

HOUSE PRICES, FUNDAMENTALS AND INFLATION

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This paper studies actual house prices relative to fundamental house prices. Using UK data and a time-varying present value approach, we find that deviations of house prices from their fundamental value (as warranted by real disposable income) are significant but not dominated by speculative activity; the driving force appears to be over-sensitivity to expectations about fundamentals. Our findings suggest that inflation (excluding house prices) responds asymmetrically with more impact on future inflation from turning points at peaks of overvaluation compared to turning points at troughs of undervaluation; and the turning points appear to have independent forecasting ability for inflation. This suggests that house prices have information about inflation which could be exploited by the Monetary Policy Committee (MPC).

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Identifying the cause of rapid rises in house prices is crucial for policy makers. Fast growth in housing wealth increases consumption, aggregate demand and future inflation. If recognised as a speculative boom this would signal appropriate intervention (increasing the Repo rate) by the Monetary Policy Committee (MPC), to avoid the potential slowdown when the price bubble bursts.¹ On the other hand, increases in house prices, justified by changes in expectations about fundamentals, do not require intervention, since this would result in a misallocation of resources. A problem facing the MPC is the difficulty in identifying the difference between speculative bubbles and changing expectations about fundamentals.² With three apparent house price bubbles (positive deviations from fundamental value) in the UK during the last 40 years (early 1970s, late 1980s and early 2000s) this is a highly topical issue with important policy implications.

Household consumption is an important expenditure component of real Gross Domestic Product (GDP) and the relationship between real house price inflation and consumption growth has been frequently examined in the literature.³ Case *et al.*

¹ In accordance with the Bank of England Act 1998, the objectives of the Bank of England are to (a) maintain price stability and (b) ..to support the economic policy of Her Majesty's Government, including its objectives for growth and employment. The current remit of the Monetary Policy Committee (MPC) is to target the inflation rate *and* "achieve high and stable levels of growth and employment by raising a sustainable growth rate and creating economic and employment opportunities for all" (letter from the Chancellor of the Exchequer to the Governor of the Bank of England, March 2004). Accordingly, the MPC takes into consideration all aspects of the economy which may affect either price stability or sustainable growth.

² For example, in a Speech by Monetary Policy Committee member, Stephen Nickell, 2002 it was stated: "Generally speaking, it is not possible, *ex ante*, to identify bubbles or speculative booms with any certainty, so the use of monetary policy to "nip them in the bud" is not normally a feasible strategy. We simply do not have enough information to operate this kind of sophisticated policy in a reliable fashion".

³ It is worth noting that the correlation between real house price inflation and consumption growth was around 0.75, for most of the period 1981-2001, and then fell rapidly since 2001 to 0.2 in 2004 (see p.12, Inflation Report, November, 2004). This seems to suggest that supply constraints, and investment in property may have superseded previously common factors, such as expectations about future economic growth and wage growth.

(2001) use data for 14 countries and report a large effect of housing wealth on household consumption, whereas the evidence of a stock market wealth effect is relatively weak. Helbling and Terrones (2003) suggest that a burst in a housing bubble is also important. These authors conclude that real private consumption, real private gross fixed capital formation in machinery and equipment and real private investment in construction all experienced larger and faster declines in their growth rates following a housing price bust than a stock market bust.

At the microeconomic level, investigations by Campbell and Cocco (2004) suggest the response of household consumption to house prices is largest for older home owners and smallest for younger renters. They also report that regional house prices affect regional consumption growth. Structural changes in the economy such as financial liberalisation also seem to have an impact. Muellbauer and Murphy (1997) show that relaxed borrowing constraints appear to drive up house prices and stimulate consumption.

Fundamental values for house prices are frequently measured by comparing house prices to rents or disposable income, where deviation from the long term average of these relations suggests a housing bubble (see for example, Muellbauer and Murphy, 1997; Helbling and Terrones, 2003 and Hawthorth, 2004). Other studies compare house prices to the 'affordability' concept in terms of fundamental values based on real wages and employment, real construction costs and real interest rates (Abraham and Hendershott, 1996; Bourassa *et al.*, 2001).

Overall, the literature suggests that the value of housing is related to some measure of 'affordability' and that the perception of wealth derived from house ownership impacts on the real economy. We build on these studies by following the idea that the value of aggregate housing stock is related to the income of households.

Our new approach is to allow this benchmark to vary over time according to expectations of future real disposable income and to include a risk premium associated with such expectations.⁴ This means that we can consider the extent to which house price deviations from fundamentals are driven by irrational (potentially speculative) behaviour or rational behaviour relating to changing expectations about fundamentals.

Our contribution to the literature is simply stated. First, we investigate and analyse deviations of house prices from fundamental values in terms of rational or irrational behaviour of investment in the housing market and, second, we consider how changes in these deviations impact on inflation, focussing on asymmetries. Our findings suggest that actual and fundamental house prices do not appear to exhibit the long-run error correction-type relationship that is synonymous with speculative behaviour. Also, significant asymmetries suggest that turning points in an overvalued housing market have a significant impact on future inflation unlike turning points in an undervalued housing market. Our final contribution is to consider the emphasis the MPC should place on forecasts for inflation from housing markets during the peak of a housing bubble. The results suggest that turning points at peaks of a house price bubble do appear to have independent forecasting ability for inflation.

The remainder of the paper is organised as follows. In section 1 we present our empirical framework, while section 2 contains a discussion of the data and of some preliminary results. The empirical results are discussed in the following section, while concluding remarks are contained in a final section.

⁴ In so doing, we integrate methodology that has been used in the stock market literature, (see, for example, Campbell and Shiller, 1987, 1988a, 1988b; Shiller, 1989; Miles, 1993 and Cuthbertson *et al.*, 1997), into an analysis of fundamental house prices.

1. Empirical Framework

1.1 *Fundamental House Prices v. Actual House Prices*

We capture the size of the deviations of UK residential house prices from their fundamental value by the adaptation of the vector autoregressive (VAR) methodology initiated by Campbell and Shiller (1987, 1988a, 1988b).

