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Explaining changes in house prices[1]

Against the backdrop of sharply lower global equity prices, an important question facing policymakers is the outlook for consumer spending.[2] The exact relationship between changes in household wealth and consumer spending is uncertain. Even so, the recent large declines in equity prices are likely to be a depressing influence on consumer spending in the future. Offsetting this effect is the strong recent growth in house prices in a number of countries. Academic research has documented an important influence of housing wealth on consumer behaviour.[3] The outlook for consumer spending, therefore, also depends on the future course of house prices. Presumably, a continuation of the global economic slowdown would slow the growth in house prices. Yet, house prices could also come under pressure even in the absence of a further slowdown in economic activity if stock market wealth is an important determinant of the demand for housing.

This special feature examines the extent to which house price fluctuations in six advanced economies – the United States, the United Kingdom, Canada, Ireland, the Netherlands and Australia – can be attributed to fluctuations in national incomes, interest rates and stock prices. To this end, the joint behaviour of house prices, national incomes, real interest rates and stock prices is studied within the context of a simple empirical model. The empirical framework permits one to identify the typical response of house prices to changes in a small set of key determinants and also to examine the extent to which house prices have tended to deviate from the values predicted by them.

Interesting results emerge from the analysis. For instance, the empirical results indicate that shocks to national income, stock prices and interest rates influence house prices, and that some of the recent large gains in house prices can be explained in terms of the favourable economic developments captured by these variables.

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[1] The views expressed in this article are those of the author and do not necessarily reflect those of the BIS.

[2] Greenspan (2002) discusses the uncertainties associated with the outlook for US consumer spending following the recent declines in equity prices.

[3] See, for example, the study by Case et al (2001).

Housing price data

This special feature studies the behaviour of housing prices in six countries: the United States, the United Kingdom, Canada, Australia, the Netherlands and Ireland. These countries were chosen because of the availability of relatively long time series of housing prices at a quarterly frequency.[4]

Data for six countries show rising house prices

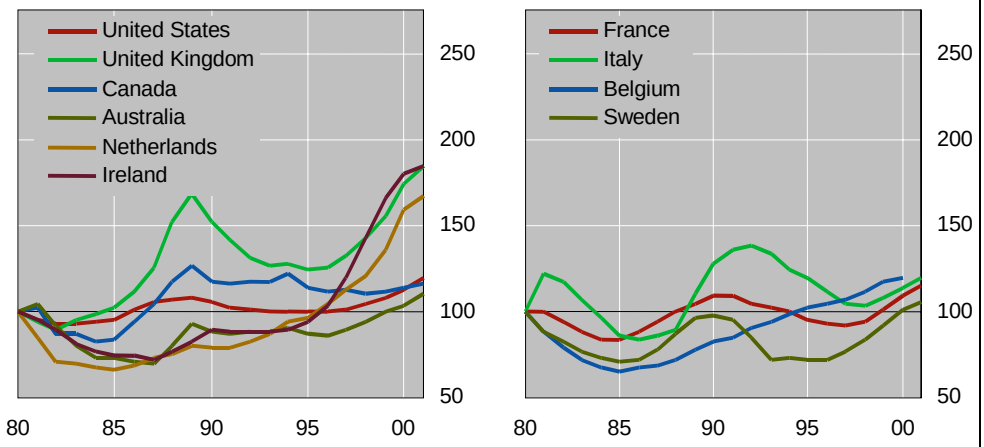
These series, which attempt to capture the average price change of existing homes, are shown in the left-hand panel of Graph 1. There is a broad similarity of general trend movements in the housing prices studied, and also in house prices in other countries (Graph 1, right-hand panel). Since the mid-1990s, housing prices have been increasing fairly rapidly. In the United States, for example, real house prices rose 21% over the 1995–2001 period. Other markets have recorded even stronger gains. In the United Kingdom, real house prices rose 42% over the same period and in the Netherlands and Ireland 60% and 70%, respectively. There was a similar period of rapid growth during the 1980s, after which the global economic slowdown of the early 1990s was associated with lower house price appreciation.[5]

The empirical framework

The empirical model adopted in this special feature is a small vector autoregressive (VAR) model of the type pioneered by Sims (1980). This framework, explained in more detail in the box on page 54, permits one to study the dynamic influences of a small number of key determinants on home

Inflation-adjusted house prices

1980 = 100



Sources: Catella; Frank Russell Canada Ltd; Investment Property Databank Ltd; Ministère de l'Équipement, des Transports et du Logement; National Council of Real Estate Investment Fiduciaries; Nomisma; national data. Graph 1

[4] From a starting point in the 1970s to the first quarter of 2002.

