

Financial Econometrics Series

SWP 2011/05

**The Importance of Real and Nominal Shocks on
the UK Housing Market**

P.K. Narayan and S. Narayan



**THE IMPORTANCE OF REAL AND NOMINAL SHOCKS ON THE UK
HOUSING MARKET**

Paresh Kumar Narayan and Seema Narayan

Mailing Address of Corresponding Author

Professor Paresh Kumar Narayan
School of Accounting, Economics and Finance
Faculty of Business and Law
Deakin University,
221 Burwood Highway,
Burwood, Victoria 3125
Australia.
Telephone: +61 3 924 46180
Fax: +61 3 924 46034
Email: paresh.narayan@deakin.edu.au

THE IMPORTANCE OF REAL AND NOMINAL SHOCKS ON THE UK HOUSING MARKET

ABSTRACT

The goal of this paper is to examine the responsiveness of the UK housing market to real and nominal shocks. To achieve this goal, we use a structural VAR model, based on quarterly data for the period 1957:1-2009:4. We find that in response to an interest rate shock, house prices (aggregate house price and modern house price) fall sharply over the first 4 years and do not recover to their pre-shock level. In response to a real GDP shock, both house prices react in a positive inverted U-shaped manner. Finally, we find that an inflation shock has a U-shaped negative impact on aggregate and modern house prices in the UK.

1. Introduction

The UK housing market has attracted much research interest in two main areas. There are studies on the ripple effect in the UK house prices (see Cook and Thomas, 2003; Cook, 2005a,b; Meen, 1999) and the determinants of UK house prices (see Stern, 1992; Hendry, 1984; Hamnett, 1988; Fleming and Nellis, 1985a,b; Nellis and Longbottom, 1981; MacDonald and Taylor, 1993). However, the responsiveness of the housing market to real and nominal (monetary policy) shocks has received little attention in the literature on housing economics. Three studies stand out in this literature. Iacoviello and Minetti (2003) analyse the impact of financial liberalisation on the relationship between house prices and monetary policy for Finland, Sweden, and the UK for the periods 1987:2 to 1999:3, 1985:4 to 1998:4, and 1986:3 to 1999:4, respectively. Using a VAR model, they find that a contractionary monetary policy (a rise in interest rate) reduces real house prices in all the three countries.

Lastrapes (2002) uses a structural VAR model to examine the impact of money supply shocks on real house prices and housing sales. His study is based on monthly data over the period January 1963 to August 1999. He finds that both house prices and housing sales increase in the short-run in response to positive money supply shocks. Giuliadori (2005) examines the impact of a rise in short term interest rates on house prices for nine European countries, namely Belgium, Finland, France, Ireland, Italy, the Netherlands, Spain, Sweden, and the UK, using quarterly data for the period 1979:3-1998:4. He applies a structural VAR model and finds that an interest rate rise negatively affects house prices in these European countries.

The goal of this paper is to re-examine the responsiveness of the UK house prices to nominal and real shocks. There are four aspects of our work that distinguish it from the three studies, which are similar in spirit, reviewed above. First, we consider not only real interest rate shock, but also identify other theoretically plausible nominal and real shocks that potentially influence house prices. In particular, we show interest in examining the role of inflationary shocks and real GDP shocks in shaping house prices in the UK. Second, we consider two types of house prices: an aggregate house price that represents all types of houses (old, modern, and new) and prices for modern houses. This allows us to make a comparison of the relationship between real and nominal shocks on house prices of two different types. Third, all studies identified above, which have used the structural VAR model, assume that the underlying variables are integrated of order one. We depart from this practice, in that we specifically test the variables for stationarity using structural break stationarity test. Fourth, our study covers the most recent data. Previous studies have not considered the post-1999 data. We consider the period 1957:1-2009:4, thus our study is seven years most recent.

Briefly foreshadowing the main results, we find that in response to an interest rate shock house prices (aggregate house price and modern house price) fall sharply over the first 4 years and do to recover to their pre-shock level. In response to a real GDP shock both house prices react in a positive inverted U-shaped manner. Finally, we find that an inflation shock has a U-shaped negative impact on aggregate and modern house prices in the UK.

The plan of this paper is as follows. We explain the econometric model in section 2. The econometric model is based on the familiar structural VAR model. In section 3, we identify our estimable model and explain the theoretical framework. In section 4, we examine data and discuss the results. In the final section, we conclude with the main findings.

2. Econometric Model

Based on the theoretical discussions (see next section), the vector of endogenous variables

$$Y'_t = [HP_t, GDP_t, IR_t, P_t]$$

where HP is the real house prices, GDP is the real gross domestic product, IR is the short-term interest rate, and P is the inflation rate. The income variable is important to measure the impact of real shocks, while the interest and inflation variables are important to measure the impact of nominal (or monetary policy) shocks. The importance of the UK housing market in monetary policy setting has already been recognised by Iacoviello and Minetti (2003: 34), who point out that “... given the importance of housing wealth in the portfolios of households and businesses, housing markets play a key role in the transmission of monetary policy”

We can begin with a reduced form VAR model of the following form:

$$Y_t = AY_{t-1} + \dots + A_p Y_{t-p} + \Psi D_t + \mu_t \quad (1)$$

where p denotes the order of the VAR model, Y is an $n \times 1$ vector of endogenous variables, μ_t is an $n \times 1$ vector of reduced form residuals. We can safely ignore the deterministic component simply because it is unaffected by shocks to the system.

Then the SVAR model can be written as follows:

$$AY_t = A_1^* Y_{t-1} + \dots + A_p^* Y_{t-p} + B\varepsilon_t \quad (2)$$

Here the matrix A is used to model the instantaneous relationships, while the matrix B contains structural form parameters of the model. ε_t is an $n \times 1$ vector of structural disturbances and $\text{var}(\varepsilon_t) = \Lambda$, where Λ is a diagonal matrix with the variance of structural disturbances making up the diagonal elements.

