prices and mortgage lending. Given the reduction in mortgage lending after the GFC, we also expect this to cause house prices to fall. The increase in downpayment requirements would also be expected to reduce house price growth, as this increases the severity of liquidity constraints facing potential borrowers. Thus, we discuss the role that the UK Government's Help-to-Buy policy could have in stimulating housing transactions, the housing market and house prices, as it would reduce the impact of this constraint.

The remainder of this paper is structured as follows: the next section discusses the possibility that economic growth periods linked to rising house prices and debt can cause bubbles in house price formation. The paper then considers interlinkages between the housing market and the macroeconomy. House price change by region is then

examined followed by a discussion of the modelling approach and results. The paper then proceeds to discuss the potential impact of the Help-to-Buy policy before the concluding discussion.

2. House price bubbles

Mortgage market debt finance flows into housing markets that are imperfect and characterised by asset heterogeneity and asymmetric information. In addition, there are considerable transactions costs that can adversely affect return performance over short holding periods. Such costs are less of a barrier when house prices increase rapidly, but act as a source of friction for speculative investments during periods of low or negative price change. The persistent increase in real house prices before the GFC has raised the issue of bubbles in asset values in general and in housing specifically.

Kindleberger (1987, p. 281) defined a bubble as:

> […] a sharp rise in price of an asset or a range of assets in a continuous process, with the initial rise generating expectations of further rises and attracting new buyers – generally speculators interested in profits from trading in the asset rather than its use or earning capacity. The rise is usually followed by a reversal of expectations and a sharp decline in price often resulting in financial crisis.

Whilst this may be tautologically correct, it implies that bubbles can only be identified after they have occurred (Hendershott *et al.*, 2003). Hendershott *et al.* (2003, p. 993) then define a bubble as "a sharp, temporary price increase that cannot be plausibly explained by changes in fundamental value drivers."

Stiglitz (1990) relates bubbles to deviations from fundamental values where those deviations arise due to inaccurate expectations of (too) high house price growth. Smith and Smith (2006, p. 3) define a bubble as:

> A situation in which the market prices of certain assets (such as stocks or real estate) rise far above the present value of the anticipated cash flow from the asset.

The rapid price rise brings speculative activity on expectations of future price increases rather than focusing on the asset's cash flow or fundamental factors driving the market. "What truly defines a bubble is that market prices are not justified by the asset's anticipated cash flow". (Op. Cit, p3).

In practice, it may prove difficult to identify bubbles. One assumption could be to implicitly assume that prices were equal to fundamental values historically before a period of rapid asset price inflation and, hence, observed price rises are due to bubbles. Alternatively observed historic prices may have been too low and that increasing prices may have (at least in part) reflected an adjustment process towards long-run equilibrium values.

The existence of bubbles is supported by papers such as Hendershott (2000) and Wheaton *et al.* (2001). These authors argue that at the peak of the market, real estate assets are overpriced. They argue that this is because investors do not recognise the mean reversion tendency of markets in general. They argue this because the peak prices observed deviate from their long-run equilibrium values. Investors make the mistake of interpreting the observed "short run" prices as equilibrium values and/or that the long run trend has changed. The investor is unable to evaluate the fundamental long-run equilibrium value of the asset. This is exacerbated in markets where there is limited and

asymmetric information. In this situation, it is easier to make mistakes about pricing and expectations about the trajectory of future price movements.

Himmelberg *et al.*, (2005) examine the possibility of bubbles in housing markets. They adopt a "user cost" approach to:

> […] calculate […] the financial return associated with an owner-occupied property [compared with] the value of living in that property for a year – the "imputed rent", or what it would have cost to rent an equivalent property – with the lost income that one would have received if the owner had invested the capital in an alternative investment – the opportunity cost of capital. (Op Cit, p. 74)

This approach is then used to discover whether property is over or under valued. Hendershott and Slemrod (1983) and Poterba (1984) have also adopted user cost formulations to identify fundamental values.

Black *et al.* (2006) examine house prices relative to fundamental values using UK data. They estimate a relationship examining a price – income ratio as a function of lagged changes in income, return variance and the coefficient of relative risk aversion. The authors separate the influence of change in exogenous variables from within market factors. They use real disposable income as the exogenous variable in their estimation. They find that towards the end of their period of observation (2005), house prices were overvalued and that this overvaluation was split evenly between "intrinsic and price dynamics components. The latter component [was] found to be driven by momentum behaviour [where the direction of movement is expected to persist]". (Op Cit, p. 1,553) Such momentum is characteristic of irrational bubbles based upon inaccurate expectations.