[5] For a more detailed discussion, see BIS (1993, 2002).

values.[6] Arguably, the demand for housing, like the demand for other goods, is positively related to real household income and wealth. Accordingly, the growth of real national income and changes in stock market wealth are two of the key determinants of house values included in the VAR.

A house is a long-lived asset that delivers consumption services over many periods, and the implicit value of a house is the discounted value of the expected service stream. Home values therefore depend on the current and expected future interest rates used to discount the housing service flow. Under ideal market conditions, a long-term interest rate might be expected to capture the influences of the entire time profile of discount rates. However, capital markets are often less than perfect. In particular, short-term rates may capture financing constraints and cash flow effects. In fact, floating rate mortgages are quite common in a number of the countries considered here.[7]

Our model captures effects of income, stock market wealth and interest rates

Economic theory suggests that housing prices, like other asset prices, respond to new information about the determinants of value. Within the context of the VAR model, it is possible to compute the typical response over time of house prices to unforecastable changes, ie "surprises", in the key determinants of value. For instance, one can compute the typical response over time of house prices to a surprise in the growth rate of national income. There follows a discussion of the response of house prices to three shocks, roughly one standard deviation in size: a 1% surprise increase in the growth rate of national income, a 1 percentage point surprise decrease in interest rates and a 10% increase in stock prices.

What drives house prices?

Statistical tests suggest these effects are significant

This section discusses the responses of house prices to the three shocks mentioned above. Before discussing the estimates, a question that naturally arises is whether the cumulative influences presented actually represent responses of housing prices to the key determinants examined or instead simply reflect a coincidence of sampling error. In an attempt to answer this question, formal statistical tests were conducted. The results of the tests indicate that, as a group, the key determinants considered are statistically significant variables in explaining changes in house prices.[8] To be sure, there is substantial uncertainty concerning the precise size of the influences. Nevertheless, every cumulative response has the theoretically correct sign, further suggesting that the results are unlikely to be due only to chance.

There is also uncertainty concerning the appropriate model for studying these dynamic relations, for which the VAR model employed here is just one possibility. Furthermore, the appropriateness of the assumptions used to

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[6] The quarterly percentage change in real house prices is included in the VAR, rather than the level of prices, because it is more likely that growth rates in house prices fluctuate around a constant mean.

[7] See Borio (1995).

[8] These tests, which rely on Monte Carlo experiments, are discussed in more detail in the box on page 54.

identify the VAR model can also be questioned, including the appropriate ordering of the variables. These caveats are discussed in more detail in the box on page 54.

Shocks to GNP growth

Increases in national income lead to higher house prices ...

Increases in the growth rate of national income would be expected to lead over time to higher house prices, and this intuition is consistent with the data (Graph 2). There is a broad similarity of the estimated responses across countries. Point estimates indicate that increases in GNP growth have a lasting positive influence on house prices, even though they are also associated with a contemporaneous rise in real interest rates. A 1% increase in the growth rate of GNP is associated with a rise in real house prices in the range of 1–4% after three years. The estimated effect is greatest in Ireland. This is due in part to the high degree of persistence of the shocks to Irish national income. Over the sample period, an unexpected increase in the growth rate of Irish GNP has been associated with higher GNP growth over the next few years.

