Booms, Busts and Ripples in British Regional
Housing Markets[*]

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November 2005

Abstract: We present and discuss an annual econometric model of regional house prices in Britain estimated over the period 1972 to 2003. The model, which consists of a system of inverted housing demand equations, is data consistent, incorporates spatial lags and errors, has some spatial coefficient heterogeneity, has a plausible long run solution and includes a full range of explanatory variables. We use our results to explain the periods of boom and bust and the ripple effect from London house prices to house prices elsewhere. We also address the issue of whether there has been a bubble in the British housing market

Keywords: House Prices; Ripple Effect; Bubble.

JEL Codes: C51, E39.

1. Introduction

In this paper we present and discuss an annual econometric model of regional house prices in Britain. The model, which has been estimated over the period 1972 to 2003, consists of a system of inverted housing demand equations with the predetermined regional house stock appearing as an explanatory variable alongside regional incomes, real and nominal interest rates, demographics and other demand shifters. A major advantage of this approach is that we have strong priors regarding the values of the key long run elasticities which we should find. These priors correspond to the "central estimates" set out in Meen (1996) and Meen and Andrews (1998) inter alia.

Regional house price models have many advantages and some disadvantages. On the one hand, regional data are generally richer (less cyclical and correlated with each other etc.) and thus more informative about the determinants of house prices than national data (see Figure 2). The additional information content can be very helpful in obtaining more accurate estimates of the important influences on house prices, and hence addressing more accurately issues such as whether there has been a bubble in the British housing market, as some, including the Chancellor of the Exchequer, have argued. On the other hand, a lot of regional data is only available for shorter time periods than national data and at the annual frequency.

Some sort of regional house prices model is necessary to address regional issues such as:

- The "ripple effect", whereby house prices in Greater London tend to lead prices in the South East and, with longer lags, the rest of Britain;
- Housing affordability in Greater London and the South East.
- Policy issues such as those raised by the Office of the Deputy Prime Minister (ODPM), where the question arises of what the medium term impact will be of increasing the number of new homes to be built in different regions.

In addition, as Bover et. al. (1989) and others argue, the operation of the owner occupied (as well as the social rented) housing market at the regional level has macro consequences since it can contributes to regional mismatch in the labour market.

The outline of the paper is as follows. In Section 2, we outline the standard or textbook model of house prices which is the starting point of our research. We also briefly review the literature on modelling regional house prices in the UK. We set out and present the results of estimating our regional house price model in Section 3. We illustrate and discuss our results further in Section 4. In Section 5 we use our results to address the address the issue of whether there has been a bubble in the British housing market. Our conclusions are set out in Section 6. The data used in the paper are described in the Appendix.

2. Modelling Regional House Prices in the UK

In this Section we outline the standard or textbook model of house prices and briefly review some of the many papers which model regional house prices in the UK. Our house price model is based on the standard model of the housing market. The basic model consists of three equations - a demand equation which, given the housing stock, real incomes, interest rates etc. largely determines house prices in the short run; a supply equation which determines the supply of new houses and an equation showing how the stock of houses changes over time as new houses are completed. The house price equation is derived from the demand for housing services by inverting and rearranging the demand equation, so that the dependent variable is house prices as opposed to the quantity of housing services / housing stock. This is the most common form of estimated house price equation in the international literature.

A simplified version of our house price equation can be derived as follows. The demand for housing services, which is assumed proportional to the housing stock, may be specified as:

(1) $hs / pop = (y / pop)^{\alpha} r_h^{-\beta} d$

where hs is the housing stock, pop is population, y is real income, r_h is the real rental price and d represents other factors, such as demography, which shift the demand for housing curve. The α and β coefficients are the income and price elasticities of the demand for housing services. The international

literature suggests that the income elasticity α is between ½ and 1 in cross section data and as high as 1¼ in time series data, and, that the price elasticity β is about ½. See Meen (1996) and Meen and Andrews (1998) for example.

In Britain, the rental r_h is difficult to measure since the private rented sector is small and may not be representative of the overall housing stock. However, in equilibrium, the rental r_h equals the real user cost of housing which, in principle, may be calculated. Hence, r_h may be replaced by a suitable expression for the user cost. In the simplest case, the user cost may be defined as:

(2)　　$hp \, (r^a + m + t_h - hp^e / hp) \equiv hp.uc_h$

where hp = real price of houses; r^a = tax adjusted real interest rate; m = rate of expenditure on maintenance and repair etc.; t_h = net rate of tax on housing; hp^e / hp = expected rate of appreciation of real house prices and uc_h is the user cost of housing, expressed as a proportion of the price of the house. In practice, the main drivers of the user cost are the mortgage rate and the rate of inflation of house prices.

The inverted demand curve is obtained by substituting (2) into (1):

(3)　　$hp = (y/pop)^{\alpha/\beta} (hs/pop)^{-\beta} uc_h^{-1} d^{1/\beta}$

House prices are positively related to real per capita incomes y / pop, negatively related to the per capita housing stock hs / pop and the user cost of capital uc_h and positively related to other variables that increase the demand for housing. Using central estimates of 1 and ½ for the income and price elasticities of housing demand, α and β, (3) may be rewriiten in terms of real income per house, the user cost and other demand shifter:

(3')　　$hp = (y / hs)^2 uc_h^{-1} d^{1/\beta}$

A log linear version of this could be estimated:

(4) $\ln hp = \beta_0 + 2(\ln y - \ln hs) - \beta_1(r^a + m + t_h - (\ln hp^e - \ln hp_{-1})) + \beta_2 \ln d + u$

Equations similar to (4) may also be derived from an explicit multi-period utility maximization problem. Income y is then a measure of permanent income or some combination of physical and financial wealth and current and future real income. At the core of our regional house price equations, is a long run equation very similar to (4).

In practise, estimated versions of (4), which conditions on the housing stock hs, are always a good deal more complicated. Many of the modelling choices, such as the choice of proxies or selection of lag lengths, are largely data determined. Estimated versions of (4) are invariably dynamic - they include lagged house prices and lagged explanatory variables on the right hand side of (4) and often include an error correction term.

The unobserved hp^e term in the user cost in (4) has to be proxied in some fashion. For example, it may be replaced by hp which is then instrumented or the expected capital gains $(\ln hp^e - \ln hp_{-1})$ may be proxied by lagged capital gains or the fitted value from a simple regression on predetermined variables. Very often, the real interest rate and capital gains components of the user cost appear separately in the equation, with a larger coefficient on the interest rate term. See Meen (2002) for example. Nominal interest rate effects and proxies for credit conditions and/or mortgage rationing are generally significant as well. Regional house price models, which we now turn to, are yet more complicated again.

An extensive review of regional house price models for the UK is not necessary for a couple of reasons. Firstly, Muellbauer and Murphy (1994) and Meen and Andrews (1998), inter alia, review much of this literature. Their review is extremely comprehensive and informative. Secondly, many of the papers, especially those which focus on statistical (i.e. unit root and cointegration) issues, either (i) include no other explanatory variables besides house prices or (ii) only consider a small set of explanatory variables and/or (iii) use non-structural models which are difficult to interpret. Most of these papers say little about the economic determinants of regional house prices.

Giussani and Hadjimatheou (1991a,b) set out to develop structural models for the evolution of regional house prices. In their (1991a) paper, they start by investigate the ripple effect and discuss various causal mechanisms. They suggest that "rising incomes, favorable financial conditions, and regional differences in supply elasticities over time lead to an initial widening of house price differentials, with house prices in the South increasing faster than in the rest of the country. In short, the old equilibrium is being disturbed. As a result of the excessive differentials people find it worthwhile to move from the South to the less house-expensive regions until a new equilibrium is established." They cite evidence on inter-regional migration rates consistent with this view.

They estimate a series of regional reduced form house price equations. Their long-run house price equations are not interpretable as inverted demand curves since construction costs are included as an explanatory variable. They also condition on the number of households - which would itself depend on income and housing costs, as well as on population and demography. Not surprisingly they find substantially lower income effects on prices than the "central estimates" in Meen (1996) and Meen and Andrews (1998) and, given the number of households, a much higher sensitivity of prices to the housing stock. The long-run relationships are embedded in a short-run adjustment mechanism, which incorporates non-linearity in lagged house price changes to reflect housing market frenzy, as well as changes in building costs and in net mortgage advances and, the acceleration of the aggregate national mortgage stock. Moreover, the lagged rate of change of London house prices, with different lag lengths for different regions, represents the ripple effect of house price transmissions. Muellbauer and Murphy (1994) discuss some of the problems with their model including the formulation of their long-run relationship for house prices in nominal as opposed to real terms.

Giussani and Hadjimatheou (1991b) estimate a relative house price equation for the South East and the North West. Relative house prices are a function of relative incomes, the relative household numbers to housing stock ratio, an interest rate to reflect the bigger effect of interest rates in the South East, the rate of change of unemployment in each region and the lagged relative housing wealth per household. It appears that the number of households relative to the housing stock is not significant while lagged housing wealth

relative to the number of households has a significant positive effect. This implies, implausibly, that an increase in the supply of houses increases the house price in a region, while an increase in the number of households reduces it. Curiously, the rate of return, primarily driven by lagged house price changes is missing from this model, despite their emphasis on it in their other paper. In the long-run, their model implies an income elasticity for house prices of seven, far beyond the realms of plausibility.

MacDonald and Taylor (1993) study regional house prices in a cointegration framework. They find that log nominal house prices, using quarterly data from 1969 to 1987, are integrated of order one so taking first differences makes them stationary. They then use the Johansen framework to investigate their cointegration properties - what linear combinations of the regional house prices are stationary. They find as many as nine cointegrating vectors. This, as they admit, is econometrics with a "black box" flavour since no explanatory variables such as income, population or the housing stock enter the analysis. Essentially, their conclusion is that, with one exception (presumably Northern Ireland) regional house prices do not diverge systematically in the long-run.

Alexander and Barrow (1994) cover similar ground to MacDonald and Taylor (1993). Inter alia, the authors report Granger causality as well as bivariate and multivariate cointegration tests for quarterly house prices for eight UK regions. They present a thorough analysis of the time series properties of the data and report evidence of the ripple effect and cointegration of house prices. For example, the pairwise bivariate test for cointegration suggest only six sets of pairwise cointegrating regions whereas the multivariate tests suggest that there are between three and five cointegrating vectors. However, there is little discussion of the transmission mechanism behind the ripple effect or why some house prices, and not others, appear to be cointegrated.

Muellbauer and Murphy (1994) use annual data for 1972 to 1991 to estimate inverted demand equations explaining relative house prices in the ten Standard Statistical Regions (SSR's) of Great Britain. They suggest that changes in house prices can best be explained by changes in factors that affect demand, given the regional supply of housing - as long as account is taken of time-lags and the possibility that prices may not clear the market in

the very short run. The authors take account of contiguity effects as well as spatial lags and errors. They also model the ripple effect.