It is common knowledge in this literature that shocks cannot be observed directly. This demands imposing some restrictions. The common practice is to multiply equation (2) by A^{-1} , leading to the following relationship between the reduced form disturbances and the structural disturbances:

$$\mu_t = A^{-1}B\varepsilon_t \quad (3)$$

We estimate the AB model proposed by Amisano and Giannini (1997). This allows us to write equations (3) as follows:

$$A\mu_t = B\varepsilon_t \quad (4)$$

3. Model and theoretical framework

We impose the following restrictions:

$$\begin{bmatrix} \varepsilon_t^{\text{HP}} \\ \varepsilon_t^{\text{GDP}} \\ \varepsilon_t^{\text{IR}} \\ \varepsilon_t^{\text{P}} \end{bmatrix} = \begin{bmatrix} 1 & * & * & * \\ 0 & 1 & * & * \\ 0 & 0 & 1 & * \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \mu_t^{\text{HP}} \\ \mu_t^{\text{GDP}} \\ \mu_t^{\text{IR}} \\ \mu_t^{\text{P}} \end{bmatrix} \quad (5)$$

Here, $\varepsilon^{\text{HP}}, \varepsilon^{\text{GDP}}, \varepsilon^{\text{IR}}$ and ε^{P} are the structural disturbances; that is, house price shocks, output shocks, interest rate shocks and inflation shocks, respectively; and $\mu^{\text{HP}}, \mu^{\text{GDP}}, \mu^{\text{IR}}$ and μ^{P} are the residuals in the reduced form equations, representing unexpected disturbances (given information in the system).

The first equation depicts contemporaneous relationship between house prices and real and nominal variables. This restriction is consistent with theory, in that interest rates and inflation are likely to have negative effects on house prices, while real GDP, due to the wealth effect, is likely to have a positive effect on house prices.

Consider first the relationship between interest rate and house prices. When a central bank unexpectedly raises the short term interest rate, this influence the mortgage interest rate charged by commercial banks. Thus, a contractionary monetary policy increases the cost of borrowing. This results in a fall in demand for housing. The high cost of borrowing also discourages construction of new dwellings and renovations of existing dwellings (Giuliodori, 2005). A general fall in demand for housing, consistent with demand theory, will result in a fall in house prices. It follows that a contractionary monetary policy is likely to result in a fall in house prices. For a detailed discussion of the relationship between interest rate and the housing market, see Kau and Keenan (1980, 1981).

The relationship between inflation and house prices is also expected to be negative. If inflation increases, other things being equal, real income falls. Consumers have less income to spend and save. This has a negative effect on consumers spending patterns. First home-buyers, in particular, will be discouraged to commit to a mortgage in the face of declining real income. Indeed, a declining real income will not stimulate construction activity. Thus, a slowdown in construction of new dwellings and renovations of new dwellings is likely.

The relationship between real GDP and real house prices is expected to be positive, owing mainly to the real wealth effect. As consumers' real wealth from non-real estate assets increase, they gain greater purchasing power for real estate assets. Thus, a rise in real wealth, accumulated from non-real estate assets, is likely to increase the demand for housing. Consistent with demand theory, this will result in rise in house prices.

The second equation represents a contemporaneous response of interest rate to real GDP and inflation but not to the other nominal variables. This restriction is motivated by the theoretical relationship between interest rate and output. An interest rate shock (a rise in interest rate), a contractionary monetary policy reaction, is often aimed at slowing down a fast growing economy. Normally, the impact of the interest rate rise is felt through the aggregate demand channel, where the negative effect on investment flows on to a negative effect on output. We, thus, allow output to respond contemporaneously to shocks to interest rate.

Friedman (1977) proposed the idea that when mean inflation grows there is more uncertainty about future inflation. This expectation distorts the effectiveness of the price mechanisms in optimal resource allocation, leading to economic inefficiencies. Sub-optimal allocation of resources has a negative impact on output. We, thus, allow output to respond contemporaneously to shocks to inflation.

The third equation can be perceived as representing the Fisher (1907) hypothesis, which contends that there is a positive relationship between inflation and interest rate.

Consistent with the Fisher hypothesis, we allow interest rate to respond contemporaneously to shocks to inflation.

The fourth equation does not allow a contemporaneous response of inflation to any of the nominal and real variables.

4. Data and results

4.1. Basic features of data series

We begin this section by reporting some basic descriptive statistics, namely the mean, standard deviation, skewness, kurtosis and the Jarque-Bera test statistics for normality of the series (see Table 1). The data used are real GDP, real house prices (aggregate house prices and modern house prices), short-term interest rate, and inflation. The real values are converted using the GDP deflation, while the inflation rate is computed from the consumer price index. The house price data is extracted from <http://www.nationwide.co.uk>, while data on the rest of the variables is obtained from the IMF publication – International Financial statistics. The data is quarterly, and cover the period 1957:1 to 2009:4. The series are converted into natural logarithmic form before this analysis. We notice that mean GDP is the highest followed by the house prices, interest rate and CPI. Volatility, meanwhile, is highest for interest rate and lowest for GDP. Compared with interest rate and CPI volatility, house price volatility is relatively low.

INSERT TABLE 1

Skewness is a measure of asymmetry of the distribution of the series around its mean. The skewness of an asymmetric distribution, such as a normal distribution, is zero. We notice that for all series skewness is less than 0.51 in absolute terms. For the two

house prices series and the interest rate the skewness is positive (has a right tail), while for real GDP and the CPI skewness is negative (has a left tail). Kurtosis measures the peakedness of the distribution of the series. The Kurtosis statistics around 3 for the two house price series, while it is less than three for the rest of the series, implying that the distribution is peaked (leptokurtic) relative to the normal.

