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## **Business Cycles, Mortgage Rates and Housing Starts in the United Kingdom - An Empirical Analysis\***

**Mohammad S. Hasan\*\***

*School of Business and Finance, Sheffield Hallam University,  
City Campus, Pond Street, Sheffield S1 1WB, UK*

This paper investigates the behaviour of housing starts in the United Kingdom in the light of four theoretically identified factors: income growth, movement in mortgage rates, user cost of housing and housing prices. It was found that income growth, changes in mortgage rates and housing prices exert a statistically significant impact on housing starts. However, the income growth variable exerts relatively more perceptible and larger effects on housing starts than the mortgage rate and housing price variables. **JEL: E32, R21, R31.**

### **Introduction**

The nature of the relationship between housing starts and its proximate determinants has been an issue of on-going interest among policy-makers and researchers. This has been chiefly due to the following reasons. First, housing starts, as a leading economic indicator provide important information about the current and future course of the economy. For example, a decrease in residential investment due to its possible chain of backward and forward

linkage effects lead to both declines in business investment and real economic growth during an economic downturn.<sup>(1)</sup> Conversely, a prolonged and deep recession will reduce the demand for new dwellings because of associated job losses and unemployment risk. Second, business cycle fluctuations, broadly measured by real output growth, are associated with more severe fluctuations in housing starts. As Figure 1 suggests, growth in housing starts

has been much more volatile than real output growth over the period 1968-1996. Podenza (1990), and Wheeler and Chowdhury (1993) noted that volatility in residential investment has an important influence on the volatility of aggregate economic activity. Therefore, understanding the behaviour of housing starts and the impact of business cycle fluctuations on housing starts is central to modelling the housing market. Third, the housing sector is an important channel through which monetary policy changes can influence economic activity (Podenza 1990). The monetary authority conducts open market operations to achieve a target range of short-term interest rates in order to ensure financial market stability. Changes in short-term interest rates then lead to changes in the mortgage rate. To the extent that mortgage rates are closely tied together with short-term interest rates, monetary policy is expected to have a direct impact on housing starts.<sup>(2)</sup> Figure 2 depicts the logarithms of variables: housing starts and mortgage rates. Visual inspection of the graph clearly indicates that housing starts and mortgage rates are inversely correlated. Therefore, understanding the transmission mechanism of monetary policy through mortgage rates is of prime importance to policy formulators, researchers and the business community.

Despite the practical importance of this issue, most previous studies have focused on the US economy.<sup>(3)</sup> To our knowledge few similar investigations have been carried out on the proximate determinants of housing starts using UK data.<sup>(4)</sup> In an attempt to fill this gap, this paper examines the relationship between housing starts and its proximate determinants such as income, mortgage rates, user cost of housing and house prices in the United Kingdom over the period 1968Q1 to 1996Q2. The paper is

organised as follows. The next section briefly reviews the recently submitted final reports of David Miles (2004) and Kate Barker (2004) to the UK Treasury which addressed the recent on-going policy issues of the UK housing market. The following section describes the model and the data. The penultimate section presents empirical results while the final section offers a conclusion.

### **House Prices, Housing Market and the Recent Consultative Report to the Treasury**

In recent years UK house prices have risen sharply, up by an estimated 9% per annum from 1996 to 2002. At the end of 2002, house price inflation stood at 25%. Analogous to the price earning ratio of corporate stock, Weeken (2004) estimated house prices to net rentals and found that this ratio is currently well above its long-term average. We have also reproduced an alternative estimate of the trend of house price to earnings ratio in Figure 3 downloaded from the website of Nationwide Building Society (<http://www.nationwide.co.uk/hpi/quarterly/activity.htm>). This suggests that the rates of house price increases are unsustainable and housing is becoming increasingly unaffordable over time. Understanding these problems of sustainability and affordability coupled with issues of macroeconomic volatility and long-run supply, the treasury commissioned an independent review body to investigate the longer-term prospects of the housing supply and mortgage market in the UK. Kate Barker and David Miles submitted Final Reports and Recommendations in March of 2004 addressing key issues surrounding the UK housing supply and mortgage market. The Barker (2004) report covers a broad spectrum of issues including population