Bubbles were found to be present in markets in different countries [e.g. by Abraham and Hendershott (1996) in the USA, Hort (1998) in Sweden] and regions [e.g. Levin and Wright (1997) in London]. Mikhed and Zemčík (2009) examine both national and regional level data for the USA and find that there are distinct and prolonged periods of bubbles in house prices. However, the difficulty of accurately capturing bubbles can be considered in light of the paper by Stevenson (2008) in which he argues that pricing in the Irish housing market was only above fundamentals (i.e. contained a bubble component) in the late 1990s. The remaining house price growth he attributes to demographics, negative real interest rates as a consequence of Eurozone membership and real economic growth. However, Jones (2012, p. 2) states that in Ireland, "house prices fell by 38 per cent from the end of 2006 to 2010". The next largest price drop over the same period was of 17.3 per cent in Denmark, while prices in the UK fell by 13.3 per cent from peak to trough. Hence, identifying fundamental factors and the contribution they make to house price evolution will be a key focus in this paper.

The macroeconomy consequences of the bursting of property price bubbles have been discussed in the case of Japan. Moriizumi and Naoi (2012) evidence Japanese Government research that indicates that Japan has suffered two "lost decades" due to the bursting of the property bubble. Other commentators have criticised the role of Japanese economic policy arguing that it had failed to stop this prolonged stagnation. While these discussions are beyond the scope of this paper, we do consider the UK Government's Help-to-Buy policy and its potential impact on the housing market, overcoming downpayment constraints and, therefore, its possible wider macroeconomic impacts.

However, bubbles are, in practice, tricky to detect, and estimates of the size of bubbles can lack precision. Modelling house prices based upon fundamental variables would imply that any bubble component could be captured by the error term. This in itself is a strong assumption, as the error term is often not randomly distributed and can be affected by model specification, excluded or missing variables. Hence, in the following, we attempt to identify the role played by mortgage lending that increased significantly before the financial crisis, the role of monetary policy and real interest rates.

Links between mortgage liquidity and housing demand and house prices have been identified in recent research (Mishkin, 2007; Muellbauer, 2008; Iacoviello, 2005, Bernanke, 2010). Increases in finance, income or demographics impact housing demand and with imperfectly elastic supply tend to raise prices. This in turn increases housing wealth that further impacts on housings' ability to act as loan collateral.

Modelling of housing markets has tended to focus (at a macro level) on identifying long-run trends and short-run dynamics of adjustment. Housing markets may find it difficult to respond quickly to demand changes that may reflect inelastic supply. In addition, credit conditions affect demand (Levitin and Wachter, 2013). Thus, increases in financial flows into the mortgage market may lower mortgage costs and lead to an increase in mortgage demand and house prices. Setzer *et al.* (2010) and Friedman (1988) suggest that housing amplifies the impact of monetary policy. Hence, there are strong interlinkages between housing markets, financial markets and monetary policies that need to be captured when modelling the housing market.

In addition to mortgage flows and interest rates mentioned above, household income and housing stock changes are also included in our models to capture key demand and supply side factors. We also consider if there is any impact from demographic change via immigration on house prices. The reason for including this is because of the significant rise in net inward migration, particularly after 2004 and up to the beginning of the financial crisis. This demographic change might be expected to impact on the demand side of the market and, thus, to positively impact house prices.

Thus, we model the factors affecting house prices and identify whether they have short- or longer-term impacts on price. This approach is disaggregated by region. In addition, our analysis permits us to comment on the role of the government's Help-to-Buy scheme, discussed further below.

3. Regional house price movements

Figure 1 displays real house prices by region and for the UK as a whole from 1983q1 to 2011q1. The figure captures the large increase in house prices in the late 1980s, mainly in more southern regions of England. After price falls in the early 1990s, prices stabilised by the mid-1990s, and then began to increase almost persistently until the onset of the GFC in 2007/2008. This latter period of house price increases can be seen to have affected all regions. The impact of the GFC is also nationwide, with all regions showing significant price falls. London and the South East of England show the highest prices and the figure also points to a widening gap between the South East and more Northern regions. Scotland tends to display the least volatility, while in contrast Northern Ireland experienced significant price increases and decreases.

These cycles occur around longer-term trend movement in house prices. In the run up to the GFC, rising incomes, falling interest rates and increasing volumes of mortgage lending may have contributed to price appreciation. Combined with expectations of