Finally, the JB test examines whether the series is normally distributed. Under the null hypothesis of a normal distribution, the J-B statistic is distributed as χ^2 with 2 degrees of freedom. We reject the null hypothesis of a normal distribution at the 1 per cent level for interest rate, CPI and GDP, at the 5 per cent level for modern house prices and at the 8 per cent level for the house price of all houses.

In Figure 1, we plot the quarterly growth rates in real GDP, real house prices, interest rate and CPI (inflation). Over the entire sample period, we notice that quarterly growth rate is highest for inflation (1.44 per cent) followed by house price (all houses) (0.82 per cent), modern house prices (0.79 per cent), GDP (0.62 per cent), and interest rate (0.35 per cent). We considered quarterly growth rates over the most recent 10-year period (1997:1-2009:4) and found that the quarterly growth rate was highest for aggregate house prices (2.20 per cent) followed by modern house prices (1.01 per cent). The quarterly growth rate in GDP was only 0.32 per cent in this period, while inflation grew at 0.51 per cent. Interestingly, the interest rate fell over this period at a quarterly average of 0.08 per cent. From this simple quarterly growth data, we observe that over the most recent decade, interest rates have fallen marginally and house prices have risen by more than 1 per cent per quarter in the case of modern houses and by around 2.2 per cent per quarter in the case of all houses taken together.

INSERT FIGURE 1

In Table 2, we report the correlation coefficients between the variables, together with the associated t-statistics to judge the statistical significance of correlations. We find that the correlation coefficient between interest rate and the two houses prices is low and statistically insignificant over the period 1957:1-2009:4, while the correlation coefficient between inflation and house prices is fairly high (around 0.85) and is statistically significant. Similarly, we notice a positive (over 0.92) and statistically significant correlation between real GDP and house prices.

INSERT TABLE 2

4.2 Multiple structural breaks unit root test

In this section, we attempt to establish the integrational properties of the data series. This is a crucial consideration as it has implications for the form in which we estimate the proposed SVAR model. The extant literature, as highlighted earlier, has assumed that the underlying variables are integrated of order one, and have thus modelled treated variables in their level form in the SVAR model. We do not depend on this assumption, rather we want to statistically confirm that variables are integrated of the same order before we proceed to estimating the SVAR model.

We test for the null hypothesis of stationarity, following closely the pioneering work of Carrion-i-Silvestre (2003) and Carrion-i-Silvestre *et al.* (2005) that allows for at most 5 structural breaks in a univariate series. Their work draws motivation from the work of KPSS (1992). The model has the following form:

$$y_t = \alpha + \sum_{k=1}^5 \theta_k DU_{k,t}^* + \beta t + \sum_{k=1}^5 \gamma_k DT_{k,t}^* + \varepsilon_t \quad (6)$$

here subscript $t = 1, \dots, T$ time periods; the dummy variable $DT_{k,t}^* = t - T_{b,k}$ for $t > T_{b,k}$ and 0 elsewhere; and $DU_{k,t} = 1$ for $t > T_{b,k}$ and 0 elsewhere, where $T_{b,k}$ denotes the k th date of the break and $k = 1, \dots, 5$. Following Kwiatkowski *et al.* (1992), the test statistic is of the form

$$LM(\lambda) = \hat{\omega} T^{-2} \sum_{t=1}^T \hat{S}_t^2 \quad (7)$$

where $\hat{S}_t = \sum_{j=1}^t \hat{\varepsilon}_j$ denotes the partial sum process that is obtained using the estimated OLS residuals from Equation (1), with $\hat{\omega}$ being a consistent estimate of the long-run variance of ε_t . Finally, λ denotes the dependence of the test on the dates of the break, which is obtained using the Bai and Perron (1998) procedure. We calculate specific sample size critical values through Monte Carlo simulations by taking account of the statistically significant structural breaks, as the critical values are influenced by the structural breaks.

The results are reported in Table 3. We generate finite sample critical values at conventional levels of significance and report them in the final column. The main finding is that for all the five series we are unable to reject the null hypothesis of stationarity. For the interest rate variable, the test statistic is 0.018, which is less than the 10 per cent level critical value of 0.05; for the CPI variable the test statistic is 0.022, which is less than the 10 per cent level critical value of 0.043; for the real GDP variable the test statistic is 0.018, which is less than the 10 per cent level critical value of 0.08; for the two house price variables the test statistics are 0.008 and 0.006 which

are less than the 10 per cent level critical values of 0.044 and 0.058, respectively. Thus, we accept the null that all variables are stationary at the 10 per cent level of significance. The main implication of our findings of stationarity is that we can model all the variables in their level form in the SVAR model.

INSERT TABLE 3

In addition, we notice that with the exception of real GDP, all the variables are affected by at least three statistically significant structural breaks. The objective of this exercise was to confirm the integrational properties of the variables and not to undertake a detailed analysis of structural breaks. It is, however, obvious that most of the breaks are associated with major events, such as the oil price shocks of the early 1970s and the late 1970s, and the early 1980s recession.

4.3. Impact of nominal and real variables on UK house prices

The impulse response functions of the impact of a real GDP shock, price shock, and interest rate shock on aggregate house prices and on modern house prices are plotted in Figures 2-7. We construct bootstrap percentile 95 per cent confidence intervals to illustrate parameter uncertainty following the approach in Hall (1992). We consider responses of up to 10 years ahead and use 1000 bootstrapped replications. The lag lengths of the VAR model are selected using the Schwarz Bayesian criterion. For the model that includes the aggregate house price, the optimal lag length is 7, while for the model that includes the price of modern houses the optimal lag length is 10.