growth, changing pattern of household formation, rising income and the weak supply response of the house building industry and sets out a series of recommendation. Miles's (2004) study furnished an in-depth demand and supply side analysis with implications, opportunities, cost and risks of longer-term fixed-rate mortgages in the UK. The study also analysed factors underlying the lower relative share and preference among mortgage borrowers for fixed-rate mortgages in the UK compared to the US and other European countries. A brief summary of the reports of Barker and Miles is outlined below to inform readers of the recent topical issues that are under review and consideration by policy makers and researchers.

1. Although population growth, changing patterns of household formation and rising income determine the long-term trend growth of housing demand, the recent surge in house prices are attributed to lower interest rates, expectations of greater economic stability and the weak supply response of house building to prices changes.

2. The trend rate of real house price growth in the UK has been 2.4% over the period of the last 30 years. We reproduce Table 1 from the Barker (2004) report which would enable readers to compare the UK with other European countries. The table shows that the trend growth rate of the UK real house price is higher than the European average of 1.1%. Side by side, the construction of new homes was 12.5% lower over 1992-2002 than the previous ten years of 1982-1991, with the output of new houses falling to its lowest level in 2001 since the second World War. Furthermore, UK house building is only half as responsive as the French, a third as responsive as the US and a quarter as

responsive as German house building which further exacerbated the housing shortage problems. Higher demand and poor supply response therefore tend to translated into higher house prices and market volatility rather than an increased output of house building.

3. (a) Rising and volatile house prices have important implications to individuals, households, family and the wider economy. One important issue in the policy arena is affordability and sustainability. Miles (2004) noted that the proportion of first time buyers with loan-to-income ratios in excess of three has increased over time in the Whole UK, in Greater London and in the South-East. For example, these proportions have increased from just over 10% in 1993 to 45% for the UK and close to 60% for London and the South-East by the middle of 2003. Barker (2004) noted that 37% of new households could afford to buy a property in 2002 compared to 46% in the late 1980s.

(b) Barker (2004) and Miles (2004) contend that the residential sector plays an important role in the transmission mechanism of the UK monetary policy in which changes in interest rates affect the macroeconomy through their effects on real expenditure. Interest rates affect the cost of housing as a consumption good and also affect the cost of investing in housing relative to other assets. Miles (2004) argued that changes in the short-term interest rates currently have two effects on the UK housing market. First, there is a direct effect on the cost of existing variable-rate debt which in turn has a substantial impact on a household's discretionary income. Second, a temporary change in short-term interest rates induce changes in the demand for housing as the former exerts a powerful impact on the initial debt servicing costs of mortgage loans.

(c) Barker (2004) noted that rising house prices benefit home owners and provide an increase in wealth which can be accessed through equity withdrawal in order to increase consumption. It can also benefit the next generation through intergenerational transfer. Table 1 shows a close relationship between consumer spending and house prices with a correlation coefficient of 0.85. The magnitude of correlation between housing wealth and house prices is higher in the UK than other European countries. This high correlation suggests that house price volatility feeds through into the wider economy as changes in house prices and house wealth are closely linked to private consumption; and consumer spending influences economic activity. This implies that the UK economy is more susceptible to business cycle fluctuations induced by housing price volatility. Miles (2004) conducted a simulation exercise using the Oxford Economic Forecasting (OEF) model and found that around a third of the impact of short-rates on GDP operates through the effect on house prices and another one sixth operates via the impact of change of short-rates on consumption.

(d) Miles (2004) contends that with fixed-rate mortgage lending, the impact of a given change in short-rate on house values and possibly on consumption expenditure will be lower.