The model suggests that regional differences in house prices from the UK average are related to the following factors within the region and adjoining regions - income; the rate of return attained from owner-occupation (adjusted for time lags); the rate of acceleration of the unemployment rate in the South East (with a different impact in different regions). Within the region, the following factors matter: - regional population relative to the regional housing stock (both owner-occupied and rental); the cost of servicing mortgage debt relative to income; an index of financial liberalisation (with a different impact in different regions); the mortgage stock/income ratio and income inequality.

Muellbauer and Murphy (1994) use their model to answer a number of important questions - why geographical differences in house-prices are so much greater than those in income; why the North-South difference in house prices widened in the 1980s; why the South leads the house-price cycle; why upswings in house prices tend to be self-reinforcing; why the downswing in the South East was sharper than elsewhere in the economy. For example, they point out that one important reason why regional differences in house prices exceed those in incomes is that the income elasticity for housing is about two. They also explain why movements in regional house prices tend to be self-reinforcing.

Reilly and Witt (1994) investigate the hypothesis that repossessions have a direct effect on house prices. Using annual data for 1987 to 1990 for ten regions, they regress log house prices on time effects, region effects and on income, unemployment, the age structure, repossessions relative to the owner-occupied housing stock and a small set of interaction effects. Given that repossessions were concentrated in the South East towards the end of the period (and reflect, in part, high debt levels, high interest charges and the very collapse of house prices being explained) it is not surprising that they find that repossessions have a significant effect on house prices. If there is a causal role for repossessions, it is likely to have been swamped by a combination of omitted variables and the reverse causation.

Drake (1995) uses the Kalman filter and a time varying parameter model to look for evidence of regional convergence in house prices and the ripple effect. For regions other than the South East, he regresses the log of the national UK to regional house price ratio on a constant and the log UK to South East house price ratio. If the estimated value of the time varying slope parameter is close to one on average, then this is evidence of convergence. If the slope parameter varies pro-cyclically around one, then this is evidence of convergence and the ripple effect. Overall, Drake (1995) finds little evidence of regional convergence in house prices outside the Midlands and the South of England. He also finds little evidence for a strong ripple effect.

Munro and Tu (1996) construct a fairly simple model of regional house prices using the two-step, Engle-Granger cointegrating regression procedure. Regional house prices are explained by regional household income, interest rates interacted with a policy dummy for the removal of mortgage rationing in the early 1980's, and either UK or Greater London and South East house prices. They find evidence of the standard ripple effect, although house prices in Wales, Scotland and Northern Ireland appear to be fairly independent of house prices in England. The fit of their equations is rather poor.

Ashworth and Parker (1997) use the Johansen maximum likelihood procedure and quarterly data for the eleven (SSR) regions of the UK to estimate a model relating regional house prices to regional per capita income, the real interest rate and regional private sector housing starts. The resulting equations are difficult to interpret since the housing stock, rather than the flow of new housing, should be the appropriate quantity variable in an inverted housing demand equation. The authors report finding cointegrating house price equations for every region apart from Scotland and Northern Ireland; similar equations across regions; weak interest rate effects and house price to income elasticities between 3 and 4, which are rather high. They also cast doubt on the existence of the ripple effect.

Meen (1999) provides a new interpretation of the ripple effect. He suggests that income differences and spatial lags do not fully explain the ripple effect. He argues that differences in structure between regions, which show up as differences in the coefficients of regional house price models, are important.

He uses annual data to estimate general, dynamic inverted demand equations for log relative house prices. His explanatory variables are relative consumption, proxying permanent income, the regional unemployment rate differential, the nominal mortgage interest rate, national/UK average consumption and the national unemployment rate. The latter two variables are restricted so that they only enter the short run dynamics and not the long run solutions, thus ensuring that the ripple effect holds in the short run. In the long run, regional house price differentials only depend on regional income differentials since relative unemployment rates and the nominal interest rate do not enter the long run solution. Presumably, these are data based restrictions. Nominal interest rate effects could conceivably wash out when considering relative house prices.

Meen (1999) finds that the estimated coefficients, especially on the UK variables, display a significant amount of spatial heterogeneity with a distinct and plausible spatial pattern. He uses his estimated equations to simulate the effects of various shocks to the UK variables on relative house prices in the regions. He finds that his model, with short run coefficient variation and common long run coefficients, generates a ripple effect which leads him to conclude that differences in structures between regions are important. In practice, given the available data, there will always be some tension between the need to capture spatial patterns of coefficient heterogeneity and the need to include the full range of variables found to be important in national house price models.

Wood (2003) focuses on the ripple effect. He discusses various transmission mechanisms which could generate the ripple effect. Using quarterly house price data for the regions of the UK and Granger causality tests, he tries to identify whether regional house prices have moved in a way consistent with the ripple effect. His results are mixed. He finds little evidence of the ripple effects operating post 1994. He also finds little evidence that Greater London or South East house prices help forecast national house prices. However, his model of national house prices is extremely naïve – national house prices are only determined by average earnings and the real interest rate in the long run!

Cook (2003) argues that the existence of a (stable) ripple effect implies that regional to national house prices ratios converge in the long run i.e. the ratios are stationary. He uses quarterly regional house price data for the UK and two unit root tests – the standard augmented Dickey-Fuller test and an extension of this test with asymmetric adjustment terms – to examine this issue. He suggests that many regional / national house prices ratios are stationary once one allows different speeds of adjustment over the cycle and by region. Cook (2005) extends these results using a joint testing framework. He uses the GLS-based Dickey Fuller test (with a null of a unit root) in combination with the KPSS test (with a stationary null) and finds that more regional / national house prices ratios than before appear to be stationary.

Meen and Andrews (1998) suggest that any valid model of regional house prices should possess the following features:-

- It should be data consistent;
- It should incorporate spatial lags and errors;
- It should capture spatial patterns of coefficient heterogeneity;
- The implied estimates of the income and price elasticities of housing demand should be plausible;
- It should include the full range of variables found to be important in national house price models;
- The implications for housing efficiency should be clear;
- It should be capable of explaining the ripple effect;
- The relative importance of demographic, as opposed to economic determinants, should be clear.

Meen and Andrews (1998) suggest that the majority of the UK regional house price models, which they surveyed back then, did not satisfy many of these criteria. Unfortunately, our survey suggests that things have not really improved since then.

3. An Outline of the Regional House Price Model

We model real house prices in eight regions of Great Britain – the North (NT), Yorkshire and Humberside (YH), East Midlands (EM), West Midlands (WM), Greater London (GL), the South (ST), the South West (SW), Wales (WW) and Scotland (SC). The choice of regions is determined by the need for consistent

regional boundaries since the government switched from Standard Statistical Regions (SSR's) to Government Office Regions (GOR's) in the mid 1990's. The North region is the sum of the current North East and North West GOR's, which is the sum of the old North and North West SSR's. The South region is the sum of the South East and Eastern GOR's, which is the sum of the old Rest of South East (i.e. excluding Greater London) and East Anglia SSR's.

--- Figures 1 and 2 About Here ---

Figure 1 shows log real regional house prices for Greater London, the West Midlands and the North. It suggests that the regions experienced broadly comparable long run movements. Greater London is considerably more expensive than the other regions.[1] Figure 2 shows the same information in terms of log changes, which allows the heterogeneity in movements to be seen more clearly. The leading role of Greater London house prices and the tendency of house prices in the North to lag further behind those in the West Midlands are clear.

We estimate a system of inverted housing demand equations using the seemingly unrelated regression (SUR) procedure, which takes account of contemporaneous spatial correlations. The equations are non-linear with many cross-equation restrictions because of common parameters and interaction terms. However, some spatial coefficient heterogeneity is allowed for. We use annual data from 1972 to 2003.

--- Tables 1 and 2 About Here ---

Our basic regional house price / inverted demand equation is set out in Table 1. We have annotated the equation to help the reader. The Greater London and South equations are similar to the equation set out above except that (i) some of the short run coefficients and time dummies are allowed to take different values and (ii) negative changes in the real value of the FTSE are included as an additional explanatory variable.

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[1] Note that 1990 average second hand house prices are used to scale the regional mix-adjusted indices.

The SUR parameter estimates with robust standard errors are set out in Table 2. We have imposed some restrictions, partly to save degrees of freedom and partly to tie down the long run of the model or non-linear interaction effects. In all cases, we can accept the restrictions. For example, the long run elasticity of house prices with respect to income and the housing stock γ is set to 2. This corresponds with our priors and the central estimates in the literature. The freely estimated value of γ is approximately 1.75 with a standard error of about 0.2.

We model the log change in real house prices[2] $\Delta lrhp_r$ (the r subscript stands for region r) in each region (deflating by the consumer expenditure deflator) using lagged real log house price changes, real log income and real log house price levels, and other variables. We check for inflation effects and find that the rate of acceleration of prices, $\Delta^2 lpc$, conveniently summarises current and lagged inflation effects.

The long-run solution is for $lrhp_r$, the real log level of house prices in region r. The key element in the long-run solution is the log of real personal disposable non-property income per house[3], following Meen's work. For example, see Table 3.2 in Miles (2003). For region r, we write this as $lrynhs_r$ defined as log(real personal disposable non-property income in region r) - log(lagged housing stock in region r) - 0.7*log(lagged rate of owner-occupation in region r). The owner-occupation term suggests a modest spill-over from non-owner occupied supply onto the owner-occupied housing market. See Muellbauer and Murphy (1997). This means that one rented house added to the stock has around 30% of the effect on prices compared to the effect of adding a house for owner-occupation.

Note that population or the number of households is implicit in this formulation since income and the housing stock can both be put on a per capita basis, but

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[2] Muellbauer and Murphy (1994) and many other researchers model relative house prices. Given a model for UK house prices, it does not matter greatly whether one models real or relative regional house prices. However, a model for real regional house prices is a good deal easier to interpret and can also be helpful in finding a coherent specification for a national house price model.

[3] Data definitions and sources are set out in the Appendix. Note that we do not use regional personal income data from the Regional Accounts since it is biased (Cameron and Muellbauer, 1999). Instead we use regional earnings and employment data to modify the National Accounts personal income data to estimate personal non-property income on a regional basis.

the number of people or households just cancels out. However, we find that all regions are influenced not just by the own region value of income per house $lrynhs_r$ but also by the GB value, $lrynhs_{GB}$. We can accept the restriction that the weights (w_0 and $1-w_0$) on $lrynhs_r$ and $lrynhs_{GB}$ are equal to 0.3 and 0.7 respectively.[4]

We can also accept the hypothesis that the long-run effect of log real income per house on the log real house price (γ) is two in line with previous studies of national house price determination. The speed of adjustment (λ) is ¼ which means that about three quarters of the adjustment to an income shock is completed within four years.

Each equation contains a region specific intercept and time trend. In all regions, these trends have positive coefficients. This may reflect trends in housing quality or supply (for example, trends in conversions and improvements) which do not show up in the housing stock data, or other trending variables such as income inequality.

Other levels effects in the long-run solution include:

- an index of credit conditions (cci) which measures credit supply to UK households, which has greatly expanded since 1980.
- the interaction of this index with both the log nominal tax adjusted mortgage rate (labmr) and the real mortgage rate (rabmr). These interest rate effects are consistent with findings for mortgage demand in Fernandez-Corugedo and Muellbauer (2005).