INSERT FIGURES 2-7

We notice that an interest rate shock reduces house prices. The impact is statistically significant over the 10-year horizon. We find that over the first 3-4 years when the interest rate rises, the fall in house price is fairly sharp. After the 4-year horizon, however, the impact tends to stabilise while it is still negative. Consistent with demand theory this suggests that when prices fall the demand for housing increases.

Comparatively, we notice a slightly different outcome reported by Giuliiodori (2005). His findings suggest that an interest rate shock leads to a sharper fall in house prices over the first seven years and the impact while negative only stabilises after 10 years. Moreover, the findings of Giuliiodori and Minetti (2003) are also different. They find a much sharper fall in house price in response to an interest rate rise. This difference in results is not entirely surprising and can be attributed to a number of factors, in particular the use of different sample sizes. Our sample size is most recent covering the period including 2009. It should be noted that neither Giuliiodori nor Giuliiodori and Minetti cover the post-1999 period. In this light, our sample size is seven years more recent, and, as shown earlier, includes the time period where the growth rate in short term interest rates has been marginally negative.

The impact of positive real shocks (real GDP shocks) on aggregate house prices and on modern house prices are plotted in Figures 4 and 5, respectively. We find that the impact of a real shock has a statistically significant impact on aggregate house prices for the first four-and-a-half years, while it is statistically significant for the first four years in the case of modern house prices. Over the first two years, an income shock increases aggregate house prices after which house prices tend to decline but remain positive over the statistically significant years.

In the case of the price of modern house, while the rise in house price lasts for the first two years, the decline in price is rapid. In sum, the impulse responses suggest that the response of both house prices is an inverted U-shape. This implies that the wealth effect lasts for only the first two years. Over this period, due to the rise in income there is an increase in demand for housing, which pushes prices up. However, after this initial rise in demand perhaps the rise in house prices reaches a level which no longer attracts first home buyers, thus demand begins to fall and so does prices. This threshold reaction, according to our findings, comes about after around two years from a positive income shock.

In Figures 6 and 7, we plot the responses of aggregate house prices and prices of modern houses to an inflation shock. Two features of the reaction of house prices to inflation shock are worth noting here. First, the impact of an inflation shock is more persistent in the case of aggregate house prices than prices of modern houses. The impact of an inflation shock on aggregate house prices is statistically significant over the entire 10-year period, while it is only statistically significant over the first 6 years in the case of prices of modern houses. Second, the general behaviour of house prices is as follows. They decline sharply with an inflation shock over the first two years after which there is a gradual rise in house prices but the impact remains negative in that it is not able to recover to its pre-shock level. So, an inflation shock has a U-shaped negative impact on aggregate and modern house prices in the UK.

5. Concluding remarks

In this paper we used a structural VAR model to examine the relationship between house prices (aggregate houses and modern houses) and real and nominal shocks, namely real GDP shock, interest rate shock and inflation shock. We found that when interest rate rises, over the short-term the fall in house price is fairly sharp. After the 4-year horizon, however, while the impact tends to stabilise it is still negative. On the relationship between an income shock and house prices, we find that over the first two years an income shock increases aggregate house prices after which house prices tend to decline but remain positive. In the case of the price of modern house, while the rise in house price lasts for the first two years, the decline in price is rapid. The response of both house prices, thus, is positive inverted U-shaped. Finally, our results suggest that house prices decline sharply following an inflation shock over the first two years. This is followed by a gradual rise in house prices but the impact remains negative in that it is not able to recover to its pre-shock level. We conclude that an inflation shock has a U-shaped negative impact on aggregate and modern house prices in the UK.

The main implication of our finding is that home affordability or home ownership is crucially dependent on macroeconomic shocks, such as those emerging from real income (real wealth effect), and the central banks monetary policy setting based on inflation targeting and short-term interest rate manipulation. Our findings suggest that central bank's monetary policy setting has statistically significant implications for the UK housing market. Thus, ignoring this relationship in monetary policy management may have implications for home affordability in the UK.

REFERENCES

Amisano, C., and Giannini, C., (1997) Topics in structural VAR econometrics, Springer-Verlag, Berlin.

Bai, J. and P., Perron 1998. 'Estimating and Testing Linear Models with Multiple Structural Changes', *Econometrica* 66, 47-78.

Bai, J., and Ng, S., (2004) A new look panel testing of stationarity and the PPP hypothesis. In D. Andrews and J. Stock (Eds.), *Identification and inference in econometric modelling: Essays in Honour of Thomas J. Rothenberg*, Cambridge: Cambridge University Press.

Carrion-i-Silvestre, J.L., (2003) Break date misspecification error for the level shift KPSS test, *Economics Letters*, 81, 365-371.

Carrion-i-Silvestre, J.L., Barrio-Castro, T, D., and Lopez-Bazo, E., (2005) Breaking the panels: An application to the GDP per capita, *Econometrics Journal*, 8, 159-175.

Cook, S., and Thomas, C., (2003) An alternative approach to examining the ripple effect in UK house prices, *Applied Economics Letters*, 10, 849-851.

Cook, S., (2005a) Detecting long-run relationships in regional house prices in the UK, *International Review of Applied Economics*, 19, 107-118.

Cook, S., (2005b) Regional house price behaviour in the UK: Application of a joint testing procedure, *Physica A*, 345, 611-621.

Drake, L., (1993) Modelling UK house prices using cointegration: an application of the Johansen technique, *Applied Economics*, 25, 1225-1228.

Fisher, I., (1907) The rate of interest, Macmillan, New York.

Fleming, M., and Nellis, J., (1985a) Research policy and review 2. House price statistics for the United Kingdom: a survey and critical review of recent developments, *Environment and Planning A*, 17, 297-318.