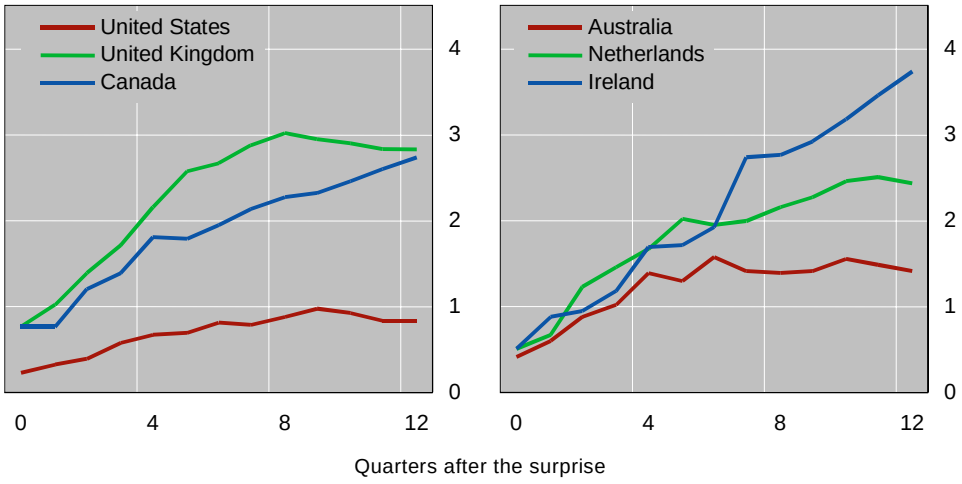
Shocks to real interest rates

... as do declines in interest rates

The point estimates also indicate that decreases in real interest rates lead over time to increases in house prices (Graph 3). This is true whether a real long-term interest rate or a real short-term interest rate is included in the model. A 100 basis point decrease in the real short-term interest rate leads to an increase in house prices in the range of ½–1½ percentage points over four quarters. For all countries, there is a weaker response of housing prices to decreases in long-term interest rates. As discussed above, the difference in the impacts of long and short rates could be attributable to capital market imperfections.

Response of house prices to GNP

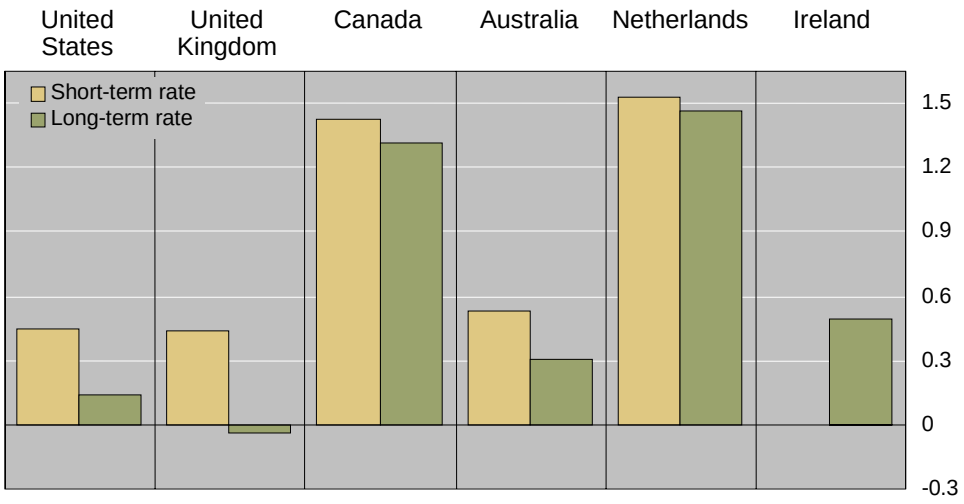
Cumulative quarterly changes following a 1% increase in GNP, in percentages



Sources: National data; author's calculations. Graph 2

Response of house prices to interest rates

Cumulative percentage change after four quarters to a 1% point decrease in interest rates[1]



[1] Calculated for both a real short-term and a real long-term interest rate (for Ireland, long-term rate only).

Sources: National data; author's calculations. Graph 3

Changes in equity prices

Stock prices seem to have a strong effect in the United Kingdom and Canada ...

For all countries, the estimated model suggests the existence of a positive relationship between changes in equity and house prices (Graph 4). Point estimates indicate that in the United States, Canada and Ireland house prices increase by about 1% over three years following a 10% rise in equity prices. In Australia and the Netherlands, house prices increase by about 2%. A much larger effect is estimated for the United Kingdom, where housing prices typically rise by 5% after three years.

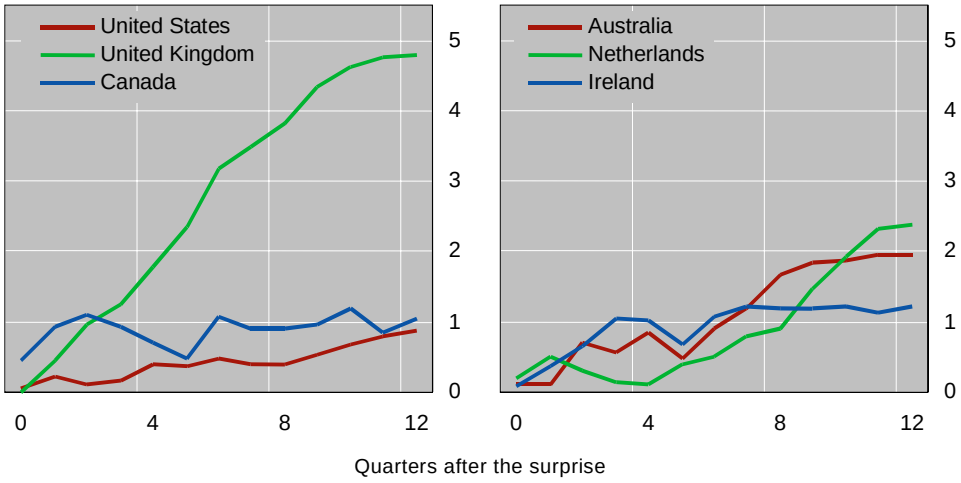
... because they anticipate income growth