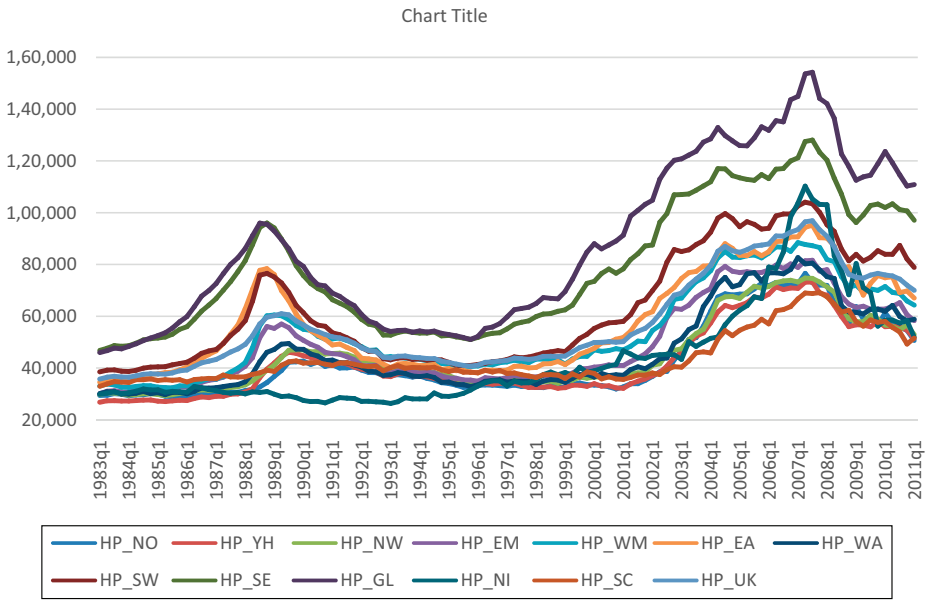

Figure 1.
Real house prices by region

future price rises, house prices increased above inflation and wage growth. Therefore, when modelling house prices, we separate the shorter- and longer-term influences on prices.

4. The model

Demand for housing can take the following form:

$$H_t^D = \gamma[Y_t^P, w_t, Pop_t, F_t, P^H, uc_t] \quad (1)$$

Where Y_t^P is permanent income, w_t is wealth, Pop_t is population, F_t is the flow of financial funds into housing, P^H is house prices and uc_t is the user cost. The user cost may be written as:

$$uc = [(1 - \phi_t)i_t - \pi_t + \delta_t - (\delta ph/ph)_t] \quad (2)$$

Where ϕ_t is income tax rate, i_t is the interest rate, π_t is the inflation rate, δ_t is the housing depreciation rate and $(\delta ph/ph)_t$ refers to the expected capital gain in housing. Mortgage finance is captured in equation (1) in F_t. Funds for mortgages can be considered to come from the financial sector in general. Tsatsaronis and Zhu (2004) suggest that there is a strong connection between house price growth and the growth in mortgage finance. Greater mortgage market liquidity feeds into higher house prices. They also note that changes in bank lending impact house prices, particularly in countries where there are high loan-to-value (LTV) ratios and variable interest rate mortgages, such as exist in the UK. Using a reduced form version of (1) and as in Andrew and Meen (2003), we can write:

$$P_t^H = \alpha_1 + \alpha_2 POP_t + \alpha_3 Y_t + \alpha_4 h_t + \alpha_5 w_t + \alpha_6 F_t + \alpha_7 uc_t + \varepsilon_t \quad (3)$$

Lastrapes (2002) constructs a dynamic equilibrium model of the housing market. He constructs a flow housing supply equation in which it is assumed that the change in housing supply from the current to the next time period depends upon the price of housing (supply elasticity) and depreciation of the existing stock. This formulation may represent a simplification, as it does not permit interest rates affecting the supply side or differences in elasticity between the short and long run. Combining demand and supply we have:

$$Ph_t^r = \Phi[RInc_t, mig_t, RMortg_t, rir_t, \inf_t, M3_t, \Delta Hs_t] + \mu_t \quad (4)$$

where real house prices on the left-hand side depend upon income (measured by real GVA), migration, real mortgage flows, real interest rates, inflation, money supply and the change in housing supply, respectively. μ_t is a stochastic disturbance term with mean zero and constant variance.

We use quarterly time series data for these variables over the period 1983q1 until 2011q2. The statistics were collected from publicly available sources at the office for national statistics and the Bank of England websites. We used different house price series before adopting the Halifax Bank of Scotland series in this paper. All series are deflated (other than stock and migration).

As a first step, we conduct unit root tests. The basic regression for this follows Fuller (1976):

$$\Delta x_t = \alpha + \beta_1 x_{t-1} + \sum_{i=1}^{\rho-1} \delta_i \Delta x_{t-i} + \mu_t \quad (5)$$

where the chosen value for ρ is such that μ_t will be a white noise error term. The coefficient of interest is β_1. Its t-statistic is compared with the critical values found in Fuller (1976). When only the lagged value of x is present, the test is referred to as a Dickey–Fuller (DF) test. When lagged difference terms are added, the resulting test is an Augmented Dickey–Fuller (ADF) test. An alternative approach to adding lagged values of the dependent variable has been suggested by Phillips (1987) and extended by Perron (1988) and Phillips and Perron (1988). They suggest adding a non-parametric correction to the t-test statistic. This accounts for autocorrelation that may be present. We also employ the Kwiatkowski Phillips Schmidt Shin (KPSS) stationarity test after Kwiatkowski *et al.* (1992).

5. National level results

Table I presents unit root and stationarity test results. Unit roots are present in the levels values for all variables with only the KPSS statistic for inflation suggesting otherwise. Housing supply is always found to be integrated of Order 2 on each test. Next, we estimate the long-run cointegrating relationship between the variables in equation (4)[1]. These results are presented in Table II below.