Fleming, M., and Nellis, J., (1985b) The application of hedonic indexing methods: a study of house prices in the United Kingdom, *Statistical Journal of the United Nations*, ECE3, 249-270.

Friedman, M., (1977) Nobel lecture: Inflation and unemployment, *Journal of Political Economy*, 85, 451-472.

Giuliodori, M., (2005) The role of house prices in the monetary transmission mechanism across European countries, *Scottish Journal of Political Economy*, 52, 519-543.

Hamnett, C., (1988) Regional variations in house prices and house price inflation in Britain, 1969-1988, *Royal Bank of Scotland Review*, 159, 29-40.

Hendry, D., (1984) Econometric modelling of house prices in the United Kingdom, in *Econometrics and Quantitative Economics*, Hendry, D., and Wallis, K., (eds.), Blackwell, Oxford.

Iacoviello, M., and Minetti, R., (2003) Financial liberalisation and the sensitivity of house prices to monetary policy: Theory and evidence, *The Manchester School*, 71, 1463-6786.

Kau, J.B., and Keenan, D., (1980) The theory of housing and interest rates, *The Journal of Financial and Quantitative Analysis*, 15, 833-847.

Kau, J.B., and Keenan, D., (1981) On the theory of interest rate, consumer durable, and the demand for housing, *Journal of Urban Economics*, 10, 183-200.

Kwiatkoeski, D., Phillips, P.C., Schmidt, P.J., and Shin, Y., (1992) Testing the null hypothesis of stationarity against the alternative of a unit root: How sure are we that economic time series have a unit root, *Journal of Econometrics*, 54, 159-178.

Lastrapes, W.D., (2002) The real price of housing and money supply shocks: Time series evidence and theoretical simulations, *Journal of Housing Economics*, 11, 40-74.

MacDonald, R., and Taylor, M., (1993) Regional house prices in Britain: long-run relationships and short run dynamics, *Scottish Journal of Political Economy*, 40, 43-55.

Meen, G., (1999) Regional house prices and the ripple effect: a new interpretation, *Housing Studies*, 14, 733-753.

Nellis, J., and Longbottom, A., (1981) An empirical analysis of the determination of house prices in the United Kingdom, *Urban Studies*, 18, 9-22.

Stern, D., (1992) Explaining UK house price inflation, *Applied Economics*, 24, 1327-1333.

Table 1: Some selected descriptive statistics

	HPall	HPmod	IR	CPI	GDP
Mean	11.0402	11.0512	8.1538	3.4701	12.0182
Standard deviation	0.3865	0.3737	2.9975	1.0185	0.3427
Skewness	0.3950	0.4511	0.5057	-0.2705	-0.0202
Kurtosis	2.9270	3.0102	2.2469	1.4371	2.0056
J-B	5.2449 (0.0762)	6.7848 (0.0336)	13.2525 (0.0013)	22.7942 (0.0000)	8.2530 (0.0161)

Note: The probability value is in parenthesis.

Table 2: Correlation coefficients

	HPall	HPmod	IR	CPI	GDP
HPall	1				
HPmod	0.9991 (336.65)	1			
IR	0.0249 (0.3504)	0.0017 (0.0247)	1		
CPI	0.8511 (22.814)	0.8421 (21.974)	0.1081 (1.5302)	1	
GDP	0.9262 (34.568)	0.9235 (33.887)	-0.0302 (-0.4247)	0.9583 (47.2135)	1