4. Given the inadequate housing supply and the weak responsiveness of house building to house prices, Barker (2004) projected the future additional house construction required under the alternative targets of 1.8%, 1.1% and 0% house price inflation and based on the assumption of the formation of 179,000 households per annum (information based on the census report of 2001). With an estimated 179,000 new households in

England, only 134,000 additional private houses were built in 2002. Barker (2004) projected that builders need to build an additional 70,000, 145,000 and 240,000 private sector homes to achieve the long-term house trend in real house prices growth of 1.8%, 1.1% and 0%, respectively. The Government also need to assist in building 28,000 additional subsidised housing per annum for socially disadvantaged people.

The provision of an adequate housing supply for a growing population will help to lower the trend of real house price growth, and will lead to greater market affordability, reducing the regional house price differential. The increased housing supply would also help to reduce housing market volatility and the consequent economic volatility in the economy by reducing supply bottlenecks and dampening the euphoria of expectations of future house prices among market participants. Barker (2004) conducted a counterfactual simulation exercise and found that the UK would have been \$8 billion better off, had the real house prices raised in line with the European average since 1975.

### The Model:

The phenomenon of housing starts can be analysed in the demand and supply framework. The demand and supply function of housing can be written as:

$$h^d = h^d(y, c, pop) \\ h_y^d > 0, h_c^d < 0, h_{pop}^d > 0 \quad (1)$$

$$h^s = h^s(h^0, r, p) \\ h_r^s < 0, h_p^s > 0 \quad (2)$$

$$h^d = h^s + h^0 \quad (3)$$

where the variables:  $y$  signifies output or income,  $r$  denotes the rate of interest on

borrowing or the mortgage rate,  $pop$  refers to demographic factors such as population growth and household formation. The variables  $c$  and  $p$  signify user cost of housing and housing prices, respectively.  $h^0$  denotes actual stock of housing or current stock of dwelling. Pozdena (1990) defined the user cost of housing capital to include all current, out-of-pocket costs and net foregone income, which are associated with owning a home. The user cost includes the interest cost associated with mortgages net of taxes, property taxes, costs affected by the depreciation of the structure, maintenance expenditures and expected changes in the market price of the housing unit.

Equation (1) is a demand function for housing; the expected sign attached to  $h^d_y$  incorporates the conventional view of a positive income effect on the housing demand. Koyck's flexible accelerator model of investment also postulates that a change in output determines the level of investment. The expected sign attached to  $h^d_c$  reflects the standard argument for a negative influence of user cost of housing on the demand for housing. Equation (2) is the supply function of housing; the expected negative sign attached to  $h^s_r$  reflects the standard argument that an increased cost of borrowing for new dwelling construction has a depressive effect on housing starts. The expected sign attached to  $h^s_p$  signifies that higher rates of housing prices will stimulate new dwelling construction. Equation (3) is the equilibrium condition of the model; the demand for housing ( $h^d$ ) is equal to the supply of housing starts ( $h^s$ ) and the current stock of dwellings ( $h^0$ ). The reduced form of the structural model is obtained by solving the system of equations (1-3) for equilibrium housing starts:

$$h^e = h^e (y, r, pop, h^0, c, p) \quad (4)$$

Unfortunately, data limitations and other considerations restrict us in estimating the fully specified equation (4). Data on household formation are unavailable at the quarterly frequency. Therefore, household formation is proxied through a time trend ( $T$ ). We have used mortgage rates to proxy the cost of borrowed funds for housing. Since the mortgage rate ( $r$ ) is one constituent component of user cost for housing ( $c$ ), using both mortgage rate and user cost in the estimable model may give rise to the econometric problem of multicollinearity. All these considerations lead us to choose the following regression specification in order to investigate the empirical relationship of housing starts with income, mortgages rates and house prices:

$$h = \beta_0 + \beta_1 T + \beta_2 y + \beta_3 r + \beta_4 p + \varepsilon \quad (5)$$

$$\beta_2 > 0, \beta_3 < 0, \beta_4 > 0$$

An alternative variant of model (5) is estimated with the user cost of housing ( $c$ ) variable instead of mortgage rates ( $r$ ). The counterpart data on variable income (real GDP), housing prices and mortgage rates are compiled from the 1997 issue of *Economic Trends Annual Supplement* and the Building Societies Association, respectively.<sup>(5)</sup>