In the long-run model, almost all variables are statistically significant at the 5 per cent level and correctly signed a priori. The strongest effects on house prices come from income, money supply and mortgage lending, respectively. Each of these has a positive relation with house prices. Monetary variables of money supply, interest rates and mortgage lending each have a separate and significant influence on house prices. Migration is marginally insignificant at the 5 per cent level. On the supply side, the change in stock is negatively significant consistent with a priori expectations. The

Variable	ADF	PP	KPSS
House Prices	−3.261*	−3.261*	0.219***
Gross mortgage lending	−12.318(I(2))***	−8.077*	0.130*
Income	−6.501(I(2))***	−7.431***	0.147**
Inflation	−4.897***	−10.450***	0.268(I(0))***
Interest rates	−4.377***	−4.368***	0.106(I(0))
Migration	−7.619***	−7.639***	0.294(I(2))***
Money supply	−10.456(I(2))***	−7.026***	0.136(I(2))*
Housing supply	−8.239(I(2))***	−8.239(I(2))***	0.152(I(2))**

Notes: # All variables are I (1) unless stated otherwise; ***, **, *indicate significance at the 10, 5 and 1 % levels, respectively; PP = Phillips and Peron

Table I.
Unit root and stationarity tests #

Dependent variable: house prices
Sample (adjusted): 1995Q2 2011Q3
Included observations: 66 after adjustments

Variable	Coefficient	Standard error	*t*-statistic	Probability
Constant	−11.83413	3.923760	−3.016017	0.0040
Income	1.863451	0.441976	4.216185	0.0001
Gross mortgage lending	0.229554	0.051314	4.473493	0.0000
Migration (−1)	0.123711	0.064754	1.910473	0.0617
Interest rates	−0.019321	0.009443	−2.046065	0.0459
Money supply M3	0.347062	0.168069	2.064991	0.0440
Change in stock	−0.005596	0.001625	−3.444618	0.0012
R-squared	0.969675	Mean dependent var		11.06981
Adjusted *R*-squared	0.966107	S.D. dependent var		0.249560
S.E. of regression	0.045944	Akaike info criterion		−3.210021
Sum squared resid	0.107654	Schwarz criterion		−2.961347
Log likelihood	100.0906	Hannan–Quinn criterion		−3.113157
F-statistic	271.7941	Durbin–Watson statistics		0.602178
Probability (*F*-statistic)	0.000000			

Note: S.E. = standard error

Table II.
Long run house price model

explanatory power of the model is high, although serial correlation remains. Using the Johansen cointegration rank test, we can reject the null hypothesis of no cointegration. Results for this test are presented in Table III below. Results indicate at least five cointegrating relationships. Thus, we have identified valid long-run relationships between house prices and the factors affecting them.

Given that cointegration exists in the long-run model, a short-run error correction model is estimated and takes the following form:

$$\Delta Ph_t^r = \alpha_0 + \alpha_1 \Delta RInc_t + \alpha_2 \Delta mig_t + \alpha_3 \Delta RMortg_t + \alpha_4 rir_t + \alpha_5 \Delta \inf_t + \alpha_6 \Delta M3_t + \alpha_7 \Delta\Delta Hs_t + \alpha_8 \mu_{t-1} + \varepsilon_t \quad (6)$$

Hypothesized No. of CE(s)	Eigenvalue	Trace statistic	0.05 Critical value	Probability**
Unrestricted cointegration rank test (Trace)				
None*	0.735743	258.1215	125.6154	0.0000
At most 1*	0.701542	187.5874	95.75366	0.0000
At most 2*	0.606576	123.5037	69.81889	0.0000
At most 3*	0.514159	74.06177	47.85613	0.0000
At most 4*	0.363404	35.80244	29.79707	0.0090
At most 5	0.200597	11.86658	15.49471	0.1634
At most 6	7.25E-06	0.000384	3.841466	0.9863
Unrestricted cointegration rank test (Maximum Eigenvalue)				
None*	0.735743	70.53407	46.23142	0.0000
At most 1*	0.701542	64.08368	40.07757	0.0000
At most 2*	0.606576	49.44197	33.87687	0.0003
At most 3*	0.514159	38.25933	27.58434	0.0015
At most 4*	0.363404	23.93586	21.13162	0.0196
At most 5	0.200597	11.86620	14.26460	0.1158
At most 6	7.25E-06	0.000384	3.841466	0.9863

Table III.
Johansen cointegration test results

Notes: Trace test indicates five cointegrating equation(s) at the 0.05 level; Max-eigenvalue test indicates five cointegrating equation(s) at the 0.05 level; * denotes rejection of the hypothesis at the 0.05 level; ** MacKinnon-Haug-Michelis (1999) *p*-values

Where Δ indicates first difference of the relevant variable. In this model, the error correction term is captured in the lagged residual (μ_{t-1}) from the long-run model in equation (4), and α_8 is the error correction coefficient. We also vary the short-run model by adding a dummy variable that takes a value of 0 before 2008 and 1 from 2008 onwards until the end of the data set to capture the impact of the GFC, as it affects the finance market in which higher downpayment constraints affect the ability of households to access mortgages (Table IV).