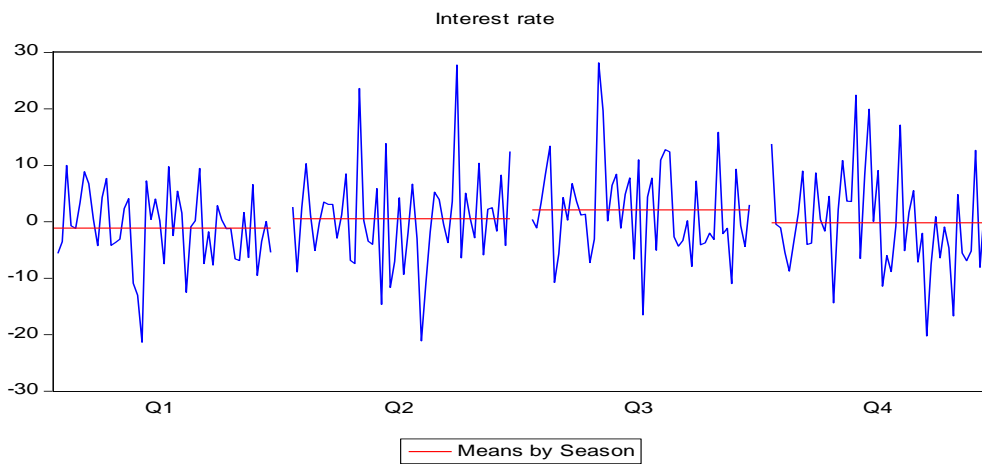
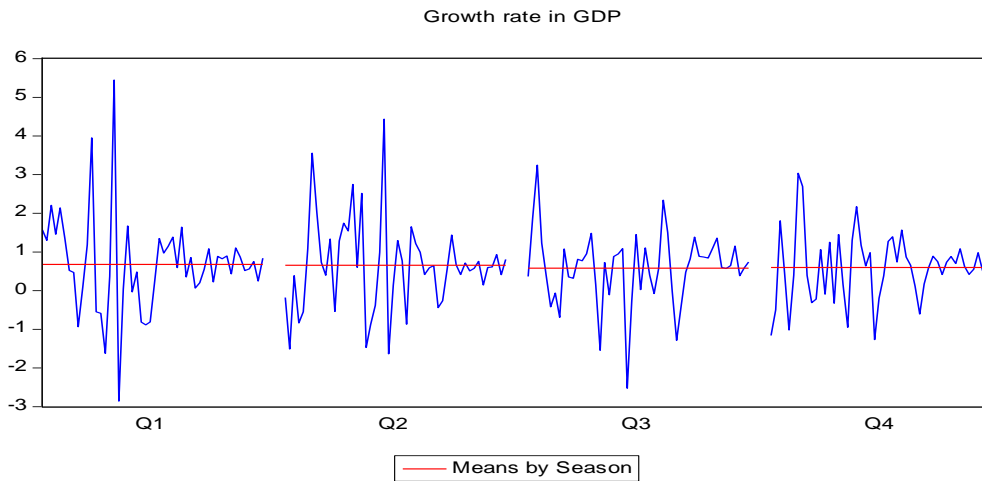
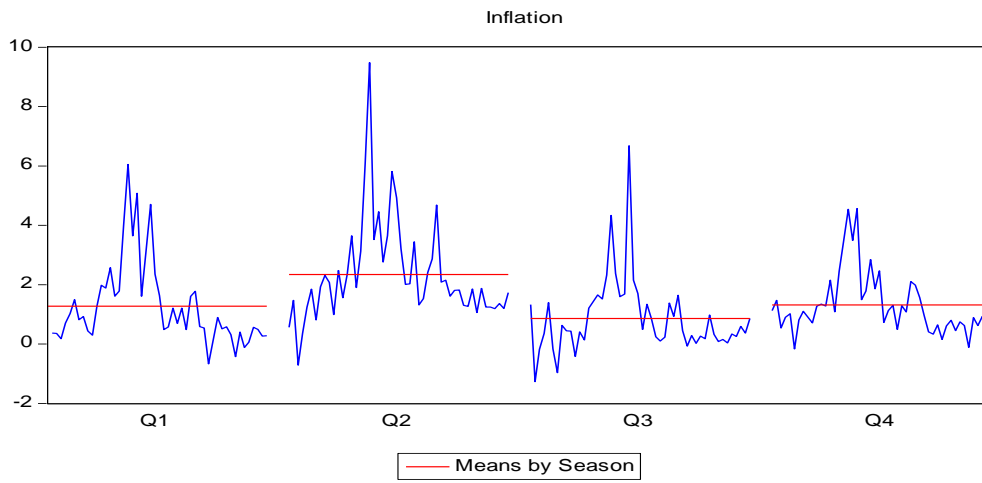
Note: The t-statistics is in parenthesis.

Table 3: Model without a time trend

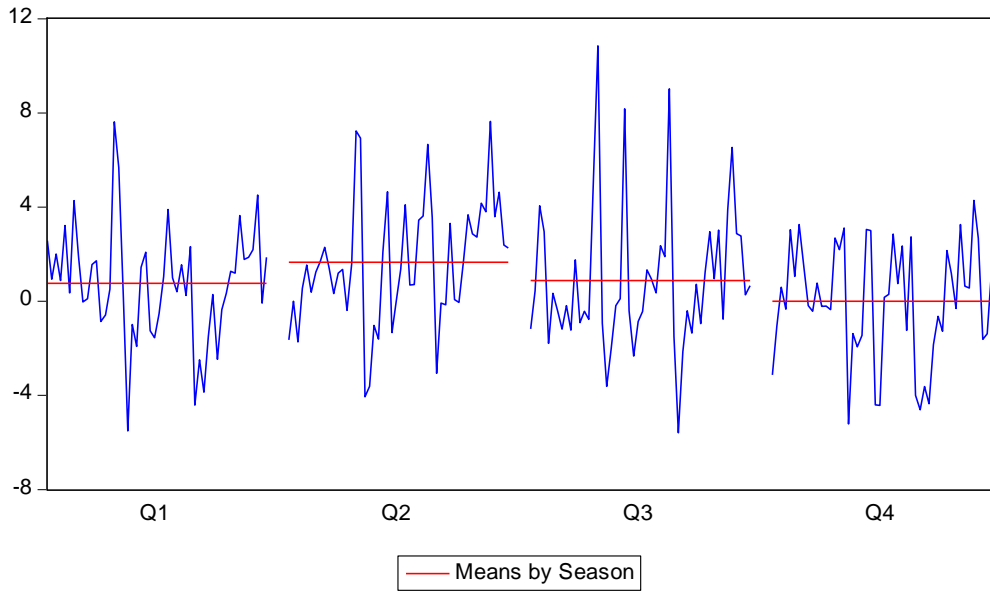
Countries	Test statistic	Break date	Finite sample critical values			
			90	95	97.5	99
Interest rate	0.018	1973:1; 1982:2; 1992:3	0.05	0.062	0.074	0.091
CPI	0.022	1970:4; 1981:4; 1999:3	0.043	0.052	0.061	0.073
Real GDP	0.018	1980:1	0.08	0.095	0.111	0.133
Real house price – All	0.008	1972:2; 1980:4; 1988:2; 1995:4	0.044	0.055	0.067	0.081
Real house price – Modern	0.006	1975:2; 1988:2; 1995:4	0.058	0.074	0.091	0.114

Notes: We compute finite sample critical values are computed by means of Monte Carlo simulations using 20, 000 replications.