## Empirical Results

The modelling technique requires a covariance stationary time series in order to deal with the spurious regression problem (see Granger and Newbold, 1974). Furthermore, while fitting the model we also need to test for cointegration in order to decide whether log level or log difference data is appropriate. We therefore begin by examining the nature of the stationary characteristics and cointegrating properties of each variable. The data have been checked for stationarity using the

Augmented Dickey Fuller (ADF) test for each of the four variables. The results of the ADF test indicate that each of the four variables,  $h$ ,  $y$ ,  $r$  ( $c$ ) and  $p$  are non-stationary at the level but stationary in first difference form.<sup>(6)</sup>

In the next step, the data series have been further checked using the Johansen and Juselius (1990) maximum likelihood procedure to test for cointegration. Appendix Table 1A presents the eigenvalue and trace tests of the four variate vector autoregressive (VAR) model comprised of variables,  $h$ ,  $y$ ,  $r$  and  $p$  and Table 1B shows the results of VAR system comprised of variables,  $h$ ,  $y$ ,  $c$  and  $p$ . The results of Johansen's eigenvalue and trace tests indicate that there exists at least one cointegrating relationship in the four variate VAR system. The results tend to suggest that there exists at least one stationary relationship between housing starts, income, mortgage rates (user cost of housing) and house prices. The finding of cointegration among these macroeconomic variables has several implications. First, consistent with economic theory this finding indicates that housing starts, real output, mortgage rates (user cost) and house prices have a long-run equilibrium relationship, which may be exploited by the monetary authorities in the formulation of monetary policy. Second, the evidence of cointegration also rules out the possibility of spurious correlations and Granger noncausality between the housing starts, real output, mortgage rate (user cost) and house price variables.

Given the fact that each of the variables is a non-stationary integrated series and there is cointegration among the variables, the optimal model building strategy proceeds with an error-correction model. To allow for adjustment and lag effects in income, mortgage rates and house prices, we

examine the growth in housing starts in a dynamic model. Following Hendry (1984), a more general model was initially specified where the housing starts variable was regressed on the full vector of exogenous variables and endogenous variables with eight-quarter lags. Through a stepwise regression procedure the following specific model was applied:

$$\begin{aligned}
 \Delta h_t = & 1.761 - .00381T - .041 ECT_{t-1} + \\
 & (2.597) \quad (-1.212) \quad (-2.587) \\
 & 2.801 \Delta y_{t-1} + 2.420 \Delta y_{t-2} - 2.487 \Delta y_{t-4} - \\
 & (3.109) \quad (2.818) \quad (-3.042) \\
 & 1.642 \Delta y_{t-5} - .288 \Delta r_{t-2} - .246 \Delta r_{t-6} \\
 & (-2.038) \quad (-1.848) \quad (-1.624) \\
 & + .606 \Delta p_{t-4} - .465 \Delta h_{t-1} - \\
 & (1.846) \quad (-3.718) \\
 & .222 \Delta h_{t-8} \\
 & (-2.746) \tag{6a}
 \end{aligned}$$

$$R^2 = .232, SE = .102, DW = 1.91, LM(4) = 4.456 (.347), F = 3.569 (.000).$$

$$\begin{aligned}
 \Delta h_t = & .295 - .0015T + .0040 ECT_{t-1} + \\
 & (.900) \quad (-.254) \quad (.872) \\
 & 2.276 \Delta y_{t-1} + 1.497 \Delta y_{t-2} - 2.428 \Delta y_{t-4} - \\
 & (2.534) \quad (1.709) \quad (-2.946) \\
 & 1.777 \Delta y_{t-5} - .0037 \Delta c_{t-2} - .0107 \Delta c_{t-6} + \\
 & (-2.186) \quad (-.799) \quad (-2.174) \\
 & .307 \Delta p_{t-4} - .448 \Delta h_{t-1} - \\
 & (.912) \quad (-3.122) \\
 & .166 \Delta h_{t-8} \\
 & (-1.964) \tag{6b}
 \end{aligned}$$