The log nominal interest rate effect means that a reduction of rates from 5% to 4% has a stronger effect on house prices than a reduction from 10% to 9%, which is plausible. The short run nominal interest rate effects are also a little stronger in London and the South East.

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[4] In practise, the results are surprisingly robust with respect to the choice of w_0. A value of 0.7 may initially appear large but some calculations suggest that this is not implausible. Consider a simple, two region, symmetric economy (r =1,2) with log-linear, housing demands given by $h_r = -\alpha_r p_r - \beta_r (p_r - p_s) + y_r + z_r$ where h_r = log housing stock, p_r = log house price and y_r = log income and z_r = other demand shifters. The own price elasticity of demand is $\alpha_r + \beta_r$ and the cross price elasticity is β_r. Solving for p_1 yields $[\alpha_1 + \beta_1 - \beta_1\beta_2/(\alpha_2 + \beta_2)].p_1 = (y_1 - h_1 + z_1) + \beta_1/(\alpha_2 + \beta_2).(y_2 - h_2 + z_2)$. If the α's and β's are all equal to 0.5, reasonably plausible values, then $¾p_1 = (y_1 - h_1 + z_1) + ½.(y_2 - h_2 + z_2) = ½.(y_1 - h_1 + z_1) + (y - h + z)$ where $y = ½.(y_1 + y_2)$ is national income etc. In this equation the weight on own region income y_1 is half the weight on national income y.

Another important level effect is the log price of house prices in London relative to GL ($rlhp_{GL}$) which we allow to vary by region. This has a positive effect in many of the regions close to Greater London, capturing some of the role of London as the driver of UK house prices.

We also investigated the role of the national possessions rate, as an indicator of fear or downside risk in the housing market, comparing it with an alternative, the average value over the previous four years of the negative return in the region's housing market, $rrhneg_r$[5]. This variable is significant and has the expected positive coefficient where the possessions rate variable is insignificant (given $rrhneg_r$) and therefore dropped from the model. This means that a history of negative returns depresses house prices for some time to come.

In the dynamics, the persistence of the previous year's house price growth rate is measured through a coefficient common to all regions. However, the relative weight attached to the own region ($\Delta lrhp_{r,-1}$), to regions contiguous to region r ($\Delta clrhp_{r,-1}$), and to Greater London ($\Delta lrhp_{GL,-1}$), varies by region. Generally speaking, regions closer to London have the largest weights on London house price growth, reflecting the 'ripple effect' emanating from London.

An important hypothesis concerns the question of stock and flow equilibrium effects on house price determination. The stock equilibrium effect enters through the log income per house variables, $lrynhs_r$ and $lrynhs_{GB}$, discussed above. A flow equilibrium can be examined through the effects of housing stock changes and population changes. The idea is that short term increases in the housing stock relative to population lead to short-term local excess supply, with downward pressure on local prices. Conceivably, this could also reflect an expectations effect in that market participants may believe that a higher rate of house building relative to population growth could have an impact on future house price changes. We measure this effect by including $\Delta ln(wpop_r/hs_{r,-1})$ in each region's equation. We find a significant effect,

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[5] The rate of return rrh_r is defined as the lagged nominal rate of house price appreciation in the region minus the tax adjusted mortgage interest rate/100 plus 0.03 to reflect the benefit from owning a home. We define $rrhneg_r$ to equal rrh_r if rrh_r is negative, and zero otherwise.

suggesting that a 1 percent rise in working age population relative to the housing stock has a short run effect of the order of 1½ to 2 percent on the region's house price index. We investigated whether the growth in the regional proportion of households in the main ages for first time buyers (20 to 39) had any effect. The estimated effect of this pp2039 variable is statistically significant and positive.

Income dynamics turn out to be important. Outside London and the South East, we impose the same coefficient on the current year rate of growth of per capita, national disposable non-property income. In London and the South East the income growth coefficients are somewhat higher. The previous year's income growth rate is also important. The region specific growth rates have little explanatory power, a surprising result.

It is often thought that the stock market, or financial wealth more generally, has an effect on the housing market. We failed to find a positive levels effect from either, unlike earlier national studies by Meen and Muellbauer and Murphy (1997). This may be because we do not have regional wealth data. However, the rate of growth of the FTSE index in real terms has significant positive effects, especially in Greater London and the South. It is sometimes suggested that relative returns or relative risks in housing and shares influence the allocation of investment between the two sectors. A simple measure of downside risk for the stock market can be defined by $\Delta lrftseneg$ which is equal to the log change in the real FTSE index, $\Delta lrftse$, if this is negative and is otherwise zero. This effect is important in Greater London and the South, where share ownership and active portfolio investors are most likely to be concentrated, but irrelevant outside these regions. The two stock market effects together suggest that, for example, a 20% stock market downturn has a much smaller (absolute) effect on house price inflation in Great London and the South than a 20% upturn.[6]

The regional equations generally include dummy variables for 1988, 1989 and 2001. 1988 is special because it became clear that domestic rates would be abolished in England and Wales and replaced by the Poll Tax. It also marked

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[6] The estimated short run, impact effects are a fall of about 1½% and a rise of about 6½% for a 20% downturn / upturn in the real FTSE.

the March announcement that from August 1st, tax relief for mortgage interest would be restricted to one per property. This led to a surge of purchases financed by joint mortgages to meet the August deadline, pushing up prices, especially in London, in the early part of the year. We can accept the restriction that the 1988 and 1989 effects were the same outside London and the South East, where the 1989 effect was lower, zero in the case of London, probably because of the advancement effect of the tax relief change, which shifted demand from 1989 into 1988. A dummy for 2001 could be argued to reflect a 9/11 effect, likely to have been more severe in London.

--- Table 3 About Here ---

Some single equation diagnostics are presented in Table 3. Overall the model fits well, although there is some evidence of mild autocorrelation in some equation. The stability of the model was checked by estimating it on different sub-samples. The specification was checked against quarterly house prices equations for the UK and the North and South of Britain and consistent results were obtained.[7] We also checked for income distribution effects, since space is a luxury good, and property tax effects (domestic rates and their abolition and subsequent replacement by council tax) since variations in tax rates over time and over regions should have effects on prices. Income distribution changes are trend like and so hard to detect here. Despite pain-staking work constructing regional tax data back to 1975, the estimated tax effects were insignificant. The use of 1988 and 1989 dummies probably picks up much of the effects of the tax switches of the time. By 1990, one can argue that it had become clear that the poll tax would not survive and property taxes would return, thus eliminating the positive effects found for the previous two years. Further work on the issue, incorporating Stamp Duty variations as well, would be desirable, although handling expectations of tax changes will always be difficult.

It seems likely that property taxes linked more closely to house prices could have damped the market and had some long run effects.

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[7] The one exception has to do with the specification of the demographic variable pp2039. The regional model uses the first difference of this variable whereas the quarterly UK house price equation prefers the level of this variable. We have looked at this issue in detail and are satisfied that the first difference specification used in the annual regional model is robust. In any case, the quarterly model was estimated over a shorter time period.

There are no frenzy effects of the kind used by Hendry (1984) and Muellbauer and Murphy (1997) in the model. We know that these frenzy effects can be captured by two threshold terms:

$$\Delta lrhp_r = X_r'\beta_r + \beta_1.pos(X_r'\beta_r - rabmr - 0.05) - \beta_2.neg(X_r'\beta_r - rabmr + 0.03)$$

where $X_r'\beta_r$ stands for everything on the right hand side of the equality sign in the model in Table 1 and pos(z) equals z if z is positive and 0 otherwise etc. The two threshold terms capture the notion that transactions costs, such as stamp duties, tend to dampen house price movements when the underlying changes are small. We allow the threshold effects to be asymmetric when house prices are rising or falling a lot. It turns out that the estimated coefficients on these two terms are significant and correctly signed, with the estimated β_1 larger than β_2 in absolute size. However the estimated coefficients are somewhat unstable – they are smaller in absolute size in recent years. We believe that changes in stamp duty rates and bands may be the reason for this instability and we are examining this issue further. Finally, there are no explicit income expectation terms in the model, though expectations effects are likely to be reflected in the interest rate and income dynamics which are in the model.

4. Further Discussion of the Results

In order to get a feel for the magnitude of the various effects in the model, it is very useful to look at some figures. Figure 3 shows the estimated long-run effect of the credit conditions index (CCI), real and nominal mortgage rates interacted with CCI and inflation volatility.[8] Relative to the 1970s, the estimated effects of CCI, in terms of its direct, positive effect on real house prices, is roughly canceled out by the effect of the rise in real interest rates. Interestingly, relatively to 2000, the estimated long-run effect of lower interest rates in 2003 is about 21%, but this falls to around 15% when measured

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[8] In terms of the formal model set out in the Appendix to this Chapter, the three effects are bcc * ave. cci / λ, ((1 – φ* ave. cci) * blabmr * labmr$_{-1}$ + bcrabmr * ave. cci * rabmr) / λ and binfvol * infvol / λ respectively where ave. cci = ½(cci + cci$_{-1}$). The interest rate / CCI interaction reduces the weight on nominal mortgage rates but increases the weight on real rates as CCI rises, with an effectively zero weight on the real rate before 1980.

against the average interest rate effect for the period 1985 to 2000. Since 1985 inflation volatility has not moved much apart from a short term rise in the early 1990s, and so does not have a special role in the recent house price boom.

--- Figures 3 and 4 About Here ---

Figure 4 shows the effects of downside risk, clearly a lagged endogenous variable, also measured as if it were a long run effect.[9] It suggests that the depth of the early 1990s housing market recession had much to do with the negative rates of return (and probably the associated payment difficulties and possessions problems faced by homeowners). This was so especially in Greater London, where the effect only began to lift after 1995.

--- Figure 5 About Here ---

Figure 5 shows the effect of changes in the proportion of the working age population aged 20-39, again interpreted as a long run effect.[10] This could be defended in terms of the approximate I(1) nature of the data. Interestingly, it plays a considerable role in explaining the out-performance of Greater London house prices in the late 1990s and early 2000s. It also helps explain why house prices were apparently slow to respond to the interest rate rises of 1988-90 - the changing age structure was still supporting the market – as well the weak market conditions between 1992 and 1997.

--- Figure 6 About Here ---

Figure 6 shows composite income, population and housing stock effects.[11] The latter include both the effect of average income per house and the effect of the rate of growth of working age population relative to the lagged housing stock. This suggests that, before 1997 or so, the rate of house building broadly matched rises in real incomes and working age populations (and implicitly household formation). However, since then, the latter have greatly

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[9] The downside risk effect is $brrhneg_{-1} * (rrhneg_{r,-1} + rrhneg_{r,-2} + rrh.neg_{r,-3} + rrhneg_{r,-4}) / \lambda$.

[10] The demographic effect is $b\Delta pop2039_{-1} * \Delta pop2039_{r,-1} / \lambda$.