Figure 1: Plot of the Log of data series



House prices - All



House prices -Modern

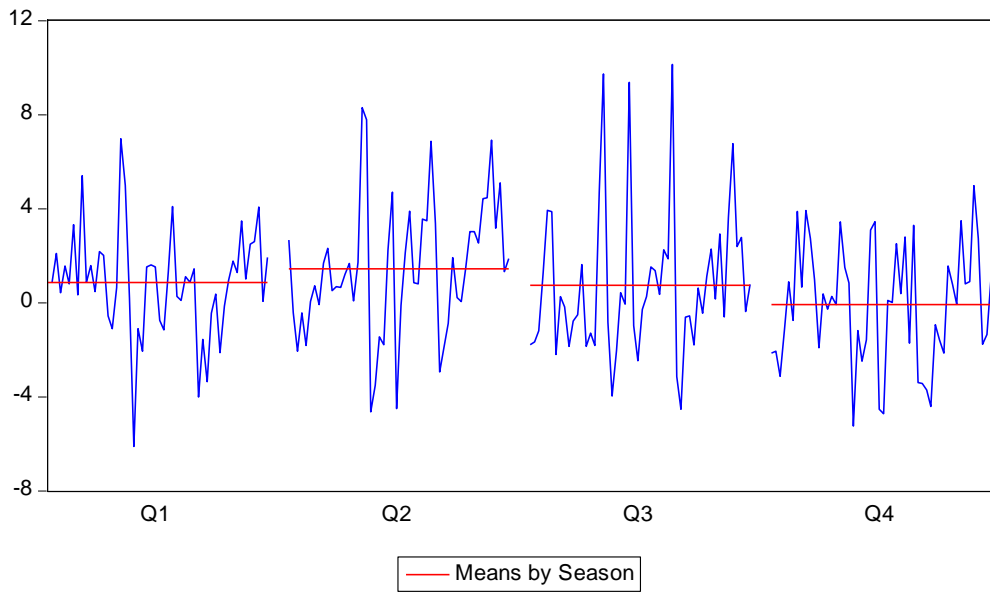


Figure 2: Impact of interest rate shock on house prices (all)

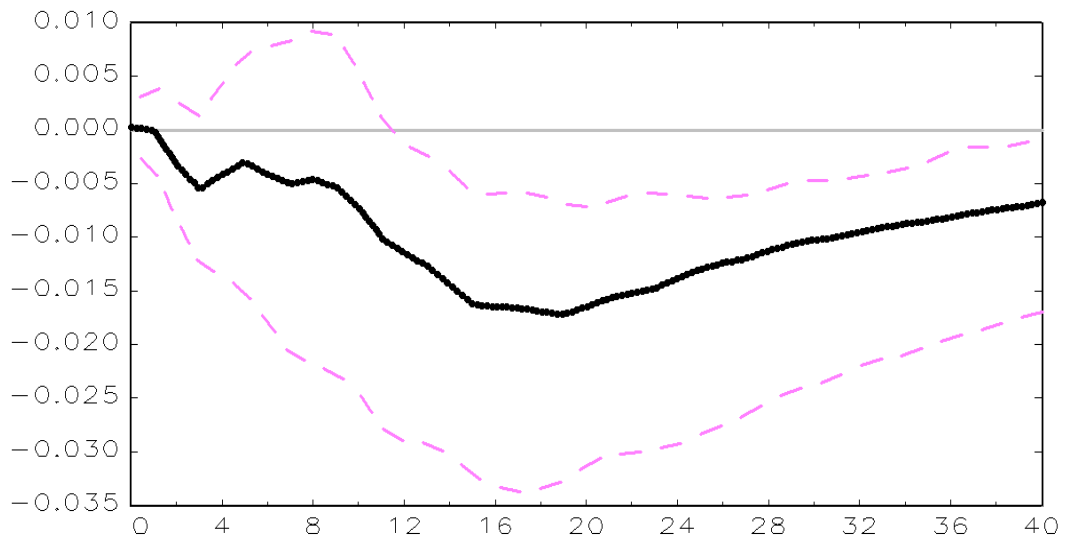


Figure 3: Impact of interest rate shock on prices of modern houses

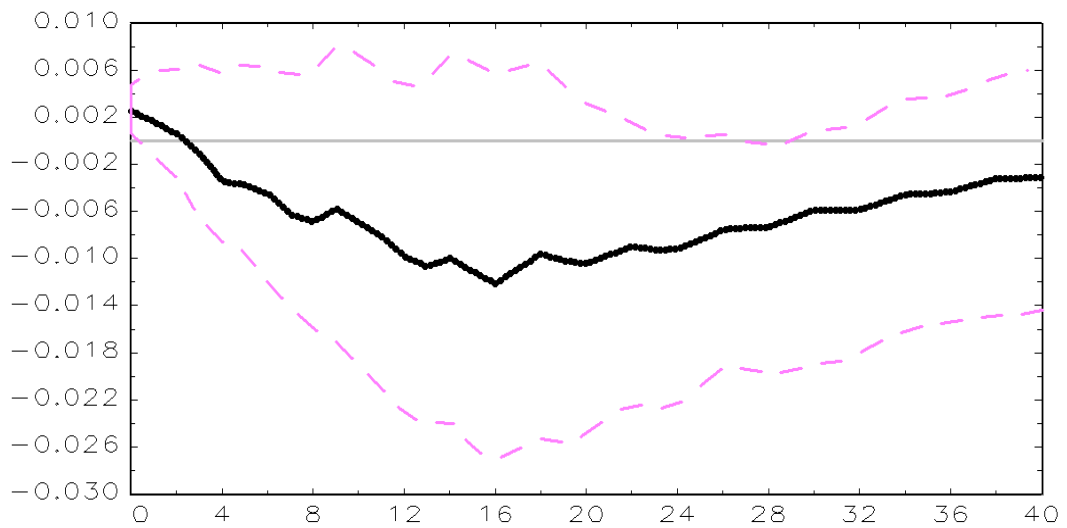


Figure 4: Impact of income shock on house prices (all)