$$R^2 = .214, SE = .103, DW = 1.93, LM(4) = 4.089 (.394), F = 3.314 (.001).$$

This exercise was carried out for the sample period 1968Q2-1996Q1. Equation (6a) reports results based on mortgage rates and equation (6b) presents results based on the user cost of housing. *ECT* signifies the error correction term. Figures in parentheses beneath the coefficients are the *t*-ratios; figures in brackets alongside the *LM* and *F* statistics are the marginal probability values. *DW*, *SE* and *F* are the Durbin-Watson statistic, standard error of the regression and the regression *F*-statistic, respectively. The *R*<sup>2</sup> and standard error of the regression are reasonable given that the equation is estimated in growth rate form. *LM(4)* is the Breusch-Godfrey LM statistic testing for the fourth order serial correlation and is indicative of no serial correlation in the residuals. The reported *F*-statistic rejects at the 1% level the null hypothesis that the model has no explanatory power. The error correction term in equation (6a) is negative and statistically significant which indicates that a long-run causality is flowing from the explanatory variables to the dependent variables,  $\Delta h$ . The small size of the coefficient (.041) implies that the speed of adjustment is rather slow for the equation to return to the equilibrium once they have been shocked. The income variable exhibits a counter-cyclical response from the fourth quarter; the interest rate variable exerts a prolonged and significant negative effect on housing starts. The housing price variable exerts a positive and significant effect on housing starts in equation (6a). The user cost of capital is inversely and significantly related to housing starts in equation (6b). Although the house price variable is positive, it is insignificant in equation (6b). Judged by theoretically expected signs and significances of coefficients, *R*<sup>2</sup> and standard error of regression, equation (6a) performs better than equation (6b).

It can be concluded from the results that growth in income and changes in mortgage rates (user cost of housing) and house prices exert a statistically significant impact on housing starts. Judged by the size and significance of the coefficients, the income growth variable exerts more perceptible and larger effects on housing starts than the other two variables, *r* and *p*. This finding accords well with Meen (1997) which found that the key factors underlying house price changes are movements in income and interest rates.

### Financial Market Deregulation and Housing Starts

There had been widespread mortgage rationing in the UK housing market before 1980. Induced by various deregulatory measures, constraints on mortgage lending were significantly relaxed in stages after 1980.<sup>(7)</sup> Flemming (1973), and Muellbauer and Murphy (1997) contend that, when credit rationing binds consumers' choice set, current consumption of households is constrained by current income and rationed current borrowing. Income expectations and the real interest rate should be more important in the determination of house prices during the period of financial liberalisation. Muellbauer and Murphy (1997) noted that mortgage market liberalisation in the 1980s has resulted in notable shifts in house price behaviour; income expectations and real interest rates became significantly more important in the house price equation.

In this section, we have investigated whether UK financial market deregulation and innovation have altered the relative importance of income and mortgage rates in the determination of housing starts after 1980. For this purpose, the sample has been split into two sub-periods identifying

1983:IV as the turning point of financial market liberalisation following the abandonment of 'corset' control and the interest rate cartel. The two sub-periods consist of 1968:II-1983:IV and 1984:I-1996:II. The estimated equations for the sample period 1968:II-1983:IV using variables,  $r$  is:

$$\begin{aligned} \Delta h_t &= 1.212 + .0038T - .0302 ECT_{t-1} + \\ &\quad (1.914) \quad (.437) \quad (-1.984) \\ 2.653\Delta y_t &- .473\Delta r_t + .405\Delta p_t \\ &\quad (2.264) \quad (-1.772) \quad (.632) \end{aligned} \quad (7a)$$

$$\begin{aligned} R^2 &= .103, S.E. = .137, D.W. = 2.058, \\ LM(4) &= 4.909 (.296), F = 2.117 (.059). \end{aligned}$$