We assume the real value of residential property is the expected value of future real disposable income discounted at the real discount rate. Therefore, real income and interest rates, proxies for affordability, are key determinants of house prices (for supporting evidence see Capozza *et al.*, 2002; Sutton, 2002; Case and Shiller, 2003; Farlow, 2004)⁵. Hence, the real (aggregate) price of residential property at the end of period t is:

$$P_t = E_t \sum_{i=0}^{\infty} \left(\frac{1}{\prod_{j=0}^i (1 + \rho_{t+j}^*)} \right) Q_{t+i} \quad (1)$$

where P_t is an index of the (constant quality) real price of property, E_t is the expectations operator, ρ_{t+j}^* is the real time-varying rate of return required by investors, and Q_{t+i} represents the real disposable income of housing market players in the economy from period t to i . Equation (1) assumes a constant relationship between the house price index and market capitalisation and between aggregate real disposable income in the economy (as opposed to the income of housing market participants) and the house price index. Given that we use quarterly data and our sample period is relatively short, this relationship is unlikely to vary substantially in practice – most of the variation in the market capitalisation of the housing stock reflects fluctuations in the house price index.

⁵ While measures of real rents have been analysed in the literature, it is well known that no satisfactory data exist on rental income for the UK (see for example Hawksworth, 2004).

We define the time stream of realised discount rates, ρ_t , to satisfy:

$$P_t = \sum_{i=0}^{\infty} \left(\frac{1}{\prod_{j=0}^i (1 + \rho_{t+j})} \right) Q_{t+i} \quad (2)$$

It follows that

$$(1 + \rho_{t+1}) = (P_{t+1} + Q_t) / P_t \quad (3)$$

Taking logs and using lower case letters to represent the logs of their upper-case counterparts, we can write:

$$r_t = \ln(1 + \exp(q_t - p_{t+1})) + p_{t+1} - p_t \quad (4)$$

where r is defined as $\ln(1 + \rho)$ and the term $(q-p)$ can be viewed as the economy-wide income-price ratio. The first term in (4) can be linearised using a first-order Taylor's approximation and (4) can be written as:

$$r_t = -(p_t - q_{t-1}) + \mu(p_{t+1} - q_t) + \Delta q_t + k \quad (5)$$

where k and μ are linearisation constants:

$$\begin{aligned} \mu &= 1 / (1 + \exp(\overline{q - p})) \\ k &= -\ln \mu - (1 - \mu) \cdot \overline{(q - p)} \end{aligned}$$

where $\overline{(q - p)}$ is the sample mean of $(q-p)$ about which the linearisation was taken.

Clearly, $0 < \mu < 1$ and in practice is close to 1.

Empirically it is common that both p and q are I(1) so that the variables are transformed to ensure stationarity. Denote by pq_t the (log) price-income ratio, $p_t - q_{t-1}$, and rewrite equation (5) as:

$$pq_t = k + \mu pq_{t+1} + \Delta q_t - r_t \quad (6)$$

After repeated substitution for pq_{t+1} , pq_{t+2} , ... on the right-hand side of (6), we get:

$$pq_t = \frac{k(1 - \mu^i)}{(1 - \mu)} + \sum_{j=0}^{i-1} \mu^j \Delta q_{t+j} - \sum_{j=0}^{i-1} \mu^j r_{t+j} + \mu^i pq_{t+i} \quad (7)$$

Letting $j \rightarrow \infty$ and assuming that the limit of the last term is 0, results in the following alternative form of (7):

$$pq_t = \frac{k}{(1-\mu)} + \sum_{j=0}^{\infty} \mu^j \Delta q_{t+j} - \sum_{j=0}^{\infty} \mu^j r_{t+j} \quad (8)$$

Hence, if $q_t \sim I(1)$ then $\Delta q_t \sim I(0)$ and, assuming that $r_t \sim I(0)$ (recall that it is the real discount rate), then pq_t will be $I(0)$ and we have the model linearised and expressed in terms of stationary variables. Finally, taking conditional expectations of both sides:

$$pq_t = \frac{k}{(1-\mu)} + \sum_{j=0}^{\infty} \mu^j E_t \Delta q_{t+j} - \sum_{j=0}^{\infty} \mu^j E_t r_{t+j} \quad (9)$$

where we interpret $E_t r_{t+j}$ as investors' required return.

In order to use (9) to generate a series for pq_t^* , the price-income ratio implied by the model and from it the implied or fundamental house price, p^* , we need to obtain empirical counterparts to the terms on the right-hand side involving expectations. For the first of these, the expectation of income growth, we use a 3-variable VAR model while for the second we assume a time-varying risk premium.

Here we follow the work of Merton (1973, 1980) on the intertemporal CAPM, and model the time-varying risk premium as the product of the coefficient of relative risk aversion, α , and the expected variance of returns, $E_t \sigma_t^2$ ⁶. The equation for the price-income ratio then becomes:

$$pq_t = \frac{k-f}{(1-\mu)} + \sum_{j=0}^{\infty} \mu^j E_t \Delta q_{t+j} - \alpha \sum_{j=0}^{\infty} \mu^j E_t \sigma_{t+j}^2 \quad (10)$$

where f is the constant real-risk free component of real required returns.⁷ In this case we forecast both real income growth and the housing return variance using a 3-

⁶ We also experimented with measures of conditional variance derived from various specifications of GARCH-type models of housing returns. However, the results were very similar to those reported below.

⁷ The assumption here is that the real required return is composed of the real risk-free rate (assumed constant) and a time-varying risk premium, denoted by the third term on the RHS of (10).

variable VAR in $\mathbf{z}_t = (pq_t, \Delta q_{t-1}, \sigma_t^2)'$ where $pq_t = p_t - q_{t-1}$. The empirical VAR is written in compact form as:

$$\mathbf{z}_{t+1} = \mathbf{A}\mathbf{z}_t + \boldsymbol{\varepsilon}_{t+1} \quad (11)$$

where \mathbf{A} is a (3x3) matrix of coefficients and $\boldsymbol{\varepsilon}$ is a vector of error terms. We assume a lag length of 1 for ease of exposition. If, in the empirical application, a longer lag length is required, the companion form of the system can be used.

Forecasts of the variables of interest j periods ahead are achieved by multiplying \mathbf{z}_t by the j th power of the matrix \mathbf{A} .

$$E_t(\mathbf{z}_{t+j}) = \mathbf{A}^j \mathbf{z}_t \quad (12)$$

The equation from which we compute the fundamental price-income ratio (and hence the fundamental stock price) is:

$$pq_t^* = \frac{k-f}{1-\mu} + (\mathbf{e}'_2 - \alpha\mathbf{e}'_3) \mathbf{A}(\mathbf{I} - \mu\mathbf{A})^{-1} \mathbf{z}_t \quad (13)$$

where $\mathbf{e}'_2 \mathbf{z}_t = E_t \Delta q_{t+i}$ and $\mathbf{e}'_3 \mathbf{z}_t = E_t \sigma_{t+i}^2$.