In the short-run error correction model, the only statistically significant demand side variable is the change in mortgage lending. Changes in mortgage finance have a positive and significant impact on house price change. The change in supply impacts on the change in house prices at the 10 per cent significance level but is marginally insignificant at the 5 per cent level. The error correction term is significant with the correct sign and suggests that just over 21 per cent of the deviation of house prices from their long-run equilibrium position is corrected in each quarter. The dummy variable capturing the GFC from 2008 onwards has a statistically significant negative impact on the change in house prices[2].

From the above we learn that gross mortgage lending has a statistically significant and positive impact on house prices in both the short and long run. Changes in lending conditions brought about by the financial crisis significantly impacted on mortgage lending volumes and, correlated with this, we have witnessed a fall in house prices. Hence, lending behaviour could also be regarded as a key variable to examine within the context of house price evolution (see, for example Koblyakova *et al.*, 2012).

Figure 2 displays the impulse response function which reflects the response by house prices to an unexpected shock in mortgage lending. Shocks are reflecting a 1 per cent standard deviation of the independent variable to changes in house prices. Mortgage

Dependent variable: change in house prices
Sample (adjusted): 1995Q3 2011Q2
Included observations: 64 after adjustments

Variable	Coefficient	Standard error	*t*-statistic	Probability
Constant	0.012195	0.004472	2.727152	0.0090
Change in Income	0.033269	0.557523	0.059673	0.9527
Change in gross mortgage lending	0.065951	0.023263	2.834996	0.0067
Change in migration	0.020359	0.039467	0.515837	0.6084
Change in interest rates	0.001063	0.008991	0.118285	0.9063
Change in money supply M3	0.109053	0.225268	0.484103	0.6306
Change in the change of supply	−0.002131	0.001102	−1.934035	0.0591
Error correction term	−0.211173	0.069129	−3.054790	0.0037
2008-Dummy	−0.039686	0.013017	−3.048776	0.0038
R-squared	0.561408	Mean dependent var		0.005991
Adjusted *R*-squared	0.486755	S.D. dependent var		0.028024
S.E. of regression	0.020077	Akaike info criterion		−4.832281
Sum squared resid	0.018945	Schwarz criterion		−4.506778
Log likelihood	144.3039	Hannan–Quinn criterion		−4.706084
F-statistic	7.520152	Durbin–Watson statistic		1.064922
Probability (*F*-statistic)	0.000002			

Table IV.
Short run error correction house price model

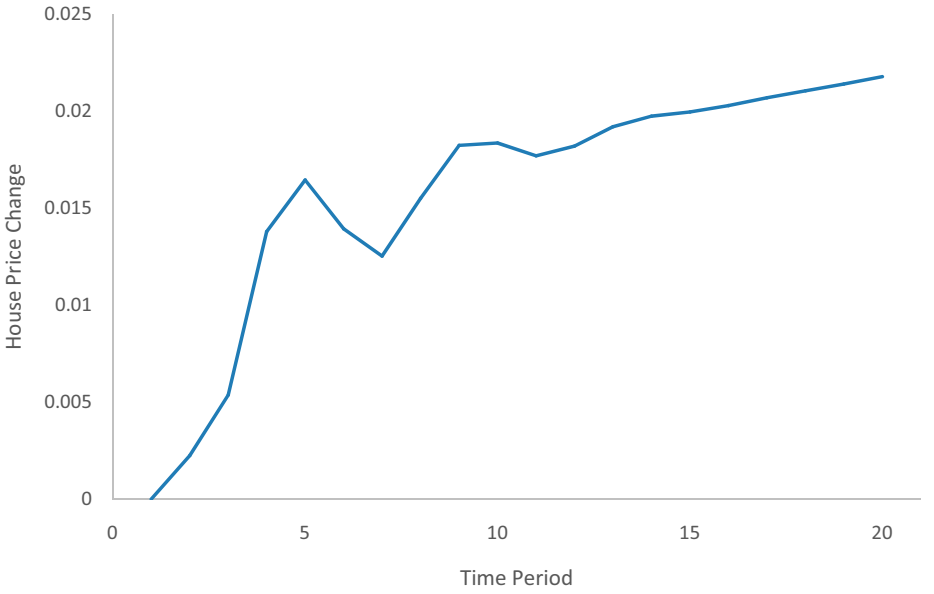

Figure 2.
Impulse response of house prices to innovations in mortgage lending

lending impacts house prices that increase sharply to period 5 (just over one year with quarterly data) before weakening slightly and then rising again between periods 8 and 20 (about two to five years). Hence, there is persistence to the role of mortgage lending in house price evolution.

However, following 2008, mortgage lending conditions became much more restricted. The number of products available on the market decreased substantially. Mortgage interest rate premiums over the Bank of England base rate increased and lenders increased deposit requirements on borrowers, in particular, increasing downpayment requirements and, hence, lowering the maximum LTV ratios. Modal LTVs fell from around 95 per cent before the crisis to no more than 75 per cent afterwards.