And for the sample period 1984:I-1996:II, the estimated equations become:

$$\begin{aligned} \Delta h_t &= 2.303 - .0012T - .054 ECT_{t-1} + \\ &\quad (2.802) \quad (-1.833) \quad (-2.856) \\ 4.519\Delta y_t &- .438\Delta r_t + .171\Delta p_t \\ &\quad (3.716) \quad (-2.624) \quad (.375) \end{aligned} \quad (7b)$$

$$\begin{aligned} R^2 &= .282, S.E. = .063, D.W. = 2.099, LM(4) \\ &= 2.951 (.566), F = 4.084 (.003). \end{aligned}$$

It is evident that the  $R^2$ , standard error of regression and  $F$  statistic have improved in the regression related to the period 1984:I-1996:II. The size and significance of the income coefficient as well as the significance of the mortgage rate variable have increased during the period of financial liberalisation. This finding accords well with the theoretical prediction and empirical evidence of Muellbauer and Murphy (1997).

### Conclusions:

This paper has examined the empirical relationship between housing starts and its proximate determinants in the United Kingdom over the period 1968Q1 to 1996Q2. Four theoretically plausible factors have been identified to explain the movement of housing starts: *income growth*, *house price inflation*, movements of *mortgage rates* and *user cost of housing*. The study found that housing starts, income, mortgage rates (user cost of housing) and house prices are tied together by a long-run equilibrium relationship. The error correction models show that growth in income, movements in mortgage rates, user cost of housing and house prices exert a statistically significant effect on housing starts. Our finding is broadly consistent with Mean (1997), and Muellbauer and Murphy (1997). Overall, the finding of this paper provides additional evidence and insight into some of the factors accounting for the movement of housing starts.

We have also addressed issues of the recent surge in house prices, affordability and housing supply in the light of Barker and Miles Reports. Weeken (2004) using a simple "dividend" discount model demonstrated that the unprecedented increase in house prices since 1996 is attributed to lower real interest rates. Weeken (2004) contends that the housing risk premium needs to fall to reduce house prices. Our finding is also consistent with Weeken (2004). The Bank of England recently has increased the base lending rate from a level of 3.5% four times (Nov. 6, 2003, Feb. 5, May 7, and June 10 of 2004) to 4.5% in a time span of seven months to moderate house price rises. However, the introduction of long-term fixed-rate mortgages like the US and other European

countries would lower the efficacy and power of the monetary policy.

**Endnotes:**

<sup>1</sup> For example, see Podenza (1990), Wheeler and Chowdhury (1993).

<sup>2</sup> Modigliani (1975) has shown that the major impact of monetary policy occurs through the cost of capital channel by a change in market interest rates, while credit rationing in the mortgage market has a transient effect on residential construction.

<sup>3</sup> For example, see Browne and Rosengren (1992), Rahman and Mustafa (1997), Wheeler and Chowdhury (1993), and references therein.

<sup>4</sup> Several interesting papers recently analysed other aspects of the UK housing market by focusing upon determinants of house prices, the impact of housing equity withdrawal on consumer durable spending, the relationship between housing market activity and unemployment and domestic savings. For example, see, Carruth and Henley (1992), Drake (1993), Hendry (1984), Holmes (1993), MacDonald and Taylor (1993), Meen (1997), Miles (1992), Muellbauer and Murphy (1997), Pain and Westaway (1996), and Stern (1992). Studies of Tsoukis and Westaway (1994), and

Meen (2000) are notable exceptions which however investigated the behaviour of the UK housing construction.

<sup>5</sup> The author sincerely thanks Nigel Pain for kindly furnishing the data of user cost of housing which were used in Pain and Westway (1996).

<sup>6</sup> To conserve space, the unit root test results are not reported here. They are, however, available upon request from the author.

<sup>7</sup> Most notable among these deregulatory measures were the abolition of direct monetary controls on banks (1980), abandonment of the interest rate cartel by building societies (1983) and the Building Societies Act of 1986. The removal of direct monetary controls (known as the 'corset') allowed the clearing banks to enter the mortgage market in a big way and led to increased competition between banks and building societies. From 1983, building societies were allowed to raise funds from the wholesale money market to finance home loans. The abandonment of the interest rate cartel allowed building societies increased freedom to set interest rates competitively. The building society legislation of 1986 further eased restrictions on funds and allowed for diversification by societies into both financial and non-financial services.