Therefore pq_t^* provides a measure of the fundamental house price series once we have estimated the VAR coefficients and the constants μ , k , and r . Given that we wish to generate a series for house prices that are warranted by (predicted) income growth, we generate (the log of) fundamental house prices as:

$$p_t^* = pq_t^* + q_{t-1} \quad (14)$$

Equation (13) can also be used to derive tests of how far actual house prices deviate from their fundamental value as warranted by real disposable income. This is simply a test of $pq_t = pq_t^*$ for all t . Since $pq_t = \mathbf{e}'_1 \mathbf{z}_t$ where \mathbf{e}'_1 is the first unit vector, we can write (13), after transforming the variables to deviations from their means to remove the constant term, as:

$$\mathbf{e}'_1(\mathbf{I} - \rho\mathbf{A}) = (\mathbf{e}'_2 - \alpha\mathbf{e}'_3) \mathbf{A} \quad (15)$$

This restriction is linear in the elements of \mathbf{A} and in the present case simply amounts to:

$$\begin{aligned}\rho a_{11} - \alpha a_{31} + a_{21} &= 1; \\ \alpha a_{32} - a_{22} + \rho a_{12} &= 0; \\ \alpha a_{33} - a_{22} + \rho a_{13} &= 0.\end{aligned}\tag{16}$$

and can be tested with a standard Wald test which is asymptotically χ^2 -distributed with 3 degrees of freedom.

1.2 *House Prices and the Inflationary Process*

Given the above we can identify the sign, size and significance of any deviations of actual house prices from their fundamental value (as warranted by real disposable income) and thus the housing premium (as measured by the spread between continuously compounded returns from actual house prices and those of the estimated fundamental house price series) embedded in housing returns. To empirically analyse the relationship between the housing premium and the inflationary process, we consider whether predictive power is affected by swings in housing market profitability. This will provide insight into any persistent asymmetries in the housing premium-inflation relationship during periods when residential house prices had been at their greatest deviation from fundamental value. Hence, we can advise on the extent to which decision-makers should heed signals provided by movements in residential house prices. To examine this issue we first characterise the over-and-under-valuation of the housing market over time. We use a Hodrick-Prescott Filter to smooth the housing premium series and apply the following simple rules to date the cycles and thus the turning points of the housing premium series, denoted as hp_t .⁸

⁸ The Hodrick-Prescott Filter is a smoothing method that is widely used among macroeconomists to obtain a smooth estimate of the long-term trend component of a series. The method was first used in a working paper (circulated in the early 1980's and published in 1997) by Hodrick and Prescott to analyse postwar US business cycles.

- A peak of positive abnormal returns occurs when $\{hp_{t-4}, hp_{t-3}, hp_{t-2}, hp_{t-1}, hp_t, >0 \text{ and } hp_{t+1}, hp_{t+2}, hp_{t+3}, hp_{t+4}, <0\}$ that is, at turning points in the data
- A trough of negative abnormal returns occurs when $\{hp_t, hp_{t-1}, hp_{t-2}, hp_{t-3}, hp_{t-4} <0 \text{ and } hp_{t+1}, hp_{t+2}, hp_{t+3}, hp_{t+4} >0\}$.

This will ensure that no phase (peak to trough) is less than 12 months in duration and that no cycle (peak (trough) to peak (trough)) is less than 24 months in duration. While the simple rules applied above may provide less turning points than one would expect from equity markets, evidence has shown that cycles are typically longer on the housing and property markets than on the equity market (Helbling and Terrones, 2003) hence peaks and troughs are also less frequent. The size of price corrections involved in housing price crashes also differ from those in equity markets with price corrections during housing crashes averaging 30% in industrial countries over the period 1970 Q1-2002 Q3, while that figure was approximately 50% for stock markets. Further, housing crashes tended to last around four years as compared to 2.5 years for equities (Helbling and Terrones, 2003).

We then use the turning point dates as calculated above to construct a set of dummy variables as follows (see for example Bry and Broschan, 1971, on traditional classical business cycle dating algorithms):

- $DP_t = 1$ if the smoothed housing premium has peaked, 0 elsewhere
- $DT_t = 1$ if the smoothed housing premium has bottomed, 0 elsewhere.

Such comparisons will allow us to consider differences in the impact of house prices at different parts of the cycle.

A simple test of the basic hypotheses that swings in housing market profitability affect future inflation can now be carried out by (robust) regression analysis. With this in mind consider equation (17):

$$inf_t = \alpha_0 + \alpha_1 X1_{t-1} + \alpha_2 X2_{t-1} + \varepsilon_t \quad (17)$$

where inf_t is inflation, $X1_t = DP_t(hp_t)$ and $X2_t = DT_t(hp_t)$. We therefore interact the two dummies with the housing premium. We should, therefore, be able to draw inferences from the sign and significance of the coefficients α_1 and α_2 . However, (17) is both somewhat restrictive and, further, does not control for the possibility that $X1$ and $X2$, may be a close proxy for more general information on the state of the economy, thus having little independent forecasting ability. We allow for simple dynamics by including lagged inflation in the regression, and also include a variable to measure the impact on inflation when aggregate output in the previous period was above or below its long-run trend – the output gap – thus indicating the amount of slack in the economy and arguably also capturing any effects of monetary policy to control for this:⁹

$$inf_t = \beta_1 + \beta_2 inf_{t-1} + \beta_3 OG_{t-1} + \beta_4 X1_{t-1} + \beta_5 X1_{t-2} + \beta_6 X2_{t-1} + \beta_7 X2_{t-2} + \xi_t \quad (18)$$

where, OG_{t-1} is the lagged output gap as measured by demeaning and detrending real aggregate GDP.

2. Data and Preliminary Results

2.1 Data Description

The UK housing data covers quarterly periods from 1973:4 through 2004:3. Data on house prices were sourced from Nationwide. The house price index tracks price changes of a representative house rather than average prices as the latter may be biased by changes in the properties' quality over time. This is achieved by finding for each time period the price of each attribute (or characteristic) of houses by (hedonic)

⁹ We also experimented with the real TB rate in the regression (unlike the nominal TB rate this was found to be stationary over the period). This variable proved to be statistically insignificant.

regression analyses¹⁰. The value of the representative house is then estimated for each period using the implicit prices of each attribute as extracted from the hedonic regressions. Price changes are thus related to the changing implicit price of characteristics in the housing market and not to changes in the quality of properties. The macroeconomic data, real disposable income, Retail Price Indices (RPI) and inflation measures were downloaded from the online facility of the Office of National Statistics at: <http://www.statistics.gov.uk>. Inflation measures were transformed from percentages into decimals and divided by four to provide quarterly measures of inflation. Housing data were deflated by the RPI All Items, thus provide prices in real terms. However, because the RPI All Items, excluding house prices, is only available from 1986, the sample period for the housing premium-inflation analysis commences from the first quarter of that year.¹¹

A graph of real disposable income growth and real residential house price returns, observed quarterly, can be seen in Figure 1 below:

¹⁰ The hedonic method constitutes a robust and often used method to construct house prices when the attributes of properties are available. The other main UK house price index, ie that of Halifax, is also constructed in this manner.