[11] The composite income, population and housing stock effect equals $\gamma * ((1 - w_0) * lrynhs_r + w_0 * lrynhs_{GB})) + b\Delta lwpophs * \Delta log(wpop_r/hs_{r,-1}) / \lambda$.

outpaced the rate of house building, especially in Greater London, so driving up real house prices. In Greater London, this was the result both of higher per capita income growth and of population growth, driven by net foreign immigration. However, since 2002 or so, the net change in population has altered, with net outflows from Greater London to other regions offsetting immigration. The overall consequence is that this composite effect explains most of the rise in real house prices since around 1997, thus confirming the relevance of the Barker Inquiry on Housing Supply (Barker, 2004).

--- Figures 7a and 7b About Here ---

Figure 7a shows one version of an error correction term including income per house, Greater London catch up, credit, interest rate and inflation volatility effects.[12] The change in age structure and the rate of change in population per house, two near I(1) variables in our data, are excluded from this figure. Figure 7a suggests that, given interest rates, incomes, population and housing stock, Greater London was only moderately overvalued in 2003, while the West Midlands and the North were substantially undervalued.

Including the change in age structure and the rate of change of working population per house in the error correction does not change the picture very much, see Figure 7b. Greater London now looks less overvalued in 2003 while the other two regions remain undervalued. The picture is very consistent with the house price changes that have occurred since 2003, where price rises in the West Midland and North have hugely outperformed Greater London.

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[12] The error correction term in Figure 7a equals:

$lrhp_{r,-1} - b0_r / \lambda - byear_r * (year - 1990) / \lambda - \gamma * ((1 - w_0) * lrynhs_r + w_0 * lrynhs_{GB}))$

$- brlhp_{gl,r,-1} * rlhp_{gl,-1} / \lambda - bcci * ave. cci / \lambda, - ((1 - \varphi * ave. cci) * blabmr * labmr_{-1} / \lambda$

$- bcrabmr * ave. cci * rabmr / \lambda - binfvol * infvol / \lambda.$

The error correction term in Figure 7b subtracts $b\Delta pop2039_{-1} * \Delta pop2039_{r,-1} / \lambda$ and $b\Delta lwpophs * \Delta log(wpop_r / hs_{r,-1}) / \lambda$ from this.

5. Is There a House Price Bubble?

In this Section, we address the question of whether or not there is currently a bubble in UK house prices, which we take to mean a widening deviation of house prices from fundamentals. A lot of the debate about house price bubbles focuses on the time series behaviour of house price to income or mortgage repayment ratios. We argue that these ratios are not very informative about the presence of absence of bubbles, because these ratios ignore a range of other important factors. For example, as we have shown, demographic and new housing supply effects are important in the short run as well as the long run[13].

Another strand of the housing bubbles literature looks at the ratio of house prices to rents, using an equilibrium asset pricing approach. For example, see Ayuso and Restroy (2003) and Weeken (2003). This approach appears very attractive and simple, since house prices do not have to be modelled. The basic problem with this approach is the small size of the private rented sector in the UK, which is not representative of the private housing sector as a whole, and the poor quality of the available rent data. In addition, a lot of auxiliary assumptions are required to implement this approach. To be fair, both Ayuso and Restroy (2003) and Weeken (2003) acknowledge these complications. Never the less, Ayuso and Restroy (2003) suggest that UK house price to rent ratios were about 20% above their equilibrium value in 2002. Weeken (2003), whose results imply that house price to rent ratios were only a few percentage points above their equilibrium level in 2002, suggests that "because of data and model limitations, no firm conclusions can be drawn".

The other strand of the bubbles literature is more technical. For example, Roche (2001) estimates a regime switching model for Dublin house prices. Special cases of this model are a fads model and a partial collapsing (speculative) bubble model[14]. The regime switching model is estimated in two

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[13] The debate in the US pays more attention to these factors. See Case and Shiller (2003) and Himmelberg, Meyer and Sinai (2005), inter alia.

[14] In both the fads and collapsing bubbles models, houses prices may systematically differ from fundamentals over a number of years. In the fads model, the non-fundamental component of house prices is mean reverting. However, in the collapsing bubbles market,

stages. In the first stage, the non-fundamental component of house prices is estimated. In the second stage, the actual regime switching model is estimated using last period's estimated non-fundamental prices as the only explanatory variable explaining the change in house prices this period. This means that the regime switching model results are crucially dependent on the model used to estimate the fundamental and non-fundamental components of house prices so modeling the determinants of house price cannot be avoided. Moreover, regime switching models can be difficult to estimate since the models are highly non-linear. In practice, long runs of high frequency data are required which often means that a limited set of explanatory variables are used. We have not explored regime switching models for this reason.

--- Table 4 About Here ---

Our model results do not suggest that house prices in 2003 are over valued by 20% or more. We say this because our model fits the data well so there is little left over to be classified as bubble. Moreover, the in-sample forecasts suggest that we have not over-fitted the model and thereby ruled out the possibility of detecting a bubble.

We also looked at some out-of-sample scenarios to see what the model suggests about the course of real house prices in the next few years. If the model were to suggest that house prices might collapse in some circumstances, then maybe house prices are actually overvalued by 20% or more. Inter alia, we considered the two scenarios set out in Table 4.

--- Figure 8 About Here ---

The base scenario, which involves a mild slowdown in the economy for a couple of years, is a fairly plausible one. The simulation results in Figure 8 provide no evidence of a house bubble. We explored the robustness of this result by simulating the effects of a 50% increase in the rate of growth of the housing stock (albeit from a very low level). We found that real house price

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there is a period when the non-fundamental or speculative component of house prices grows along with the probability of a collapse in this component.

growth would only be marginally lower, though the effect on the level of real house prices accumulated over time. If the real estate investment trust (REITS) and self invested personal pension (SIPPS) valuation effects are significant, house prices would still rise. .

We also considered a negative "gloomy" scenario in which the economy turns sour – inflation rises, interest rates rise quite a lot in response, income falls and the stock market nose dives before gradually recovering. In this case, assuming there are no REITS or SIPPS valuation effects, the simulation results that moderate nominal falls in house prices in 2006-2007 are a possibility, especially in London and the South[15]. Again, the results do not suggest that there is a bubble in house prices.

6. Conclusions

The regional house model presented here has most of the necessary features which Meen and Andrews (1998) believe a valid model should have. The model is data consistent; incorporates spatial lags and errors; has some spatial coefficient heterogeneity; has a plausible long run solution; includes a full range of explanatory variables and so on. Only time will tell whether or not the model will prove useful and hold up. When using the model for forecasting or simulating policy scenarios, feedbacks to and from regional house prices, earnings, employment and unemployment and inter-regional migration[16], as well as more conventional and important macro feedbacks from interest rates etc. must be factored in.

Our model captures long run structural features such as the effect of income, population, age composition, the housing stock, and interest rates on the long-run level of real house prices. It also builds in the effect of house price dynamics, including transmission from leading or adjacent regions on other regions. In the UK, the leading region is London, and the "ripple effect" of

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[15] If the consumption, income and exchange rate feedbacks are large, the fall in nominal house prices could be self-reinforcing resulting in a larger downturn. This downturn would be temporary since the global interest rate environment is likely to remain kind, given the high levels of debt and house prices in the UK and US.

[16] See Cameron and Muellbauer (1998, 2001), Cameron, Muellbauer and Murphy (2005) and Johnes and Hyclak (1994,1999) inter alia.

changes there impacting on other regions, first on adjacent ones, is a notable feature in the UK.

We distinguish between the short-run and long run effects of house-building and population growth. We allow for stock market effects and test for heterogeneity between regions in some of the key parameters. We also examine the effect of easier credit conditions resulting from structural changes in UK credit markets. Easier credit conditions not only have a direct effect on the level of real house prices, but also shift the relative roles of real and nominal interest rates: the former become more important and the latter less important.

The great advantage of the regional data is more precise estimation of the structural parameters, which makes it possible to draw more robust conclusions. A striking finding is that estimating the model on data up to 1996 and forecasting conditionally on the other variables leads to no symptoms of systematic under-prediction of house prices in the period 1997-2003 when house prices rose very strongly. Furthermore, our conclusion is that the evolution of regional prices in this period can be explained by the combination of strong income growth, higher population growth (partly from in-migration), lower interest rates and low rates of house-building.

We simulated house price developments for the period 2004-2010 on a range of assumptions about income growth, population growth, house-building, inflation and interest rates,. We found that only quite negative scenarios – more negative than any currently contemplated by main-stream forecasters - would produce falls in nominal house prices. London and the South are the regions where such negative scenarios would have the largest regional effects, if they occurred. The question, 'was there a house price bubble in the UK' appears, at least provisionally, to have the answer 'no'.

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Table 1
House Price Equations for Regions Other Than
Greater London and the South

$\Delta lrhp_r =$	Dependent variable = change in log real house prices in region r. House prices are mix adjusted and adjusted for changes in survey coverage.
$b0_r$	Region specific intercept.
$+ byear_r * (year - 1990)$	Region specific linear trend.
$+ b\Delta rlhp_{-1} * [(1 - w_{1r} - w_{2r}) * \Delta lrhp_{r,-1} + w_{1r} * \Delta clrhp_{r,-1}$ $+ w_{2r} * \Delta lrhp_{GL,-1}]$	Positive effect of lagged change in real house prices in the region, in contiguous regions and in Greater London. Weights are region specific.
$+ \lambda * [\gamma * ((1 - w_0) * lrynhs_r + w_0 * lrynhs_{GB}) - lrhp_{r,-1}]$ $+ brlhp_{gl,r,-1} * rlhp_{gl,-1}$	Error correction terms. The first term says that, in the long run, log real house prices are $\gamma = 2$ times log real income per house, ceteris paribus. The second term, which is region specific, allows house prices in the EM, WM and SW regions to be "driven" by GL houses prices. The speed of adjustment λ is ¼ whilst the long run elasticity of house prices w.r.t. real (non-property personal disposable) income and the housing stock γ is 2. w_0, which equals 0.7, is used to weight regional and national income per house figures. The values of λ, γ and w_0 are all data admissible.
$+ b\Delta lrpdi * \Delta lrpdin$	Positive effect of changes in national non-property personal disposable income (pdi).
$+ b\Delta lrpdi_{-1} * \Delta lrpdin_{-1}$	Positive effect of lagged change in non-property income.
$+ bcci * ½(cci + cci_{-1})$	Positive effect of credit conditions. The cci measure is from Fernandez-Corugedo and Muellbuer (2005).
$+ bcci\Delta lrpdi * ½(cci + cci_{-1}) * \Delta lrpdin$	Negative interaction of cci and $\Delta lrpdin$. Households are less cash constraint if cci is high, so income changes matter less.
$+ (1 - \varphi * ½(cci + cci_{-1})) *$ $(b\Delta_2 labmr * \Delta_2 labmr + blabmr * labmr_{-1})$	Negative effect of two period change in log (tax adjusted) mortgage rate and lagged level of the same variable interacted with the credit conditions measure cci. Interest rates matter less when credit is more freely available. The parameter φ is set to 2, based on the results in Fernandez-Corugedo and Muellbuer (2005). This restriction is acceptable.
$+ bcrabmr * ½(cci + cci_{-1}) * rabmr$	Negative effect of real tax adjusted mortgage interest rates. The effect is stronger as credit becomes more freely available.
$+ b\Delta^2 lpc * \Delta^2 lpc$	Negative effect of acceleration in the inflation rate.
$+ binfvol * infvol$	Negative inflation volatility effect.
$+ brrhneg_{-1} * (rrhneg_{r,-1} + rrhneg_{r,-2} + rrh.neg_{r,-3} + rrhneg_{r,-4})$	Negative downside risk effect, using MA_4 of lagged negative real rates of return on housing.
$+ b\Delta pop2039_{-1} * \Delta pop2039_{r,-1}$	Positive demographic effect captured by changes in the share of the working age population aged 20 to 39 in the region.