**Table 1: Real house price inflation, 1971-2001**

	Average <sup>1</sup>	Trend <sup>2</sup>	Volatility of house prices around trend <sup>3</sup>	Correlation of private consumption and house price inflation
UK	3.3	2.4	15.1	0.85
Germany	0.1	0.0	11.1	0.33 <sup>5</sup>
France	1.2	0.8	7.6	0.50
Italy	1.5	1.2	15.5	0.14
Spain <sup>4</sup>	3.3	3.0	17.3	0.55
Netherlands	2.8	1.3	25.1	0.73
Belgium	2.1	1.7	14.3	0.38
Ireland	3.1	2.2	17.4	0.66
Sweden	0.0	-1.0	19.0	0.73
Finland	0.7	0.7	13.5	0.64
Denmark	1.3	0.2	13.4	0.64
Average	1.8	1.1	15.4	0.56

<sup>1</sup> Geometric mean.<sup>2</sup> Based on a regression of (log) real house prices on a constant and a time trend.<sup>3</sup> Coefficient of variation.<sup>4</sup> Spain between 1972 and 2001 only.<sup>5</sup> Excludes former East Germany except private consumption growth 1992-2001.

Source: Bank for International Settlements HM Treasury's 'Housing, Consumption and EMU', EMU Study, 2003.

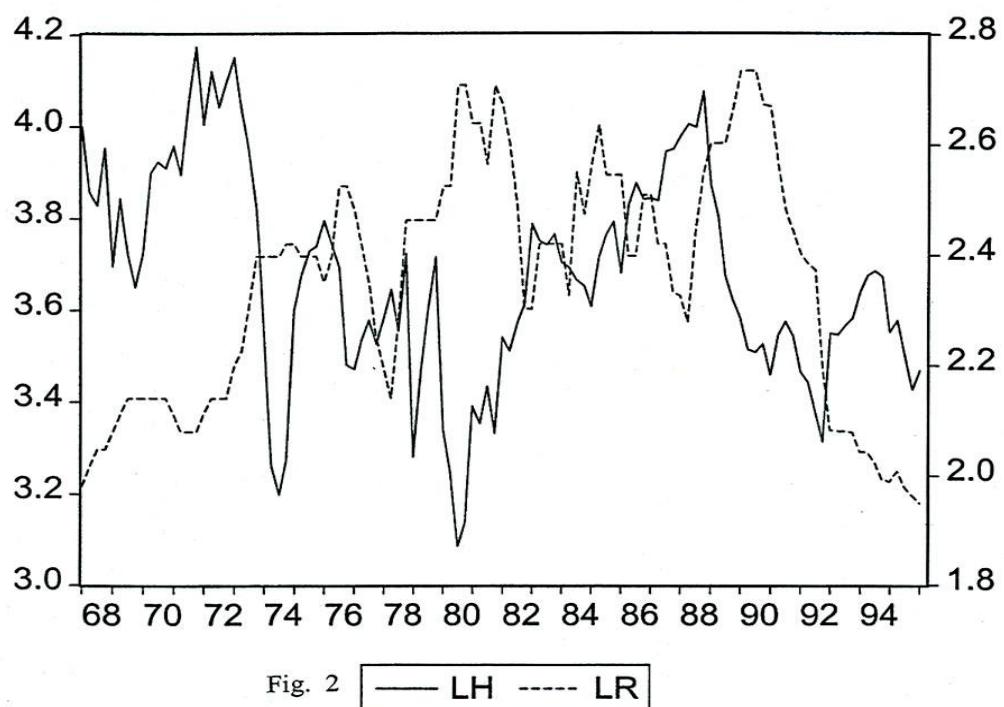
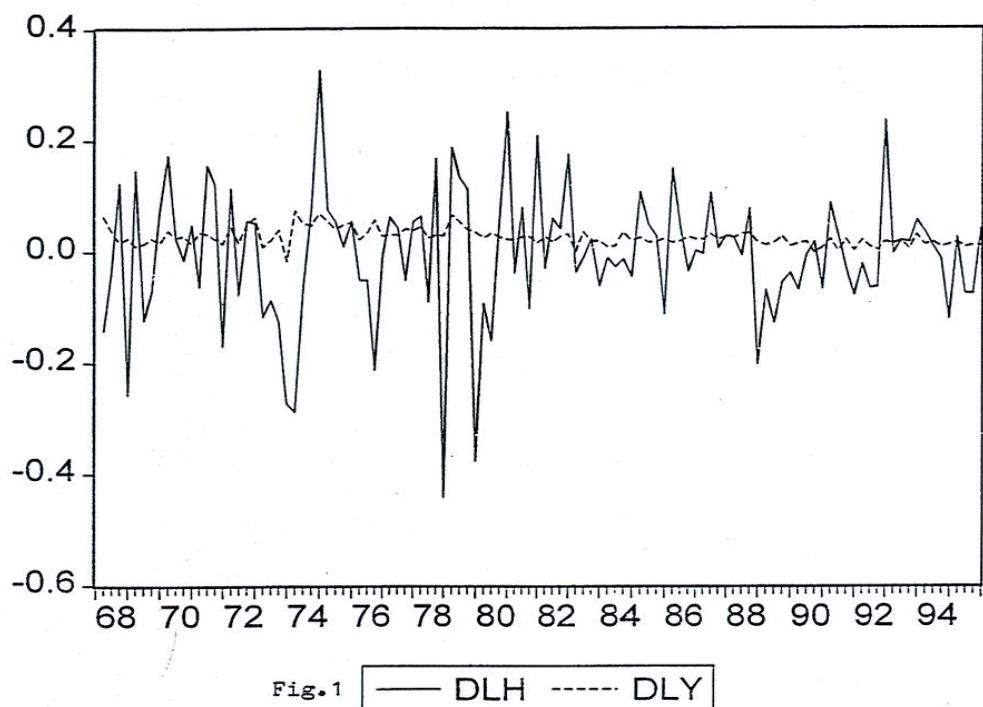
**Appendix Table 1A: Cointegrating relationships among housing starts, real income, mortgage rates and house prices**