¹¹ In order to control for the impact of house price movements on the economy-wide inflationary process, the inflation variable of interest used in that analysis excludes house price movements.

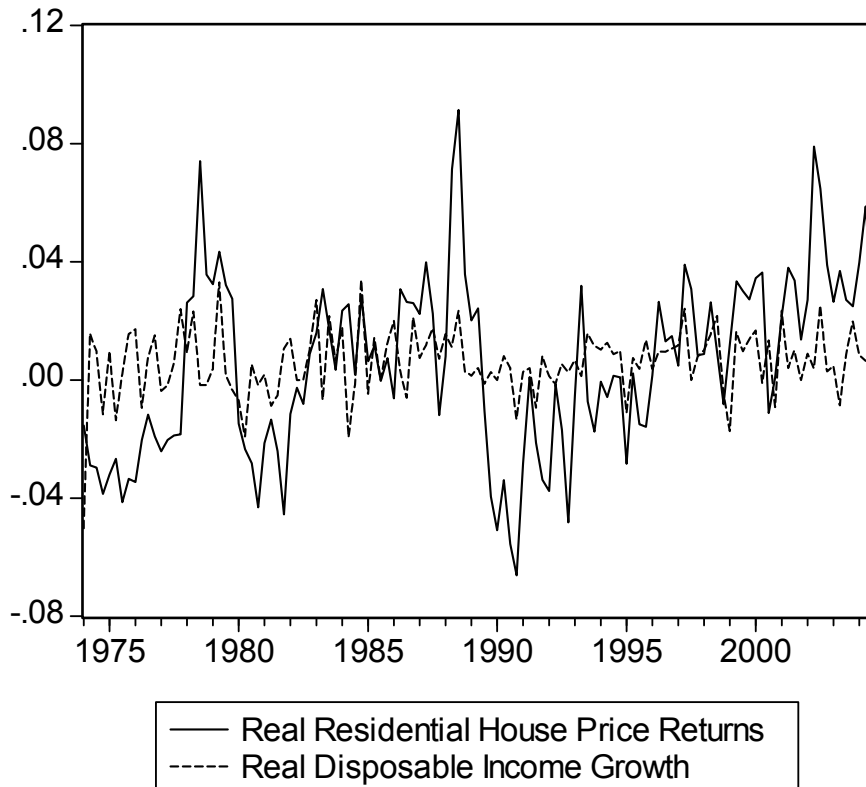


Fig. 1 *Real Residential House Price Returns and Real Disposable Income Growth*

Figure 1 suggests house price returns tend to oscillate around income growth. The series have a positive correlation: over the full sample the correlation between the two variables is 0.276, while for the sub-period 1989 through 2004, the correlation coefficient was greater at 0.336. The cyclical nature of the housing market clearly appears: in the latter part of the 1980s the market was bullish, and then it was bearish in the early 1990s with bullish characteristics reappearing during the 1990s. Overall, Figure 1 provides some motivation for a deeper analysis of the relationship between UK house prices and real disposable income.

2.2 *Preliminary Statistics*

Table 1 below provides summary statistics on the variables of interest: these are, real residential house price returns, r_t , the house price-income ratio, pq_t , disposable

income growth, Δq_t , the variance of house price returns, σ_t^2 , and the RPI measure of inflation which excludes house prices, inf_t .

Table 1
*Preliminary Statistics**

	Mean	Standard Deviation	Jarque-Bera (J-B)	ADF
r_t	0.005	0.030	0.624 (0.731)	-4.19
pq_t	9.115	0.159	3.052 (0.217)	-2.73
Δq_t	0.005	0.011	79.624 (0.000)	-13.34
σ_t^2	0.001	0.001	990.05 (0.000)	-7.27
inf_t	0.008	0.005	21.265 (0.000)	-3.51

* pq_t is the constructed price-income ratio, Δq_t is disposable income growth, σ_t^2 is the variance of housing market returns and inf_t is inflation excluding house prices. The sample period for inf_t is 1986:1 through 2004:3 and for the remaining series the sample period is 1974:1 through 2004:2. The figures in parenthesis below the J-B statistics are marginal significance levels. ADF denotes the Augmented Dickey-Fuller test for unit roots in the series. Critical values for the ADF statistics with an intercept are: 1% -3.49; 5% -2.89; 10% -2.58 (all series with the exception of inf_t). Critical values for the ADF tests with an intercept and trend are: 1% -4.10 5% -3.48; 10% -3.17 (inf_t).

Housing provided real returns of 0.5% per quarter on average over the sample period with a standard deviation of 3% per quarter. The J-B statistics provide evidence of non-normality for three of the five variables with the housing returns and the price-income ratio series showing evidence of normality.

While all variables appear to be stationary at conventional levels of significance, we note that pq_t (the price-disposable income ratio) is stationary only at the 10% level, being marginally rejected at the 5% level. Inspection of the data suggests that the stationary properties of this variable are heavily influenced by long swings in the series, and in particular the dramatic fall in this ratio over the period 1990 through 1996, and its subsequent dramatic rise. Similar time series characteristics have been reported using stock dividend-price ratios; see for example Black *et al.* (2003). Given the model is based on the assumption that (log) house

prices and (log) real disposable income are each non-stationary but cointegrated, and the marginal results reported above, we also tested these assumptions. We found (not reported) that, as expected, both variables were each non-stationary but were cointegrated, thus had a long-run stable relationship.¹² We therefore treat pq_t as stationary.

3. Empirical Results

3.1 Fundamental v. Actual House Prices

Table 2 reports the statistics and tests for the time-varying risk model discussed in section 1 of this paper. On the basis of Ljung-Box tests for serial correlation and Akaike Information Criterion (AIC) and Schwarz information Criterion (SC) tests for the optimum lag order, two lags were imposed on the VAR system to ensure the model was correctly specified.

¹² Cointegration was strongest when there was no trend in the equation.