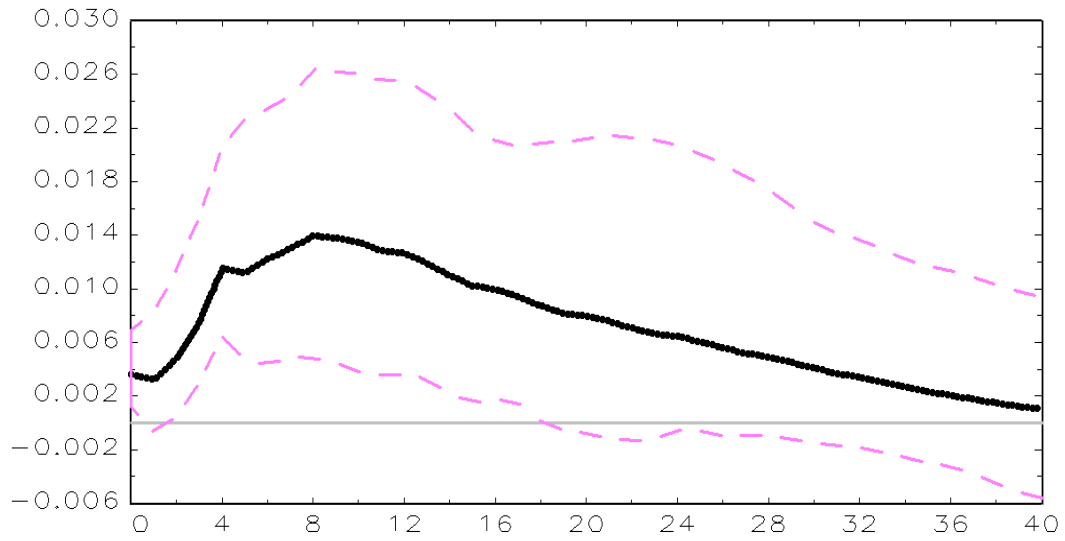


Figure 5: Impact of income shock on prices of modern houses

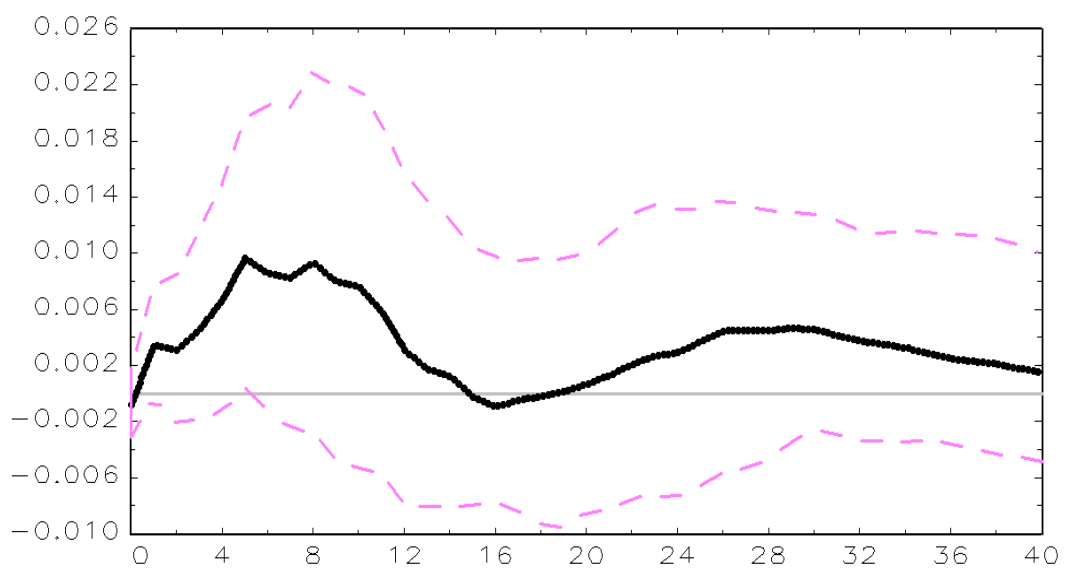


Figure 6: Impact of price shock on house prices (all)

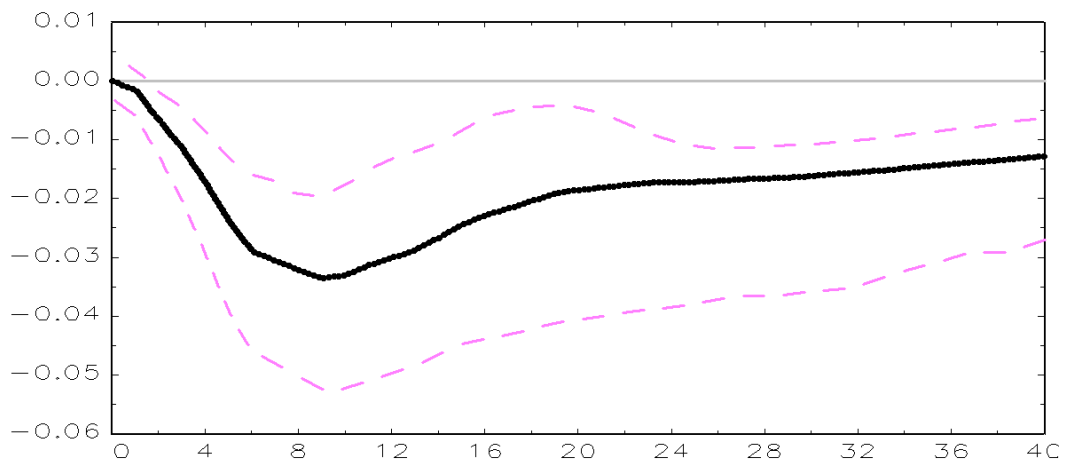


Figure 7: Impact of price shock on prices of modern houses