The change in the mortgage market might be expected to have significant impacts on house prices. Given the positive and significant relationship established in both long- and short-run models above, reductions in mortgage lending would expected to reduce house prices. Figure 3 below displays the impulse response for house prices to mortgages, given the more restrictive nature of lending conditions after the beginning of the financial crisis.

In this graph, while there are some similarities with Figure 2 particularly up to 5 periods, the pattern is notably different by 12 periods after the innovation with a substantial drop in the response function. This could be interpreted as the consequence of the more restrictive lending criteria used by mortgagors after 2007/2008.

To overcome the lower LTVs, consequent on lender behaviour, the UK Government introduced the Help-to-Buy scheme. This is a mortgage guarantee scheme (supplied by the government to the mortgage lender) that helps purchasers buy homes with a 5 per cent deposit, thus increasing their LTV to 95 per cent, similar to the levels seen before the financial crisis. The scheme is open to first time buyers as well as existing home owners who wish to move home. It is also applicable to new and second-hand properties up to a value of £600,000 significantly exceeding the UK average house price of £248,000 (Office for National Statistics)[3].

The vast majority of transactions occur below this £600,000 cap. If the policy can restore LTVs to levels seen in the pre-crisis period, it could stimulate the market increasing transactions and, therefore, lead to the multiplier effects associated with an improving housing market.

The Help-to-Buy policy was just over one year old, at the time of writing, and the most recent evidence suggests that mortgage lending has significantly increased along

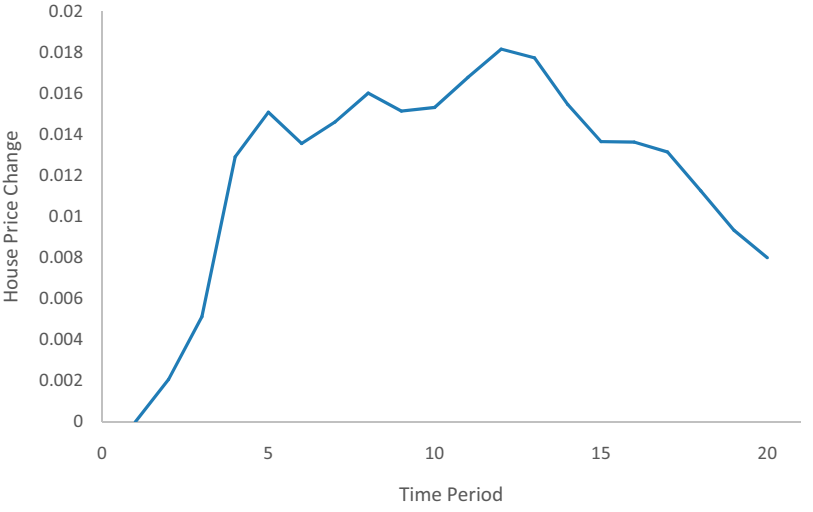

Figure 3.
Impulse response of house prices to innovations in mortgage lending after the start of the financial crisis

with turnover in the housing market. House prices also increased with the rate of real house price inflation exceeding (negative) real wage inflation. This result is consistent with the findings from Tsatsaronis and Zhu (2004) of the sensitivity of house price growth to the growth in mortgage finance.

6. Regional-level analysis

The volatility of house price cycles, whilst exceeding that of the macroeconomic cycle, varies spatially across regions. Koblyakova *et al.* (2012), using disaggregated household level data, show that the choice of mortgage product also varies regionally. They note that mortgage borrowers in the North of England, Wales and Scotland are more likely to choose variable rate mortgage products over fixed rate products in comparison to other regions of the country. Hence, these regions would be more exposed to macroeconomic volatility due to the increased exposure of households to shocks in variable rate mortgage products.

In the national level results above, in both the long and short run, mortgage lending has a significant impact on the housing market. Given the differences between regions, the role of mortgage lending, and other exogenous variables, may vary across the country. To account for this, we estimate long- and short-run regional models to identify any possible differences across the country with respect to variables that have temporary and permanent impacts on house prices. Table V below presents the results for regional long-run models.

Income positively affects house prices in all regions except the East of England, and Wales. The strongest income impact is in the North followed by the North West. Gross mortgage lending has a positive and significant impact on house prices in all regions except Yorkshire and Humberside and the North of England. The strongest and most highly significant impact is in the East of England. The impact of migration is more mixed. It is not significant in six regions, negatively affects prices in Greater London, the South East and East of England and positively affects prices in Scotland and Northern Ireland. Interest rates have a negative impact on house prices but do not have a significant impact in all regions. It is insignificant in most southern regions except Greater London. The strongest negative effects are in Yorkshire Humberside, Northern Ireland and Scotland. The money supply is significant in only five regions, while the change in stock is significant in just under half of the regions. Real personal disposable income has the largest coefficient in those regions where it is significant.