Table 2.
*VAR Statistics and Tests for the Estimation of the Time-Varying Risk Present Value Model **

$$z_{t+1} = Az_t + \varepsilon_{t+1}$$

z_{t+1}	R^2	Q	<i>CRR</i> α	<i>Wald Restrictions</i>
pq_t	0.98	5.366 (0.147)	0.77394	24.920 (0.000)
Δq_{t-1}	0.24	3.897 (0.273)		
σ_t^2	0.30	0.287 (0.962)		

* pq_t is the constructed price-income ratio, Δq_{t-1} , is lagged income growth and σ_t^2 , is the variance of the market return. The model was estimated using SUR and the figures below the estimated coefficients are the standard errors. The Q statistic is the Ljung-Box test statistic for significance of up to the third autocorrelation coefficient. Figures in parentheses below the Q statistic are marginal significance levels. R^2 is the adjusted coefficient of determination. The Wald test statistics correspond to tests of restrictions in equation (16) and μ is a linearisation constant which takes a value of 0.99921. Under the hypothesis that the model is true, the Wald statistics are asymptotically χ^2 -distributed with degrees of freedom equal to the number of restrictions imposed; marginal significance levels appear in parentheses below the reported Wald statistics. The *CRR*, α , is the coefficient of relative risk aversion.

The (adjusted) R^2 is highest for the price-income ratio due in part to the high significance of own lagged price-income ratios. We do find however (not reported), that there is significant dual causality between the price-income ratio and income growth and that the effect of the lagged price-income ratio in the variance equation is only marginally rejected as being significantly different from zero at 10% (with a marginal significance level of 11%). According to the Q statistic, the lag length is adequately specified. The $CRRRA$, computed as described in Section 1 is low relative to that reported for stock prices (the conventionally accepted range being 1- 10' for stock prices', Abel, 1991, p. 9). This may reflect the commonly held perception that investing in property is less risky than investing in stock markets and there exists ample evidence in the real estate literature that this is the case (see for example, Goetzmann and Ibbotson, 1990; Liang *et al.*, 1996). The evidence suggests that the lower perceived riskiness of property (relative to stocks) is a direct consequence of cycles in the housing market being longer and of less magnitude than in stock markets. Finally, as far as the reported linear Wald statistic¹³ is concerned we can convincingly reject the null hypothesis that the difference between the fundamental price and actual price is zero.¹⁴

Figure 2 plots the actual and computed fundamental residential house prices over the full sample period, where fundamental residential house prices are given in equation 14.

¹³ We also computed numerically a non-linear Wald test using the 'delta method' (see Campbell, Lo and MacKinlay, 1997, p. 540). The non-linear restrictions on the coefficients of the VAR were also convincingly rejected.

¹⁴ The general results are qualitatively similar when a 1-lag VAR specification is used.

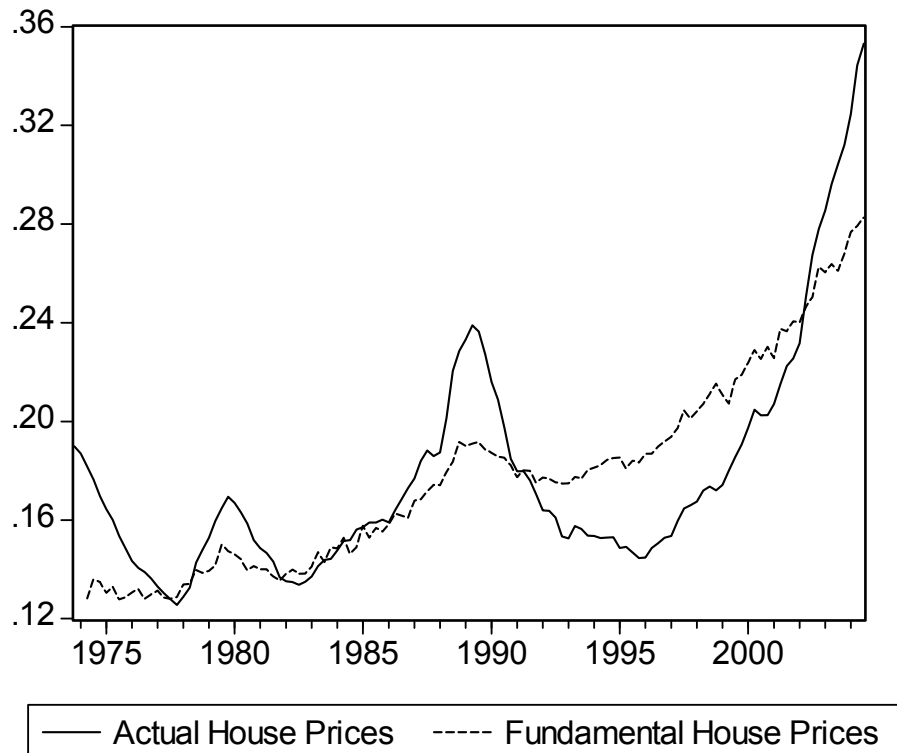


Fig. 2 *Actual House Prices and Fundamental House Prices*

Disparities between the actual and fundamental price widen in the mid-late 1980s, and overvaluation is particularly noticeable from 2001. By the end of the time period (June 2004), there is a 25% gap between the actual price and the fundamental price warranted by real disposable income growth. Further, the most recent house price ‘bubble’ appears to be more pronounced than the overvaluation of the late 1980s. This wide discrepancy has been reported by others, see for example, Hawksworth (2004) and Ayuso and Restoy (2003). However, very often such overvaluation is measured from a long term average of either a housing affordability measure (income divided by house price) or from the relation between housing prices and rents. Using averages is questionable however as the ‘benchmark’ ratio is unlikely to be constant but to vary over time.

How can we interpret deviations in actual house prices from fundamental value? Do such deviations represent irrational speculation or a rational response due

to changing expectations? To consider these questions we begin with a comparison of actual house prices with a series that represents periods when real disposable income was either above or below its long term trend – the ‘disposable income gap’.