The positive response over time of house prices to movements in equity prices could reflect the tendency of the latter to forecast growth in national income. The estimated responses lend some support to this view. In the United Kingdom, a 10% rise in equity prices is typically associated with 0.7% greater national income growth over the next three years. In Australia, such a shock is associated with a rise of about 0.3% in national income growth after three years. In general, however, the responses of national incomes to changes in stock prices do not appear large enough to completely explain the stock price effect on house prices. This result, coupled with the observation that stock ownership is fairly widespread in most of the countries studied, suggests that the positive relation probably also reflects a stock market wealth effect on housing demand.

It is perhaps surprising that the impact of stock price fluctuations on US housing prices appears to be smaller than in some of the other countries, given that stock ownership is relatively widespread in the United States. There are at least two possible explanations for this finding. First, it could be consistent with the view that households in the United States might not have regarded their

Response of house prices to equity prices

Cumulative quarterly changes following a 10% increase in equity prices, in percentages



Sources: National data; author's calculations. Graph 4

particularly large stock market gains as being permanent. In this case, the equity price gains need not have been associated with substantially larger perceived household wealth.[9] It is a puzzle why such stock market gains might not be regarded as permanent. Second, in the United States stock market investments may be a substitute for housing assets. Widespread home ownership in the United States and a history of house price appreciation and turnover in ownership seem to have made housing an attractive investment to a greater degree than in other countries. In particular, periods that witness large investment flows into equity markets may also see reduced investment demand for housing, leading to lower house price appreciation during periods of relatively strong equity price growth.

Which shocks matter?

In addition to identifying the typical response of house prices to a particular shock, the estimated VAR model can be employed to shed light on the relative importance of each disturbance in explaining movements in house prices during the period covered by the estimation.

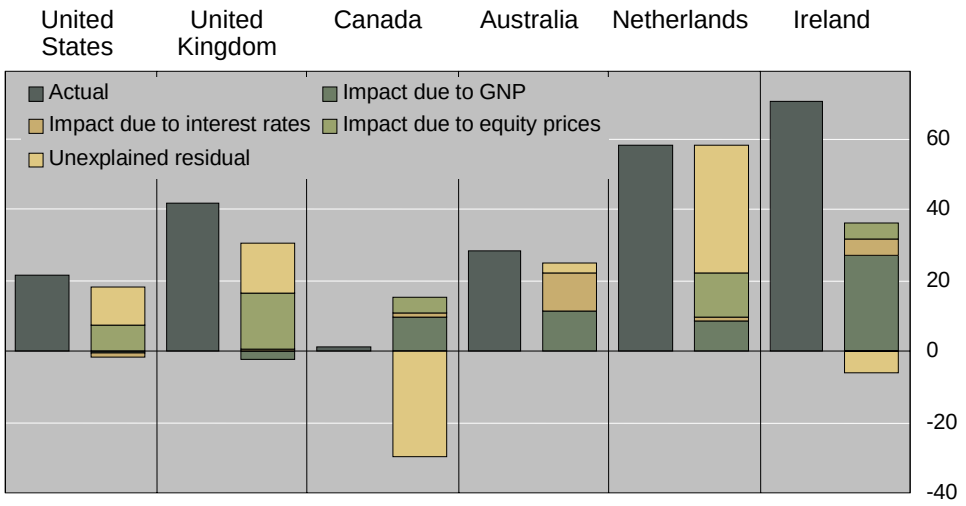
Stock prices are surprisingly important

Perhaps not surprisingly, point estimates suggest that the relative importance of different disturbances varies across countries. One common finding, however, is the relative importance of stock market fluctuations for explaining house prices. In most countries, changes in stock prices appear to be as important for house prices as are fluctuations in GNP and interest rates. For instance, in the United States, Canada and Australia, each disturbance explains between 7 and 15% of the variance of house price growth at the three-year horizon. A much larger role for stock prices is found in the United

[9] In support of this view, Lettau and Ludvigson (2002) fail to find a significant impact of the previous decade's rise in US share prices on US consumption.