+ bΔlwpophs * Δln(wpop$_r$/hs$_{r,-1}$)	Positive effect of change in the ratio of the working age population to the housing stock in each region.
+ bΔlrftse * Δlrftse	Positive wealth effect of changes in the log of the real FTSE.
+ b8889 * (d88 + d89)	Positive time dummies for 1988 and 1989. Poll tax and Lawson advance announcement of end of multiple mortgage interest tax relief.
+ b01 * d01	Negative time dummy for 2001 capturing 9/11 and stock market turmoil effects.

Notes: The Greater London and South equations are similar to the equation set out above except that (i) some of the short run coefficients and time dummies are allowed to take different values and (ii) negative changes in the real value of the FTSE are included as an additional explanatory variable. As a result, changes in the real value of the FTSE have an asymmetric effect in GL and the ST. The negative effect of a fall in the real FTSE is much smaller that the positive effect of a rise in the real FTSE.

Table 2
Seemingly Unrelated Regression (SUR) Parameter Estimates
Dependent Variables = ΔLRHP$_r$

Parameters		Estimates	Robust Std Errors	t-Stats
Region Specific Intercepts	b0$_{NT}$	0.905	0.020	46.28
	b0$_{YH}$	0.911	0.020	45.87
	b0$_{EM}$	0.897	0.032	28.22
	b0$_{WM}$	0.902	0.027	33.10
	b0$_{GL}$	0.973	0.021	45.16
	b0$_{ST}$	1.013	0.036	27.78
	b0$_{SW}$	0.963	0.030	32.05
	b0$_{WW}$	0.940	0.021	45.81
	b0$_{SC}$	0.904	0.018	49.96
Region Specific Trends	byear$_{NT}$	0.0029	0.0006	4.43
	byear$_{YH}$	0.0035	0.0008	4.70
	byear$_{EM}$	0.0035	0.0010	3.53
	byear$_{WM}$	0.0027	0.0006	4.76
	byear$_{GL}$	0.0020	0.0007	2.73
	byear$_{ST}$	0.0027	0.0007	3.72
	byear$_{SW}$	0.0028	0.0007	3.91
	byear$_{WW}$	0.0035	0.0008	4.62
	byear$_{SC}$	0.0036	0.0007	5.03
Error Correction in Real Income Per House = 2*(0.3*lrynhs$_r$ + 0.7*lrynhs$_{GB}$) - lrhp$_{r,-1}$ (λ = 0.25, γ = 2, w$_0$ = 0.7)		0.25	-	-
Relative House Prices in GL Lagged	rlhp$_{GL,-1}$ (EM)	0.119	0.051	2.33
	rlhp$_{GL,-1}$ (WM)	0.063	0.054	1.18
	rlhp$_{GL,-1}$ (ST)	0.066	0.063	1.08
	rlhp$_{GL,-1}$ (SW)	0.058	0.046	1.26
Lagged House Price Inflation = Weighted Comb. of Δrlhp$_{r,-1}$, Δcrlhp$_{r,-1}$ & Δrlhp$_{GL,-1}$		0 .462	0.030	15.28
Contiguous Region "Weights"	w$_{1,NT}$	0.662	0.194	3.41
	w$_{1,YH}$	1.433	0.251	5.72
	w$_{1,EM}$	1.199	0.265	4.53
	w$_{1,WM}$	0	-	-
	w$_{1,GL}$	0	-	-
	w$_{1,ST}$	0.098	0.288	0.34
	w$_{1,SW}$	-0.255	0.297	-0.86
	w$_{1,WW}$	1.278	0.151	8.47
	w$_{1,SC}$	0	-	-
Greater London "Weights"	w$_{2,NT}$	0	-	-
	w$_{2,YH}$	0	-	-
	w$_{2,EM}$	0	-	-
	w$_{2,WM}$	0.314	0.050	6.28
	w$_{2,GL}$	0	-	-
	w$_{2,ST}$	1.092	0.148	7.40
	w$_{2,SW}$	1.048	0.110	9.52
	w$_{2,WW}$	0	-	-
	W$_{2,SC}$	0	-	-
Credit	½(cci+cci$_{-1}$)	0.263	0.074	3.53
Income	Δlrpdi (excld. GL & ST)	0.656	0.058	11.24

Growth With Credit Effects	Δlrpdi (GL)	0.966	0.091	10.58
	Δlrpdi (ST)	0.722	0.108	6.69
	½(cci+cci$_{-1}$) * Δlrpdi	-2.930	0.464	-6.32
	Δlrpdi$_{-1}$ (excld. GL & ST)	0.568	0.063	8.98
	Δlrpdi$_{-1}$ (GL)	0.805	0.128	6.27
	Δlrpdi$_{-1}$ (ST)	0.568	0.142	4.01
Interest Rate With Credit Effects (Φ= 2)	$(1 - (cci+cci_{-1})) * \Delta_2$labmr (excld. GL & ST)	-0.099	0.011	-8.66
	$(1 - (cci+cci_{-1})) * \Delta_2$labmr (GL)	-0.130	0.022	-6.02
	$(1 - (cci+cci_{-1})) * \Delta_2$labmr (ST)	-0.124	0.019	-6.36
	$(1 - ½(cci+cci_{-1})) *$ demeaned labmr$_{-1}$	-0.082	0.009	-9.18
	½(cci+cci$_{-1}$) * rabmr	-7.179	0.413	-17.39
Downside Risk	MA$_4$ rrhneg$_{r,-1}$	0.176	0.025	7.04
Inflation Effects	Δ^2lpc	-0.736	0.046	-15.81
	inflation volatility	-0.865	0.0004	-2.32
Demog. Effect	Δpop2039$_{r,-1}$	2.182	0.493	4.42
New Houses Effect	Δ(lwpop$_r$ - lhs$_{r,-1)}$	1.629	0.186	8.74
Change in Real FTSE Effects	ΔlrFTSE (ex. GL & ST)	0.027	0.009	2.88
	ΔlrFTSE (GL)	0.275	0.035	7.92
	ΔlrFTSE (ST)	0.215	0.038	5.64
	ΔlrFTSE if neg (GL)	-0.175	0.045	-3.88
	ΔlrFTSE if neg (ST)	-0.176	0.046	-3.79
Time Dummies	'88 & '89 (ex. GL)	0.103	0.004	27.07
	'01 (ex. GL & ST)	-0.075	0.003	-24.91
	'88 (GL)	0.032	0.007	4.54
	'01 (GL)	-0.077	0.005	-14.85
	'01 (ST)	-0.078	0.007	-12.04

Notes: Seemingly unrelated regression (SUR) parameter estimates with robust standard errors. No. of Observations = 32 (1972 to 2003). Trace criterion = 247.640. Imposed restrictions: λ = 0.25 (speed of adjustment), γ = 2 (long run elasticity of house prices w.r.t income and the housing stock), w_0 = 0.7 (weight on regional income and housing stock in the error correction term) and φ = 2 (coefficient on interaction of nominal interest rates and credit conditions).

Table 3
Some Single Equation Diagnostics

	Region								
	North	Yorkshire & Humberside	East Midlands	West Midlands	Greater London	South	South West	Wales	Scotland
Mean	3.24	3.63	4.03	3.65	4.12	3.96	4.01	3.50	2.54
Std. Dev	8.44	8.94	10.68	10.21	11.76	11.97	12.10	9.64	5.81
Std. Error	2.74	2.70	2.19	1.63	3.09	2.60	2.66	2.85	2.96
R Squared	0.89	0.89	0.94	0.98	0.93	0.95	0.95	0.91	0.78
LM Hetero P Value	0.16	0.04	0.11	0.09	0.02	0.42	0.23	0.02	0.10
DW	2.37	2.25	1.45	2.04	2.24	1.45	1.59	2.12	1.89

Notes: The dependent variable in each equation is the change in log real house prices in region r ($\Delta LRHP_r$). In the tables the means, standard deviations and standard errors have all been multiplied by 100.

Table 4
Some Scenarios

Scenarios	Growth Rates Etc.	Year						
		2004	2005	2006	2007	2008	2009	2010
Base Scenario	Real non-property income	2.1%	1.5%	1.5%	2.0%	2.3%	2.5%	2.5%
	Inflation rate	1.3%	2.5%	2.7%	2.8%	2.6%	2.4%	2.2%
	Mortgage interest rate	5.0%	5.5%	5.5%	5.5%	5.0%	5.0%	5.0%
	Real FTSE	9.0%	8.0%	7.0%	5.0%	5.0%	5.0%	5.0%
Alternative Gloomy" Scenario	Real non-property income	2.1%	1.2%	0.5%	0.5%	1.0%	1.5%	2.0%
	Inflation rate	1.3%	2.5%	3.0%	2.8%	2.8%	2.6%	2.4%
	Mortgage interest rate	5.0%	5.5%	6.5%	6.0%	5.5%	5.5%	5.0%
	Real FTSE	9.0%	8.0%	0%	5.0%	5.0%	5.0%	5.0%