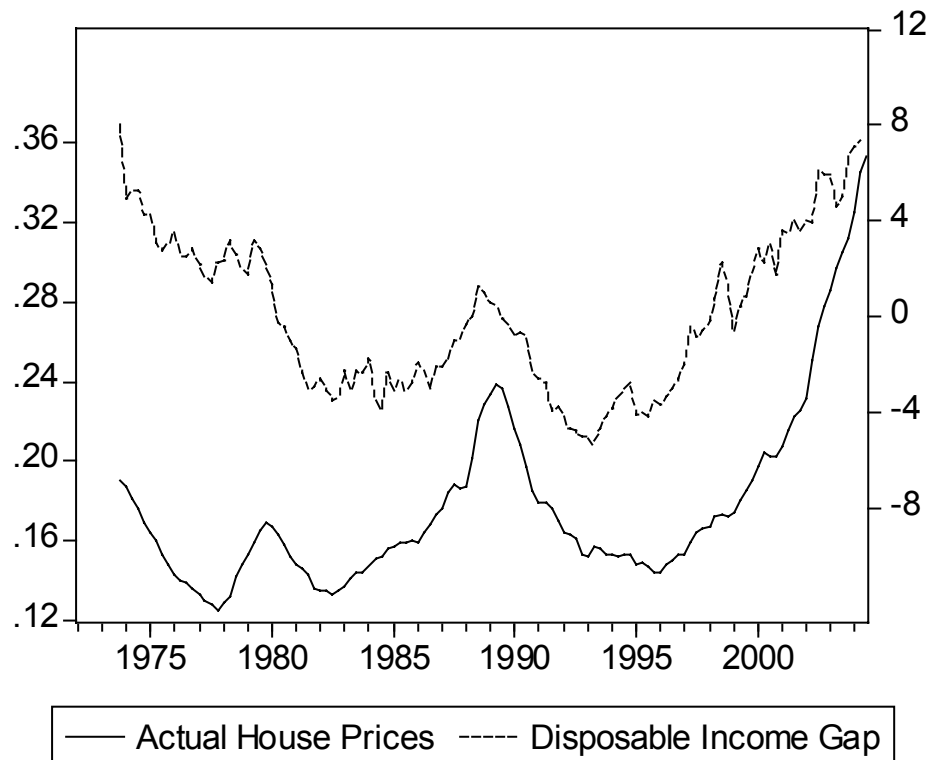


Fig. 3 *Actual House Prices and the Disposable Income Gap*

Through time the two series appear to display similar characteristics. When real disposable income is above its long-term trend there is a tendency for actual house prices to rise. This is apparent around the end of the 1980s and again towards the end of the sample. It is not clear, however, whether the rise in house prices is due to irrational or rational forces. Actual house prices rise from around 1996 as real disposable income rises. It is not until 2002 that there appears a particularly steep incline in actual house prices.

Froot and Obstfeld, (1991, p. 1180), posit that deviations in stock prices from fundamental values can be explained by the presence of a particular type of rational bubble that depends exclusively on aggregated values of the fundamental (here, this is real disposable income). They call such rational bubbles ‘intrinsic’, being deterministic functions of the fundamentals of asset value alone. In common with rational bubbles, intrinsic bubbles rely on bounded rationality and self-fulfilling expectations, but such expectations are driven by a *non*-linear relationship between prices and the fundamentals themselves, rather than factors extraneous to the asset value. This captures the idea that asset prices overreact to news on fundamentals: for a given innovation in (log) fundamentals, which is distributed symmetrically around zero, and the belief that the relevant price function is non-linear, the expected change in the asset price will, for some time, deviate from the present value or fundamental price (Froot and Obstfeld, 1991, p. 1193).

Essentially, the existence of an intrinsic bubble violates the transversality condition that the expected asset price goes to zero as time goes to infinity.¹⁵ However, agents eventually learn that their expectations regarding fundamental realizations are unreasonable, and therefore are not forever stuck on a path along which fundamental price ratios eventually explode (Froot and Obstfeld, 1991, p. 1190). It is important to note, however, that other ‘rational’ explanations are observationally equivalent to the intrinsic bubble explanation: regime shifts and managed fundamentals, can also explain non-linearities in the price-fundamental process (e.g. Froot and Obstfeld, 1991, and Ackert and Hunter, 1999).

Alternatively, deviations from fundamental value can be due to so-called irrational investor behaviour, such as ‘fads’, ‘noise’ or ‘momentum’ whereby

¹⁵ The model assumes free disposability therefore house prices cannot be negative.

speculators buy after price increases and sell after price decreases (see e.g. Shiller, 1984, Kyle, 1985, DeLong *et al.*, 1990, Daniel *et al.*, 1998, Barberis *et al.*, 1998, and Hong and Stein, 1999). Unlike the pure intrinsic bubble explanation, or other observationally equivalent explanations, irrational explanations entail speculative profitable opportunities that are eventually exploited and which drive prices toward – and arguably beyond – their fundamental value, for example see Daniel *et al.*, 1998, Barberis *et al.*, 1998, and Hong and Stein, 1999, who attempt to build models that unify theories of under- and over-reaction in stock markets.

Most existing studies have found that bubbles also occur on housing markets (for example, Abraham and Hendershott, 1996, for the US; Ayuso and Restoy, 2003, for the UK and Spain). Bubbles have however been found to be quite modest in several countries (see Bourassa and Hendershott, 1995, for Australia; Hort, 1998, for Sweden; Bourassa *et al.*, 2001, for New Zealand). Given that most housing purchases are made with a consumption rather than investment motive, irrational bubbles would be less expected than in pure investment markets, although some evidence of speculative behaviour is reported for London (Levin and Wright, 1997), Paris (Roehner, 1999) and Dublin (Roche, 2001). Momentum behaviour has been reported for the US securitised real estate market (Chui *et al.*, 2003).¹⁶

In an attempt to distinguish between the competing hypotheses of rationality versus irrationality we focus on the rational argument and its implications. Rational explanations as discussed above would imply that deviations from the present value fundamental price model are, first, highly correlated with fundamentals, which, in this case, would imply that prices are too sensitive to currently available income figures to

¹⁶ Bubbles have also been reported for the commercial real estate market (Björklund and Söderberg, 1999; Hendershott, 2000; Hendershott *et al.*, 2003) and the indirect real estate market (Brooks *et al.*, 2001).

be consistent with a linear present value model (Shiller, 1981); second, deviations from fundamental value will be more highly correlated with income than they are with prices themselves, implying that the dominant driving force is fundamentals rather than positive feedback or momentum trading; third, deviations from fundamentals will be non-stationary, thus evidence against speculative profit taking synonymous with, for example, contrarian strategies of stock market behaviour (Froot and Obstfeld, 1991). The results of this exercise are reported in Table 3.