		Test statistics		95% critical value	
H <sub>0</sub> :	H <sub>1</sub> :	Max Eigenvalue	Trace	Max Eigenvalue	Trace
r = 0	r > 0	39.69*	75.90*	31.79	63.00
r ≤ 1	r = 2	21.67	36.20	25.42	42.34
r ≤ 3	r = 3	8.41	14.53	19.22	25.77
r ≤ 4	r = 4	6.12	6.12	12.39	12.39

**Appendix Table 1B: Cointegrating relationships among housing starts, real income, user cost of housing and house prices**

		Test statistics		95% critical value	
H <sub>0</sub> :	H <sub>1</sub> :	Max Eigenvalue	Trace	Max Eigenvalue	Trace
r = 0	r > 0	37.18*	66.80*	31.79	63.00
r ≤ 1	r = 2	16.39	29.62	25.42	42.34
r ≤ 3	r = 3	8.39	13.22	19.22	25.77
r ≤ 4	r = 4	4.83	4.83	12.39	12.39

Notes: r indicates the number of cointegrating relationships. \* indicates rejection at the 5% critical value.





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\*\* **Dr. Mohammed S. Hasan** is a Ph.D. in Economics and works as a Senior Lecturer in Financial Services and Banking at Sheffield Hallam University. His specialism includes macroeconomics, monetary economics, financial economics. His papers have appeared in *The Journal of Comparative Economics*, *Empirical Economics*, *Economics Letters*, *Journal of Economics and Business*, *International Journal of Theoretical and applied Finance*, *Applied Financial Economics*, *Journal of Economic Studies*, *Applied Economics Letters*.

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