Developments in house prices

Cumulative percentage growth over 1995 Q1–2002 Q1



Note: For each country, the first bar shows the growth in house prices over the period and includes the component which can be accounted for by the dynamics of shocks up to and including 1994 Q4. The second bar decomposes the part of the actual price change that is not accounted for by these dynamics. The components correspond to the contribution of shocks to GNP growth, interest rates and equity prices since 1995 Q1.

Sources: National data; author's calculations. Graph 5

Kingdom, where stock price fluctuations explain 35% of the variance of house price growth at a three-year forecast horizon, while fluctuations of GNP explain about 20%.

Actual and "explained" house price appreciation

The VAR model can also be used to decompose the actual house price appreciation over a particular period into three parts: the part that would have been expected to occur on the basis of information available at the start of the period concerning lagged shocks, the part attributable to new information about the fundamental determinants included in the VAR, and the price gains unrelated to these determinants.

In five countries, house prices rose unexpectedly …

The results of such a decomposition are shown in Graph 5 for the 1995 Q1–2002 Q1 period. Over this period, housing prices in most countries increased by more than would have been expected at the start of the period based solely on the lagged effect of the earlier shocks to the system. The only exception is Canada, where house prices remained essentially unchanged over the period although the model predicted a 15% increase in home values. The behaviour of house prices in Canada is even more puzzling once one considers developments in national income, interest rates and stock prices. The model associates favourable surprises in these variables with higher house prices than would have been achieved in the absence of these shocks. The upshot is that Canadian house prices underperformed by almost 30% over the period.

In every other country, house price gains over the 1995 Q1–2002 Q2 period surpassed what would have been expected on the basis of information

... in three cases, because of stock price gains

available at the beginning of 1995. In the case of Ireland, the superior performance can be traced to positive surprises in national income. In the case of the United States, the United Kingdom and the Netherlands, unexpected stock market gains are the most important surprises explaining unanticipated house price growth. Nevertheless, the total price gains are larger than is predicted solely on the basis of new information about the three fundamental determinants considered.

Conclusions

This special feature has examined the extent to which house price fluctuations in six advanced economies – the United States, the United Kingdom, Canada, Ireland, the Netherlands and Australia – can be attributed to fluctuations in national incomes, interest rates and stock prices. The main empirical finding is that favourable economic developments captured by these variables appear to have played an important role in recent house price gains, although in some instances prices appear to have increased by more than warranted by the set of fundamental determinants considered. The outlook for house prices is more uncertain. Conditional on the assumptions underlying the model employed here, the recent decline in share values might foreshadow some downward pressure on house prices, although the precise amount cannot be established.

References

Bank for International Settlements (1993): "Asset prices and the management of financial distress", *63rd Annual Report*, Basel, pp 155–81.

——— (2002): "The interaction between the financial sector and the real economy", *72nd Annual Report*, Basel, pp 122–40.

Borio, C (1995): "The structure of credit to the non-government sector and the transmission mechanism of monetary policy: a cross-country comparison", in *Financial structure and the monetary policy transmission mechanism*, Bank for International Settlements (ed), Basel, pp 59–105.

Case, K E, J M Quigley and R J Shiller (2001): "Comparing wealth effects: the stock market versus the housing market", *NBER Working Paper*, no 8606.

Greenspan, A (2002): "Semi-annual policy report to the US Congress", testimony before the Committee on Financial Services of the US House of Representatives, 17 July.

Lettau, M and S Ludvigson (2002): "Consumption, aggregate wealth and expected stock returns", *Journal of Finance*, vol 56, pp 815–49.

Sims, C A (1980): "Macroeconomics and reality", *Econometrica*, vol 48, pp 1–47.

The VAR model

The basic framework for studying the joint behaviour of housing prices, national income, interest rates and stock prices adopted in this article is a small-scale vector autoregressive (VAR) model of the type pioneered by Sims (1980). Key advantages of the VAR approach are that all variables are assumed to be endogenously determined and only weak restrictions are placed on the dynamic behaviour of the variables of interest. The variables that are included in the VAR are the quarterly growth rate of real national income,[1] a real interest rate,[2] the quarterly growth rate of real stock prices[4] and the quarterly growth rate of real house prices.[3] In an unrestricted VAR, each variable in the system is regressed on a given number of lags of itself and the same number of lags of all other variables in the system. Because this can lead to a large number of estimated parameters, relative to the sample size, it is sometimes useful to place mild restrictions on the parameters of the VAR model. In the present context, this is accomplished by assuming that the growth rate of real stock prices is not forecastable on the basis of the other variables in the system.