Notes: The real non-property income growth rates are aggregate and not per capita figures.
Other assumptions: The index of credit conditions cci is assumed unchanged. The annual rate of growth of regional housing stocks and regional proportions of owner occupiers over the period 2004 to 2010 is assumed equal to the average annual rate of growth in the previous seven years. The source of our regional population numbers are the population projections produced by the Government Actuaries Department (national figures) and the Office of National Statistics (sub-national figures). Their projections show a decline in the growth of the working age population over the period 2004 to 2010. They also show a further decline in the proportions aged 20 to 39. The largest decline is around 2006. The decline tails off a little after this.
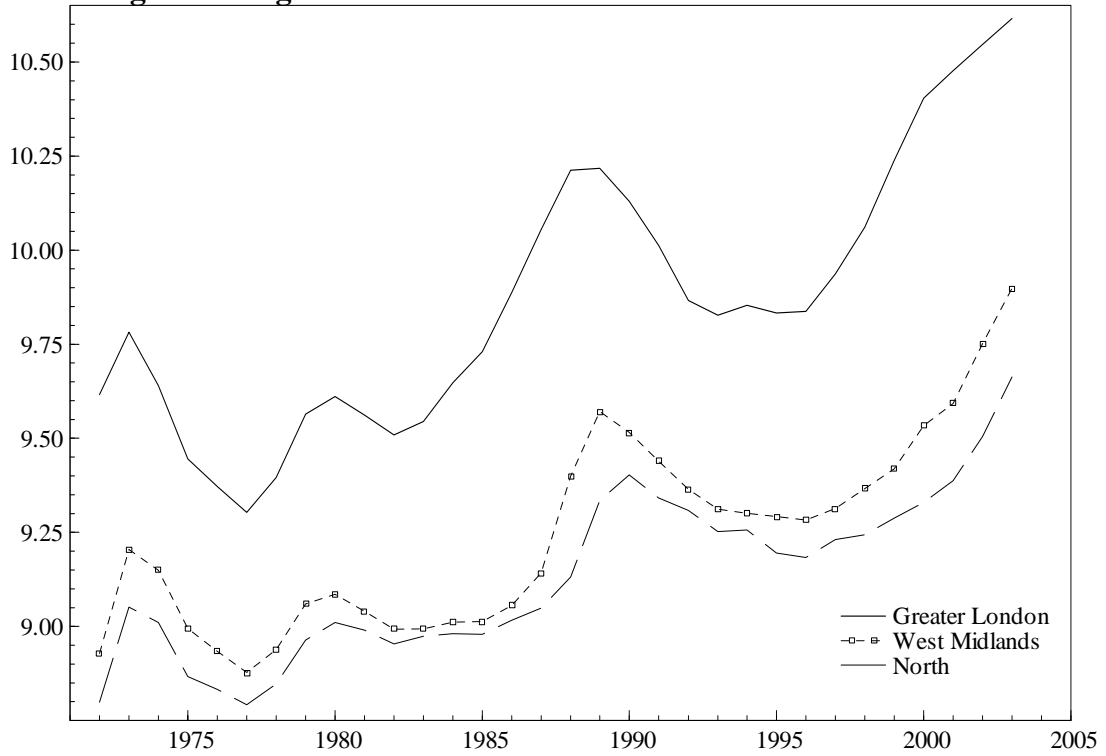
Figure 1: Log Real House Prices
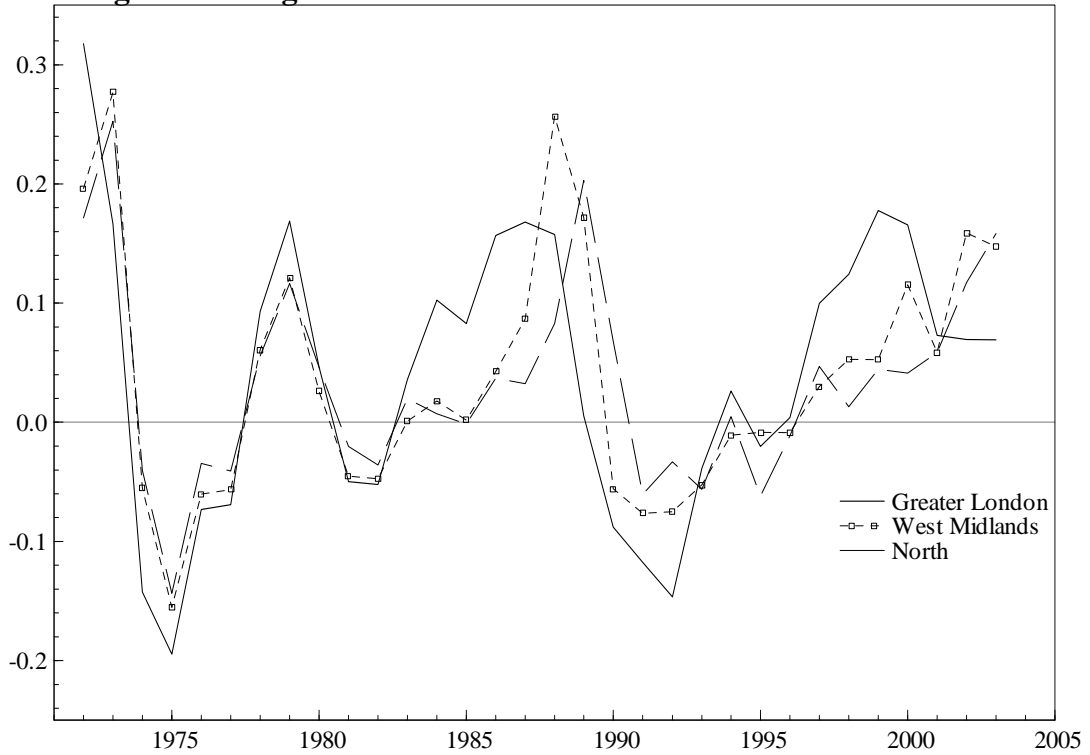

Figure 2: ΔLog Real House Prices

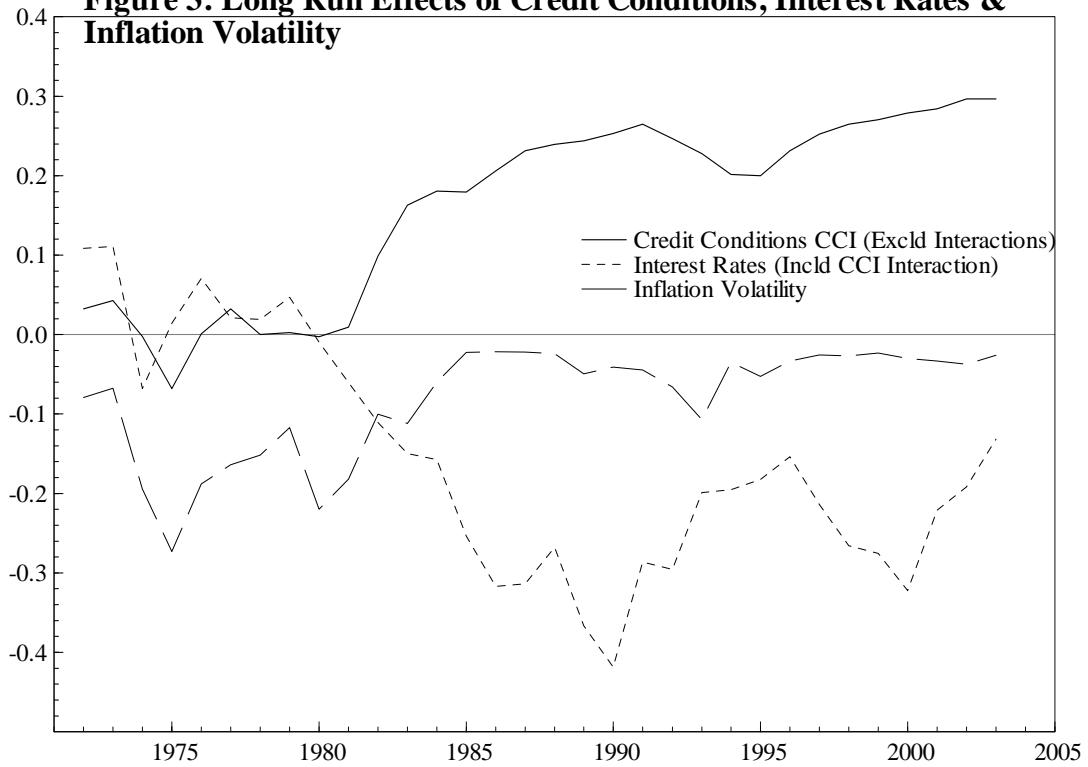**Figure 3: Long Run Effects of Credit Conditions, Interest Rates & Inflation Volatility**

Credit Conditions CCI (Excld Interactions)
Interest Rates (Incld CCI Interaction)
Inflation Volatility

Figure 4: Downside Risk Effects (in Long Run)