The long run impacts of income and mortgage lending are statistically significant in almost all regions. Further, the effect of these variables also varies significantly across regions. In all regions, we can reject the null hypothesis of no cointegration[4]. Hence, the models represent valid long-run relationships, and we can proceed to estimate short-run error correction models. These results are reported in Table VI.

In the short-run models, the change in income is significant in only three regions, Greater London, Yorkshire Humberside and the North. The change in mortgage lending flows is significant in the four Southern regions plus the North and North West of England. Changes in migration impact house price change negatively in Greater London and positively in Scotland. Changes in interest rates are significant only in Greater London. Changes in money supply are not significant, although only marginally so in Scotland. The error correction term is correctly signed and significant in most regions except for the West Midlands, Yorkshire Humberside and Scotland. The dummy for 2008 onwards reflecting the impact of the GFC on financial and lending conditions is negatively significant in most regions except for the East Midlands, Yorkshire

Table V.
Regional long run model

Variable	Greater London	South East	South West	East of England	West Midlands	East Midlands	North West	Yorkshire & Humber	North	Wales	Scotland	Northern Ireland
Constant	−8.684	−17.668	−15.581	−10.516	−12.967	−12.611	−54.409	−17.226	−62.099	−14.982	26.882	−12.512
	(−10.846)	(−9.633)	(−13.619)	(−3.572)	(−5.321)	(−4.774)	(−4.270)	(−2.399)	(−2.812)	(−3.231)	(4.302)	(−9.580)
Income	1.003	1.956	2.315	0.094	1.467	1.933	5.608	2.614	8.822	1.086	4.752	1.187
	(13.156)	(5.419)	(8.891)	(0.246)	(3.897)	(3.669)	(3.687)	(2.371)	(3.258)	(1.439)	(4.600)	(3.558)
Gross mortgage lending	0.245	0.331	0.309	0.594	0.323	0.284	0.191	0.182	0.092	0.446	0.188	0.396
	(6.733)	(7.304)	(6.793)	(14.743)	(6.924)	(4.404)	(2.479)	(1.474)	(1.332)	(5.819)	(3.333)	(6.098)
Migration	−0.063	−0.089	0.016	−0.166	0.034	0.084	−0.333	0.003	0.026	−0.014	0.099	0.049
	(−5.491)	(−3.278)	(0.618)	(−2.364)	(2.221)	(1.551)	(−1.024)	(0.072)	(1.253)	(−0.462)	(5.840)	(2.417)
Interest rates	−0.023	−0.007	−0.014	−0.009	−0.024	−0.039	0.018	−0.041	−0.015	−0.015	−0.045	−0.043
	(−3.803)	(−1.018)	(−1.906)	(−1.050)	(−2.457)	(−3.755)	(0.966)	(−2.199)	(−0.656)	(−1.112)	(−3.419)	(−3.399)
Money supply	0.126	0.041	0.405	0.788	0.023	−0.327	−0.183	−0.483	1.424	0.446	2.087	1.927
	(1.229)	(0.247)	(2.859)	(5.350)	(0.168)	(−1.463)	(−0.552)	(−1.088)	(3.071)	(1.906)	(5.701)	(9.544)
Change in stock	−3.843	−1.723	−6.150	−5.869	−3.553	−2.049	−1.662	−7.090	1.309	−6.884	−1.194	−4.455
	(−0.036)	(−1.192)	(−0.573)	(−1.582)	(−3.775)	(−2.366)	(1.083)	(−3.070)	(0.751)	(−0.757)	(−2.955)	(2.335)
Adjusted R^2	0.984	0.964	0.970	0.936	0.934	0.942	0.909	0.866	0.822	0.882	0.905	0.921
Probability of F statistic	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Durbin Watson	1.277	0.949	0.858	1.265	0.788	0.537	0.840	0.427	1.515	0.597	1.361	1.220