Table 3
*Summary Statistics on Price Deviations from Fundamental Value**

Corr(deviations,income)	Corr(deviations,house prices)	ADF
0.479 (t=6.025)	0.374 (t=4.393)	-1.44

*Deviation denotes the (logged) actual real house price less the (logged) fundamental house price. Income denotes (log) demeaned and detrended real disposable income, and house prices, the (log) of actual real house prices. Corr(.) denotes the correlation coefficient. The t-statistic is calculated as $(corr\sqrt{n-2})/(\sqrt{1-corr^2})$, where $corr$ is the correlation coefficient and $corr^2$ is the squared correlation coefficient. The t-statistic tests the hypothesis that the correlation coefficient is equal to zero. ADF is the augmented Dickey-Fuller statistic and is a test for a unit root in the series. Critical values for the ADF tests with an intercept are: 1% -3.49; 5% -2.89; 10% -2.58.

Both correlations are significantly different from zero depicting a positive relationship. The association between deviations from fundamentals and house prices is less than that reported for deviations from fundamentals and income (although the difference in correlations is not statistically significant). Such features imply that differences between actual and fundamental values are not dominated by purely speculative activities. In addition, the ADF statistic suggests that deviations from fundamental value are non-stationary – a feature that was also revealed in cointegration tests (not reported) which could not reject the null of no cointegration between actual and fundamental house prices. Hence actual and fundamental house

prices do not appear to exhibit the long-run error correction-type relationship with each other which is synonymous with long-run profit taking.

We turn now to an analysis of the housing premium (the spread between continuously compounded returns from actual house prices and those of the estimated fundamental house price series) as a predictor of current and future inflation. First we explicitly take into account possible asymmetries in the inflation-housing premium relationship – that is, the extent to which predictive power is influenced by swings in profitability. With this in mind, we first display the Hodrick-Prescott smoothed housing premium series.

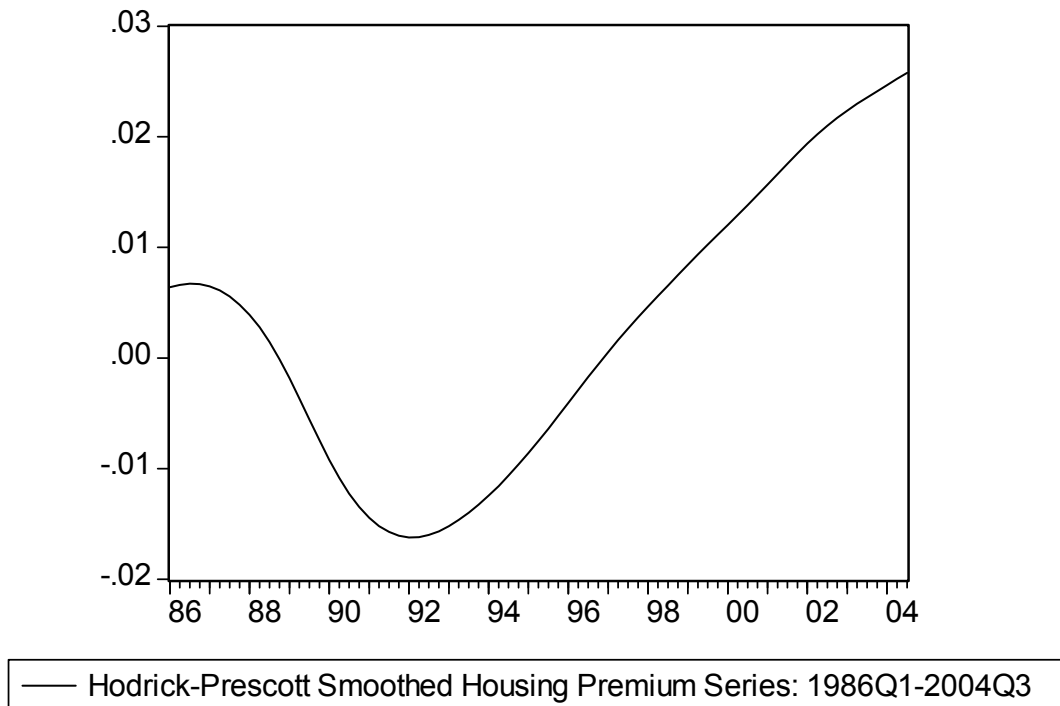


Fig. 4. Hodrick-Prescott Smooth Housing Premium Series.

The smoothed series indicates two incidents of turning points: positive turning points from 1987 Q3 through 1989 Q3 with negative turning points from 1995Q4 through

1997 Q4. The dates are consistent with the evidence reported for example in Farlow (2004). The positive turning points of the late 1980s are a reflection of the very bullish housing market of the late 1980s but whose trend was sharply reversing, while in the mid 1990s the market was bearish but soon to become very bullish again. The housing market has been a bull market ever since.

Table 5 reports the results of the estimation of equation (18), where we characterise the turning points in the housing premium series to gauge how sensitive the inflationary process is to swings in housing premium profitability.

Table 5
*Regression of Housing Premium Turning Points on Inflation**

$$inf_t = \beta_1 + \beta_2 inf_{t-1} + \beta_3 OG_{t-1} + \beta_4 X1_{t-1} + \beta_5 X1_{t-2} + \beta_6 X2_{t-1} + \beta_7 X2_{t-2} + \xi_t$$

	<i>Coefficient Estimates</i>	R^2
β_1	0.0002 (0.0009)	0.937
β_2	0.960** (0.108)	
β_3	0.019** (0.002)	
β_4	0.011** (0.005)	
β_5	-0.002 (0.007)	
β_6	-0.003 (0.032)	
β_7	0.001 (0.011)	

**inf* is inflation, *OG* is the output gap, *X1* denotes the interactive dummy measuring positive turning points in the cycle of house price return deviations from fundamental returns. *X2* denotes an interactive dummy measuring the negative turning points in the cycle of house price return deviations from fundamental returns. Figures in parenthesis below the coefficient estimates are Newey-West standard errors. ** denotes significance at least at the 5% level. R^2 is the adjusted *R*-squared.

Interestingly, there is evidence of significant asymmetries in the reaction of future inflation to housing premiums with the first coefficient estimate on the lagged

turning points in an overvalued housing market impacting significantly on future inflation even when controlling for the state of the economy. Turning points in an undervalued market would appear to have no significant effect on inflation.

Overall, the implication is that decision-makers should be more concerned with the inflationary consequences of peaks of housing market deviations from fundamental value than with troughs of an undervalued market.