Greater London
West Midlands
North
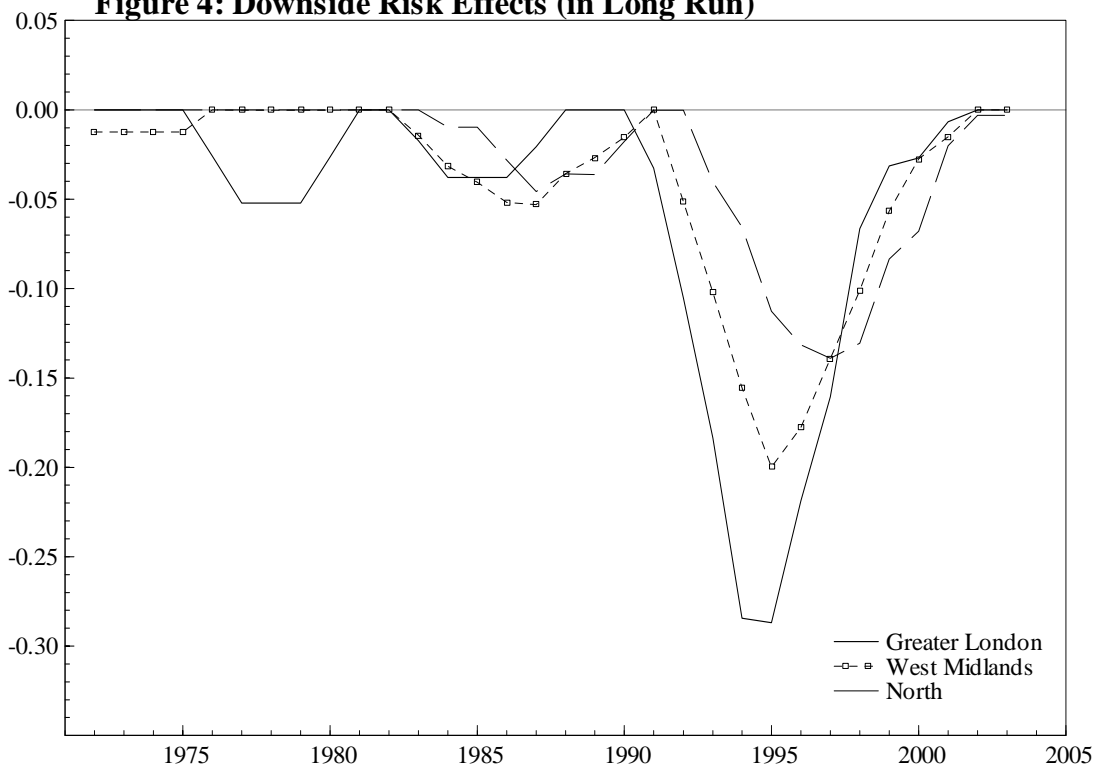
Figure 5: Effects of ∆WPOP (Working Age Population) Aged 20 to 39 (in Long Run)
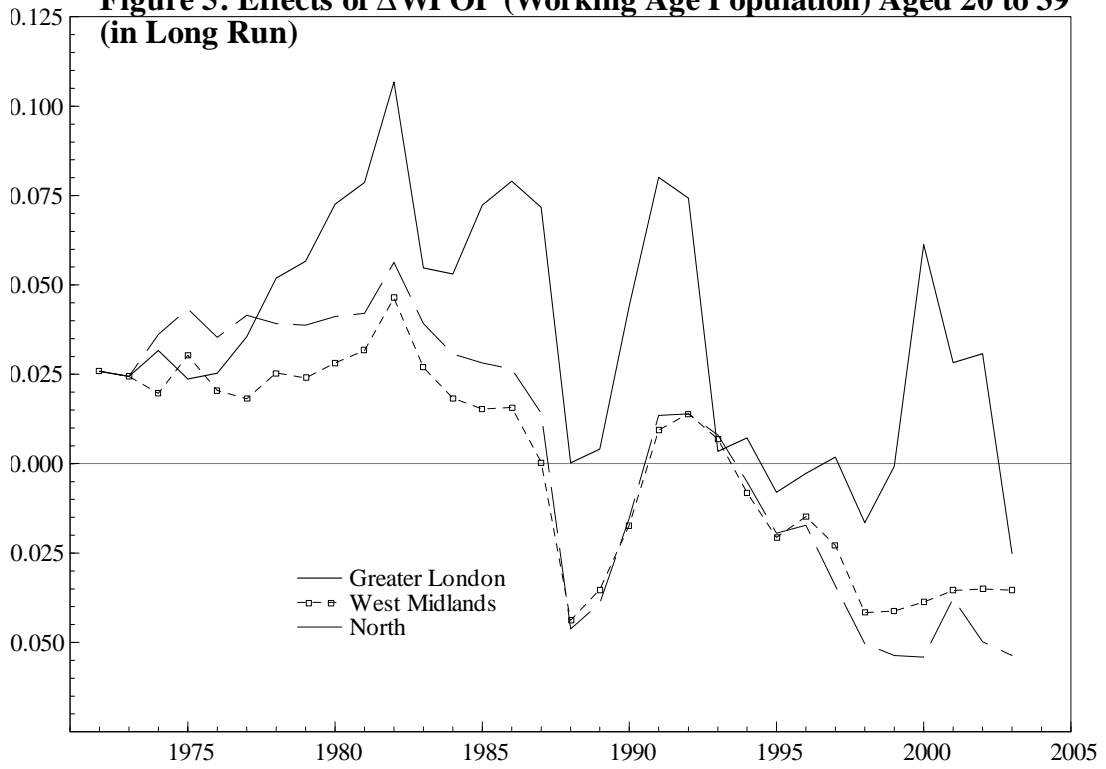
Figure 6: Composite Long Run Income, Population and Housing Stock Effects Incld ∆Log (WPOP/HS) Effect
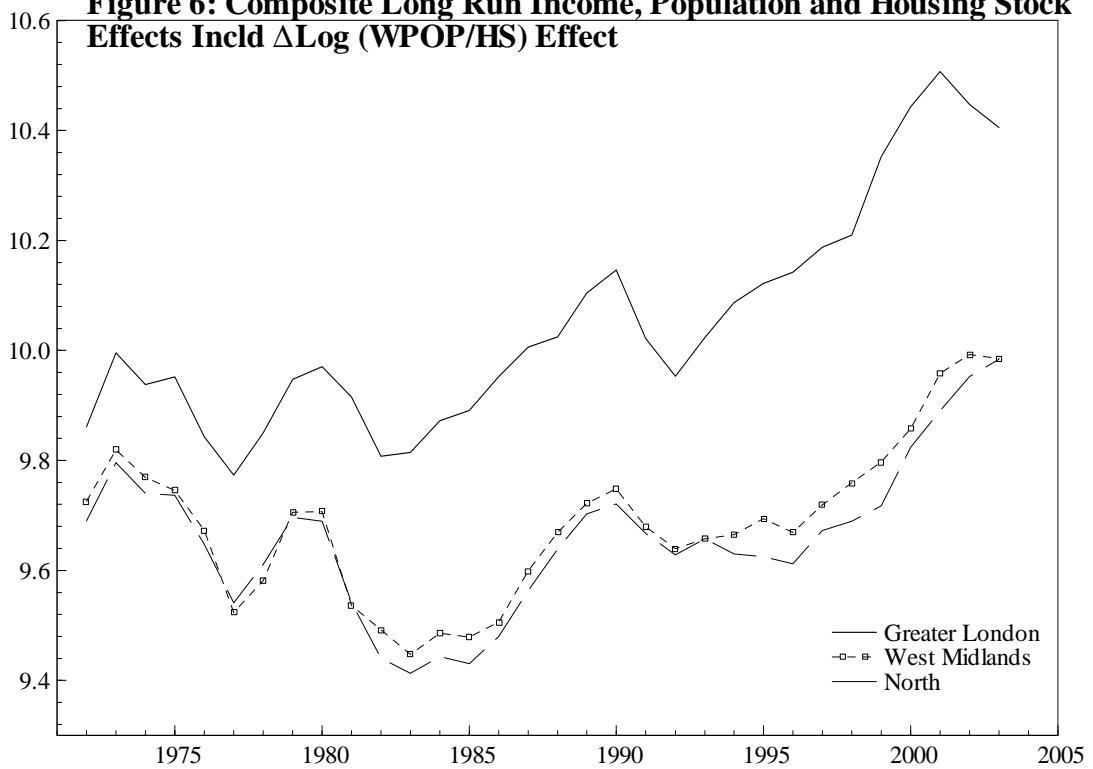
Figure 7a: Error Correction Terms, Excld ΔWPOP Aged 2039 and ΔLog (WPOP/HS) Effects

Greater London
West Midlands
North
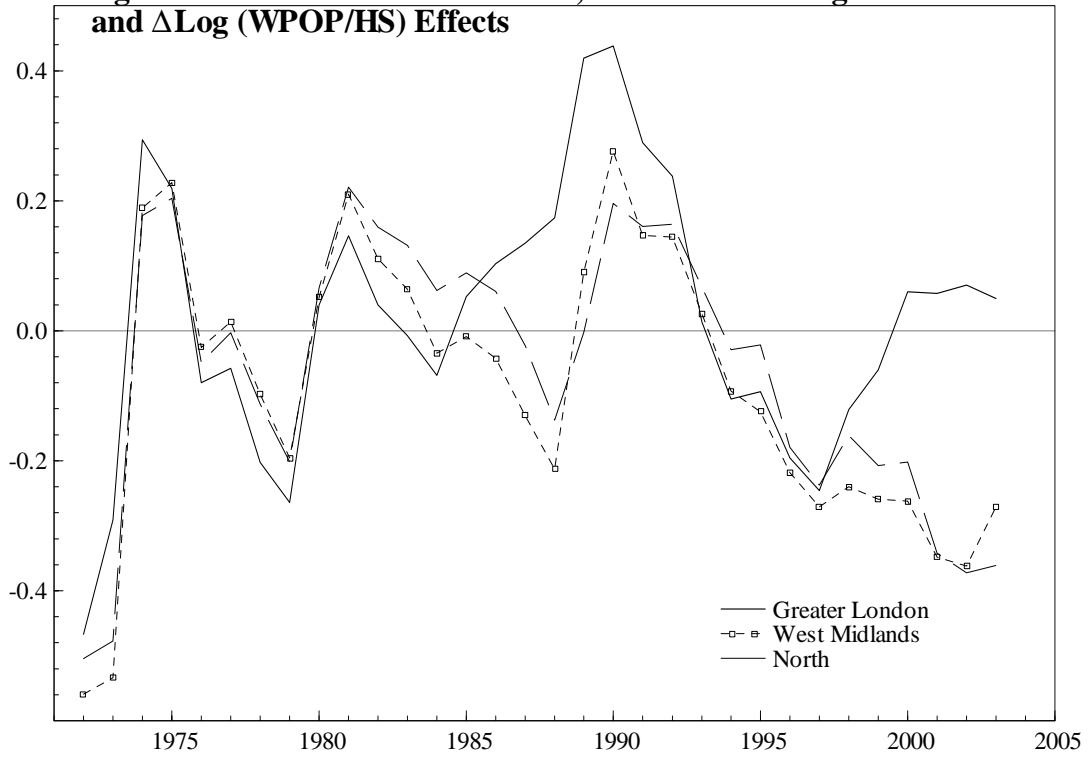
Figure 7b: Error Correction Terms, Incld ΔWPOP Aged 2039 and ΔLog (WPOP/HS) Effects

Greater London
West Midlands
North
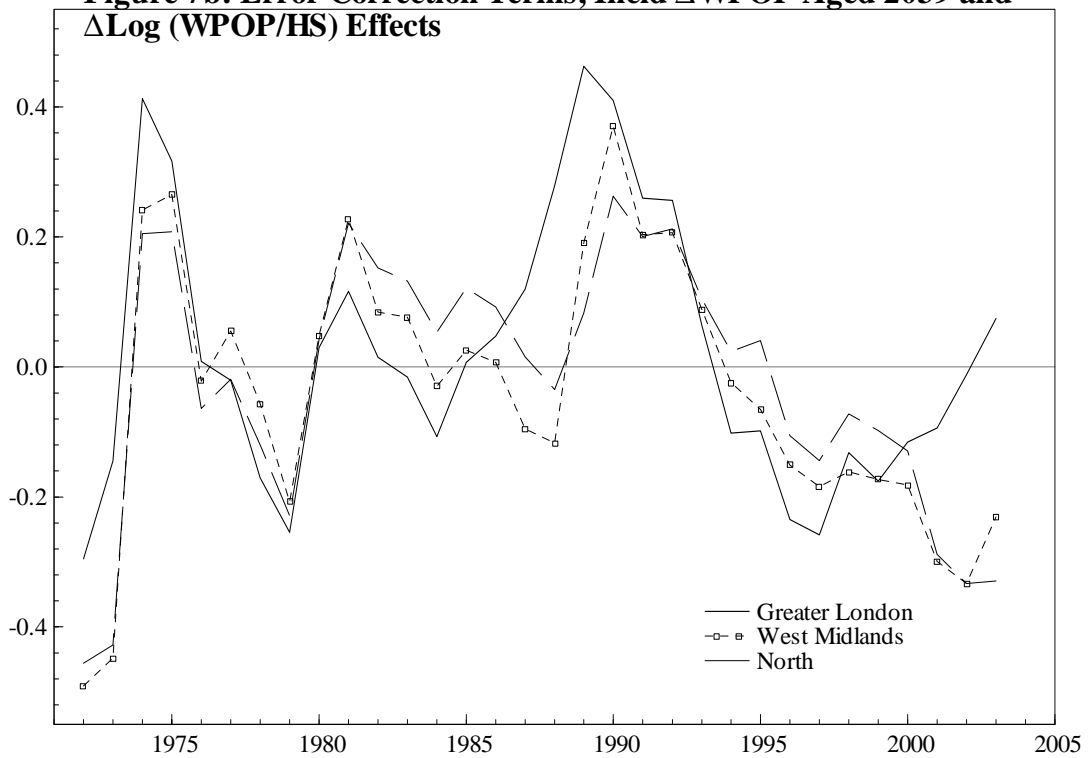
Figure 8 – Out of Sample Simulations