Table VI. Regional short-run model

	Greater London	South East	South West	East of England	West Midlands	East Midlands	North West	Yorkshire & Humber	North	Wales	Scotland	Northern Ireland
Constant	0.008	0.015	0.009	0.010	0.016	0.016	0.015	0.021	−0.003	0.018	0.012	0.003
	(1.444)	(2.905)	(1.556)	(1.749)	(2.001)	(2.466)	(1.645)	(2.167)	(−0.229)	(2.365)	(1.058)	(0.227)
Change in income	0.719	0.198	0.680	0.186	0.361	0.152	1.091	2.211	6.278	−0.015	−3.541	0.266
	(3.529)	(0.039)	(1.323)	(0.464)	(0.477)	(0.222)	(1.206)	(2.146)	(2.636)	(−1.005)	(−1.868)	(0.302)
Change in gross mortgage lending	0.112	0.071	0.082	0.125	0.047	0.016	0.075	0.053	0.122	−0.019	0.036	0.016
	(3.499)	(2.541)	(2.562)	(3.324)	(1.289)	(1.449)	(2.083)	(1.387)	(2.138)	(−0.448)	(0.672)	(0.236)
Change in Migration	−0.033	−0.027	0.014	0.030	0.011	0.043	0.003	0.015	0.041	0.007	0.046	0.030
	(−2.639)	(−1.629)	(0.882)	(0.801)	(0.881)	(1.192)	(0.176)	(0.806)	(1.525)	(0.554)	(2.337)	(1.343)
Change in interest rates	−0.017	0.005	0.003	0.010	0.004	0.003	0.005	0.002	−0.026	0.013	0.021	−0.001
	(−2.917)	(0.994)	(0.468)	(1.437)	(0.494)	(0.467)	(0.585)	(0.256)	(−1.874)	(1.467)	(1.724)	(−0.039)
Change in money supply	0.339	−0.096	−0.112	0.185	0.286	0.234	0.018	0.916	−0.735	0.174	1.389	1.163
	(1.315)	(−0.347)	(−0.391)	(0.642)	(0.677)	(0.749)	(0.035)	(1.694)	(−0.923)	(0.473)	(2.015)	(2.133)
Change in the change in stock	−2.390	−8.095	1.072	−1.564	−9.907	−1.351	−2.869	1.451	−1.904	1.556	−1.838	−2.987
	(0.025)	(−1.011)	(0.151)	(−1.913)	(−1.249)	(−2.455)	(−0.377)	(1.509)	(−1.834)	(0.354)	(−0.648)	(−0.212)
Error correction	−0.315	−0.243	−0.236	−0.168	−0.178	−0.176	−0.284	−0.023	−0.944	−0.133	−0.255	−0.378
	(−2.773)	(−3.278)	(−2.750)	(−2.254)	(−1.957)	(−2.730)	(−2.931)	(−0.289)	(−3.678)	(−2.238)	(−1.444)	(−3.576)
2008 - Dummy	−0.039	−0.051	−0.037	−0.044	−0.041	−0.022	−0.054	−0.016	−0.006	−0.047	−0.055	−0.096
	(−3.058)	(−3.505)	(−2.478)	(−2.772)	(−2.398)	(−1.344)	(−2.930)	(−0.774)	(−0.258)	(−2.162)	(−2.679)	(−3.244)
Adjusted R^2	0.509	0.448	0.386	0.408	0.264	0.332	0.506	0.339	0.603	0.239	0.387	0.351
Probability of *F*-statictic	0.000	0.000	0.000	0.000	0.010	0.000	0.001	0.001	0.004	0.006	0.014	0.000
Durbin–Watson	2.017	1.777	1.583	1.786	2.039	1.542	1.437	1.699	1.487	1.788	2.418	2.297

Humberside and the North. Its coefficient is biggest, in absolute terms, in Northern Ireland which saw the largest percentage increase in house prices in the years immediately preceding the crisis and the largest decrease after the financial crisis. Hence, both mortgage flows and the GFC can be argued to have had significant impacts across the country, although the size of these impacts varies regionally. Thus, a panel model would be inappropriate in this context and would miss the variation between the regions evident from the results above.

7. Discussion and conclusion

The discussion above has aimed to shed light on long- and short-run factors affecting house prices in the UK and, within this context, to comment on the impact of current government housing market intervention.

The model adopted explicitly considers the role of the mortgage market in impacting house prices in addition to the role of interest rates which were, in earlier research, used to capture this channel of liquidity. In practice, the role of mortgage lending flows are found to be significant having both temporary (short run) and permanent (long run) impacts on house price evolution. Hence, any factors that would affect the mortgage market would be expected to affect house prices. The financial crisis caused lenders to become much more risk averse, as reflected in the requirement for higher downpayments, lowering the maximum LTVs achievable in the market place. We attempt to capture this through the dummy variable from 2008 onward to the end of the data set. The consistent result obtained is that this change in lending behaviour has a significant negative impact on house price appreciation.

Considering the Help-to-Buy policy introduced by the UK Government in 2013, in the context of the changed behaviour of lending intermediaries, we suggest that the policy overcame the problems created for potential mortgage borrowers, particularly those for whom the downpayment constraint was binding.

Finally we examine markets across regions of the UK. Consistent with national level results, in the long-run income and mortgage funding flows are frequently statistically significant with varying magnitudes. In the short-run mortgage funding is again often significant. Hence, its role and the behaviour of the lending industry have important consequences for house price evolution.

Notes

1. We exclude the inflation term from equation (4) in estimation, as this variable was insignificant in both long-run and short-run models. Its exclusion had no impact on the significant results obtained.
2. Given that the model does not explain most of the variation in house price change and the presence of autocorrelation, it would not be appropriate to use this model as a basis for testing the existence of bubbles. Hence, we focus on identifying the role of key variables on long- and short-term house price evolution.
3. The Office for National Statistics (ONS) stated that "The average UK mix-adjusted house price in November 2013 was £248,000."
4. Johansen cointegration test results are presented in appendix A.

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