Thus far our results suggest that the UK housing premium can be a useful predictor of future inflation but that usefulness appears to be significant only when housing market returns have already peaked relative to their underlying fundamental value as measured by our time-varying present value model. This is, hopefully, useful information for policy makers and suggests that they should place more emphasis on the forecasts from housing markets during peaks of ‘bull’ housing markets. Given this implication we now turn to forecasting using the results from the above regression.

The following simple forecasting experiments are carried out. We consider the forecasting performance of a version of equation (18) which excludes the output gap variable and the insignificant peaks and trough variables identified in the above regression, but which does include lagged inflation and the lagged positive peak dummy variable. We therefore focus on whether or not positive swings in profitability can do better than a random walk model.

We do this by comparing the out-of-sample forecasting performance using a static forecasting model, with one using a dynamic forecasting model. Given the importance of the own lag of inflation in the inflationary process, the distinction between these models lies in how this ‘own’ lag is treated. The static model calculates a sequence of one-step-ahead forecasts using the actual values of the lagged

dependent variable. The dynamic model however, calculates multi-step forecasts and previously forecasted values for the lagged dependent variable are used in forming forecasts of the current value rather than the actual values. The dynamic model therefore attempts to capture expected future trends in inflation. Before we do so however, we should note that not too much should be expected from such a simple forecasting model as we are using a 'profitability index' interacted with a zero-one dummy which means that the variable of interest takes on the value of zero for a substantial percentage of the time period under analysis.

Figure 5, graphs the actual inflation series alongside the static and dynamic forecasts while Table 6 provides performance statistics on the two forecasting models.

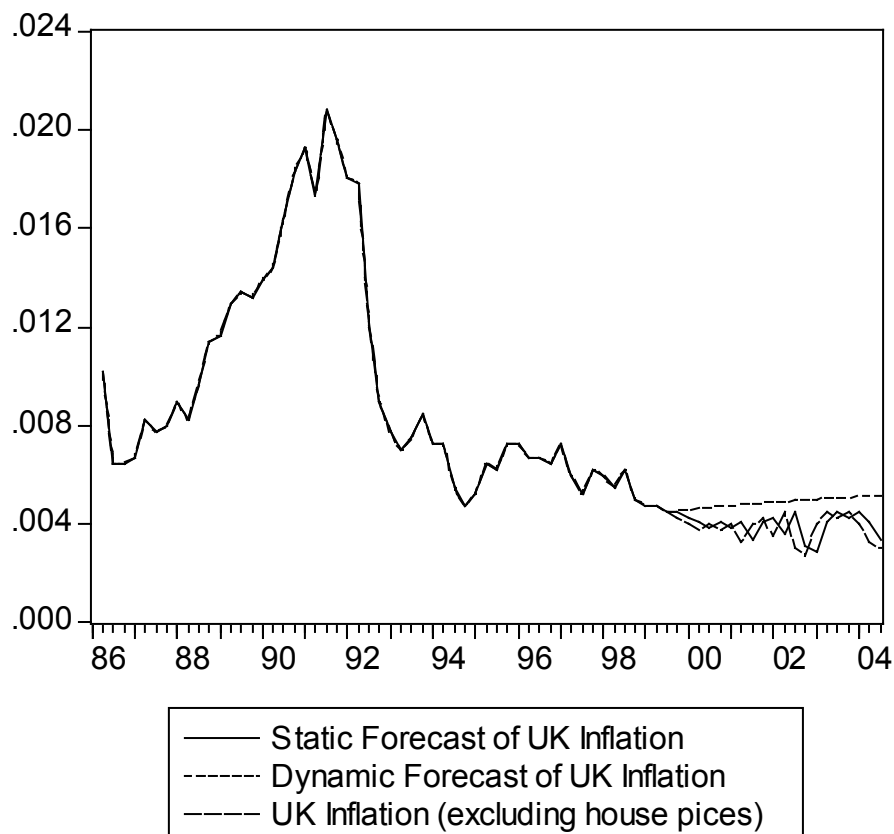


Fig. 5 *Forecasts of Inflation*

Figure 5 indicates that at the start of the forecast period the forecasted inflationary trend (multi-step forecast) was in a gently sloping upward direction while the one-step ahead forecast appears to track actual values quite well. This gap in predictive ability, of course, is not surprising given how lagged inflation is treated by the different forecasting methods. However, if turning points of profitability have independent forecasting ability the success of the one-step ahead forecast may also reflect the success of the monetary authorities in controlling inflation over this period given that the expected inflationary trend was increasing.

Table 6
*Performance of Dynamic and Static Forecasts of Inflation**

	Root Mean Square Error	Mean Absolute Error	Theil Inequality Coefficient
Dynamic Model	0.001	0.001	0.134
Static Model	0.0006	0.0005	0.081

*Estimation period: 1986:1 through 1999:3. Forecast period: 1999:4 through 2004:3.

The performance statistics reported in Table 6 imply that the turning points in the housing premium appear to have independent forecasting ability and that the static model performs better than the dynamic model with the RMSE, MAE and the Theil statistic being relatively smaller although both are well below unity. The implication is that both models can do better than forecasts from a naïve scheme of forecasting ‘no change over time’.

4. Conclusion

Four main conclusions emerge from our analysis of UK house prices, fundamentals and the inflationary process. First, deviations of actual house prices from their (present value) fundamental price exist during some sub-periods of the 1973:4-2004:3 full sample period. As of the end of our sample period, the premium amounted to 25%. Second, such deviations do not appear to be dominated solely by speculative

activities with over-sensitivity to expectations regarding fundamentals also being a major driving force. Third, inflation responds asymmetrically to the housing premium as measured by the spread between continuously compounded returns from actual house prices and those of the estimated fundamental house price series: turning points at peaks of overvaluation have more impact on future inflation (excluding house prices) than turning points at troughs of undervaluation. Finally, turning points at peaks of overvaluation also appear to have independent forecasting ability for inflation.

These conclusions contribute to the knowledge base of the monetary authorities and the debate relating to the significance of a housing bubble on inflation. The impact of the housing market on inflation is highlighted in the paper and policy-makers in their consideration of housing market conditions should recognise the asymmetry in the predictability of inflation with respect to the housing premium. Overall, this means decisions relating to intervention to curb future inflation can be made with additional knowledge about the information content in the housing markets for forecasting inflation.

A caveat of the current paper is the relatively short time period due to data constraints. Further work should focus on cross-country comparisons, in particular of the UK with some continental European countries because of the monetary policy implications of joining the Euro. Last but not least, a comparison of the timing of deviations from fundamentals for the housing and stock markets would be of interest. The impact of turning points in each of these markets on inflation would in particular warrant further research.

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