North - Actual and Fitted / Forecast (2004+) ΔLn Real HP

West Midlands - Actual and Fitted / Forecast (2004+) ΔLn Real HP
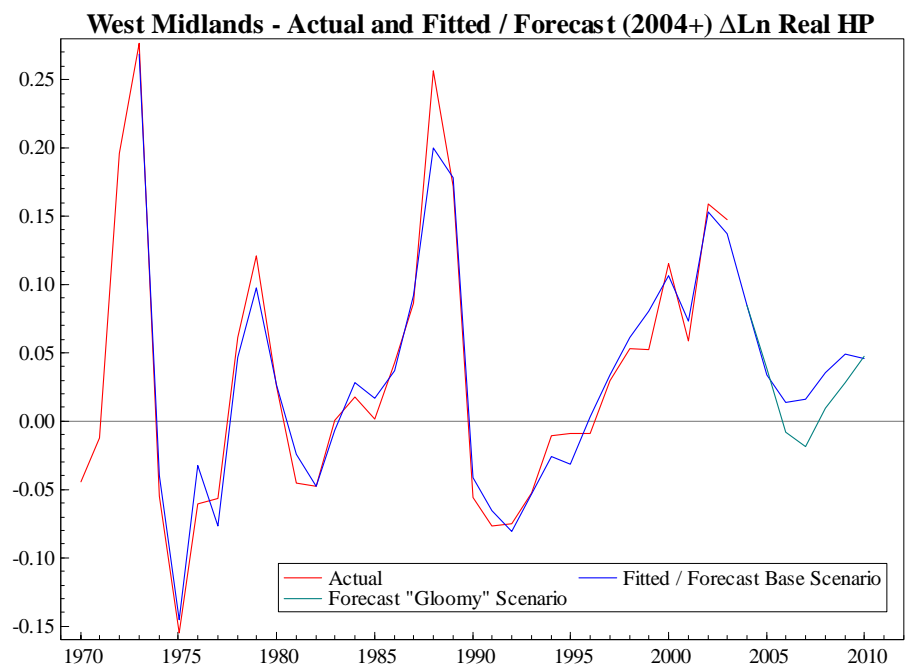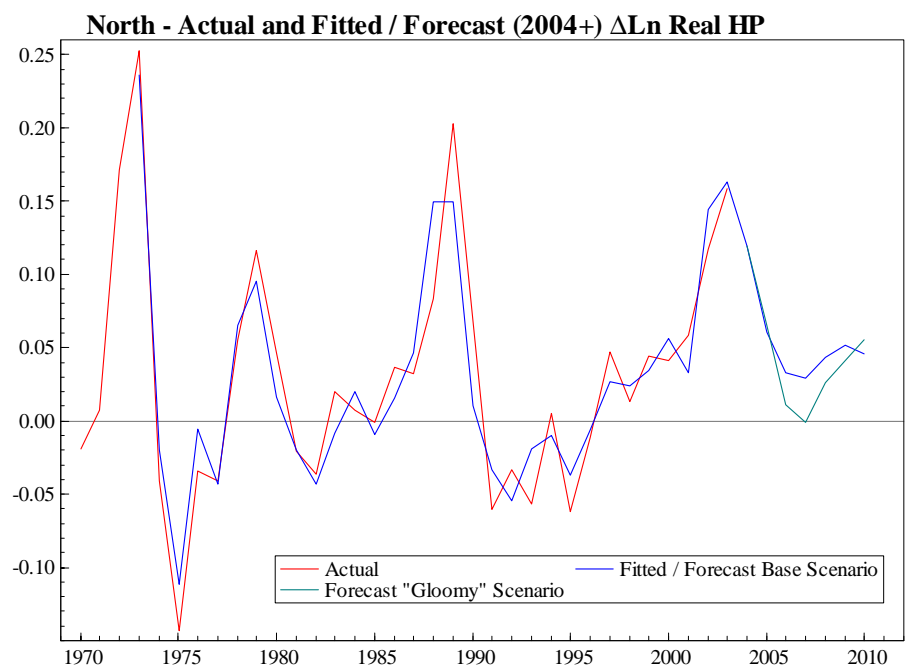
Figure 8 (Continued) – Out of Sample Simulations

Greater London - Actual and Fitted / Forecast (2004+) ΔLn Real HP

South - Actual and Fitted / Forecast (2004+) ΔLn Real HP
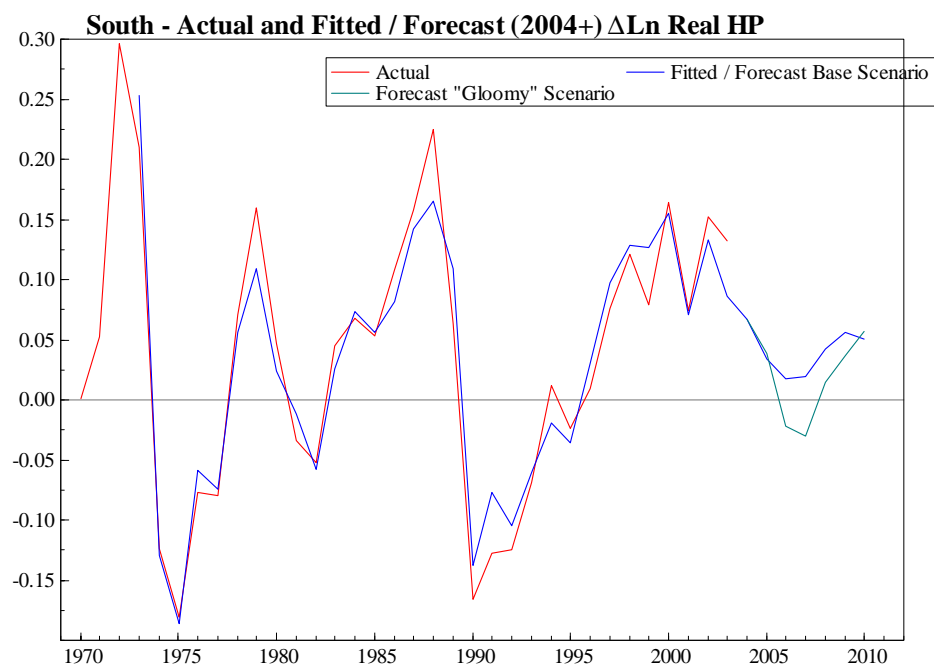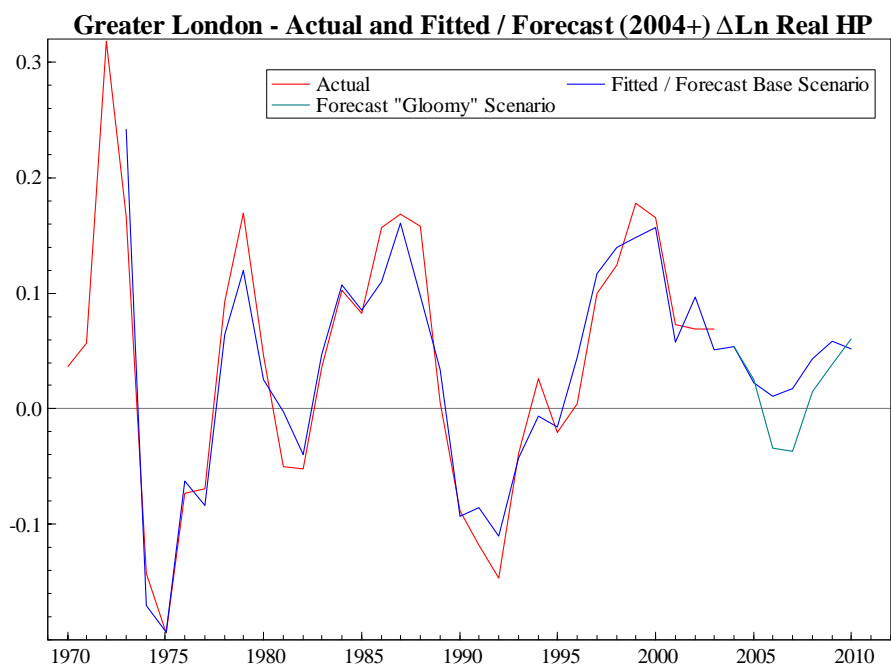
Appendix: Data Construction and Sources

(a) House prices:-

All regional and national log house price indices, which are derived by linking published ODPM mixed adjusted second hand house price indices, are adjusted by adding 0.8 * lhpadj2, which corrects for composition changes as banks etc entered the mortgage market. All indices have been rebased to 1985 using average second hand house price values.

(b) Non-property personal disposable income:-

Log real non-property personal disposable income or pdi in region r ($rlryn_r$) is defined as follows:

$$rlryn_r = lrpdin + (1/3 * rlfte_{r,+1} + 2/3 * rlfte_r) + rlempr_r$$
$$+ rlwpop_r + rltaxadj_r + \log((1-spt_r) + rept_r * spt_r$$

where lrpdin = log real non-property pdi in UK, non-property pdi = (1 - tuk) * (wage and salaries + mixed income) and tuk = 1 - (post tax pdi / pre tax pi). Sources: Blue Book for wages and salaries (qwlt) and mixed income (qwlm); Oxford Economic Forecasting (OEF) regional model databank for tuk.

$rlfte_r$ = log relative total full earnings in April in region r, relative to GB. Source: New Earnings Survey (NES) data linked to Annual Survey of Hours and Earnings (ASHE) data. We used ⅔ of current earnings and ⅓ of next years earnings value because the data are for April.

$rlempr_r$ = log relative employment rate in region r. Source: OEF regional model data.

$rlwpop_r$ = log relative working age population in region r. Source: OEF regional model data;

$rltaxadj_r$ = log relative (post tax pdi / pre tax pi) in region r. Source: OEF regional model data.

spt_r = share of part time employment in total employment in region r. Source: ONS.

$rept_r$= ratio of average part time to full time earning in region r. Source: NES, assumed unchanged post 2001 and pre 1975.

(c) Log income per house:-

$$lrynhs_r = rlryn_r - \log(hs_{r,-1}) - 0.7 * \log(poo_{r,-1})$$

where hs_r = housing stock in region r and poo_r = proportion of owner occupiers in region r.

(d) Return on housing:-

$$rrh_r = \Delta lhp_{r,-1} + 0.03 - abmr$$

$$rrhneg_r = rrh_r * 1(rrh_r < 0)$$

where Δlhp_r = first difference of log house price index in region r (source: linked ODPM data); abmr = tax adjusted building society mortgage rate (bmr) with the adjustment based on basic rate of tax (source: OEF data) and $1(rrh_r < 0) = 1$ if rrh_r is negative and 0 otherwise.

(e) Contiguous house price changes:-

$\Delta clrhp_r$ = log change in real house prices regions contiguous to region r. The contiguity weights are based on the full time wage bills in contiguous regions.

(f) Other variables:-

cci = index of credit conditions from Fernandez-Corugedo and Muellbauer (2004).

lpc = log consumer expenditure deflator (source: Blue Book).

rabmr = abmr - Δlpc = real mortgage rate.

crabmr = cci * rabmr.

$pp2039_r$ = (population aged 20 to 39) / (population aged 20 to 69) in region r.

infvol = MA_4 of lagged absolute value of $\Delta_4 lpc - \Delta_4 lpc_{-4}$ based on quarterly data, then annualised.

$\Delta lrFTSE$ = change in log (FTSE/pc) i.e. real FTSE index.

$\Delta lrFTSEneg$ = $\Delta lrFTSE$ if negative and zero otherwise. It is a proxy for downside risk in the stock market.

D88 = dummy for mix of 1988 effects - replacement of domestic rates by poll tax and Lawson proposal to end multiple tax relief on Aug 1st 1988.

D01 = dummy for 9/11 bombing and stock market turmoil in 2001.