More formally, the estimated VAR model consists of the following four equations:

(1) $$\Delta y_t = c_1 + \sum_{i=1}^{8} \alpha_{1,i} \Delta y_{t-1} + \sum_{i=9}^{16} \alpha_{1,i} r_{t-1} + \sum_{i=17}^{24} \alpha_{1,i} \Delta s_{t-1} + \sum_{i=25}^{32} \alpha_{1,i} \Delta p_{t-1} + u_{1t}$$

(2) $$r_t = c_2 + \sum_{i=1}^{8} \alpha_{2,i} \Delta y_{t-1} + \sum_{i=9}^{16} \alpha_{2,i} r_{t-1} + \sum_{i=17}^{24} \alpha_{2,i} \Delta s_{t-1} + \sum_{i=25}^{32} \alpha_{2,i} \Delta p_{t-1} + u_{2t}$$

(3) $$\Delta s_t = c_3 + u_{3t}$$

(4) $$\Delta p_t = c_4 + \sum_{i=1}^{8} \alpha_{4,i} \Delta y_{t-1} + \sum_{i=9}^{16} \alpha_{4,i} r_{t-1} + \sum_{i=17}^{24} \alpha_{4,i} \Delta s_{t-1} + \sum_{i=25}^{32} \alpha_{4,i} \Delta p_{t-1} + u_{4t}$$

where Δy_t is the growth rate of real national income between quarter t-1 and t, r_t is a real interest rate, Δs_t represents the growth rate of real stock prices, Δp_t is the growth rate of real house prices and u is the reduced form error term. In equation (3) it is assumed that, aside from a constant term, all of the other coefficients are equal to zero. This corresponds to the belief that, at the one-quarter horizon, stock returns are unforecastable on the basis of the variables included in the VAR model.

One can compute, from the estimated VAR coefficients, the dynamic response of a particular variable to innovations or "surprises", ie unforecastable movements, in other variables. These so-called impulse response functions are useful for gaining a better understanding of the interactions between the variables of interest. Of particular interest in the present context are the dynamic responses of housing prices to innovations in the growth rate of real national income, the level of real interest rates and the growth rate of real stock prices.

Equations (1)–(4) are estimated by ordinary least squares with data for each country,[5] and impulse response functions are derived from the parameter estimates. However, one difficulty that arises when analysing the dynamic properties of systems like equations (1)–(4) is the potential for contemporaneous cross-equation correlation of the u s. It makes little sense to study the responses of a system to a shock to one of the reduced form error terms in isolation if historically that disturbance has tended to move together with another of the model's reduced form error terms. For this reason impulse response functions are not computed for the reduced form residuals. Instead, following Sims (1980), impulse response functions are computed for a triangular representation of the reduced form error terms:

(5) $$u_{1t} = \varepsilon_{1t}$$

(6) $$u_{2t} = \gamma_{2,1}\varepsilon_{1t} + \varepsilon_{2t}$$

(7) $$u_{3t} = \gamma_{3,1}\varepsilon_{1t} + \gamma_{3,2}\varepsilon_{2t} + \varepsilon_{3t}$$

(8) $$u_{4t} = \gamma_{4,1}\varepsilon_{1t} + \gamma_{4,2}\varepsilon_{2t} + \gamma_{4,3}\varepsilon_{3t} + \varepsilon_{4t}$$

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[1] National income is defined as gross national product. The consumer price index is used to convert nominal variables to real quantities. [2] The real long-term interest rate is defined as the 10-year government bond yield minus the previous four-quarter percentage change in the consumer price index. The real short-term interest rate is defined as the three-month interbank rate minus the previous four-quarter change in the consumer price index. [3] It is assumed that the real rate of interest is stationary but the logs of real national income and real stock prices need to be differenced to achieve stationarity. [4] For Australia, the Netherlands and Ireland, the stock price indices are the total market indices provided by Datastream. For the United States, the stock market index is the S&P 500, for the United Kingdom it is the FTSE 100 and for Canada the TSE 300. [5] For the United States, the United Kingdom and Canada, the sample period is 1973 Q2–2002 Q1. For Australia and Ireland, the sample period is 1975 Q2–2002 Q1. For the Netherlands, it is 1977 Q2–2002 Q1.

where ε are mutually uncorrelated random variables with unit variance. Impulse response functions are computed for three shocks: a 1% unexpected increase in national income $(\varepsilon_{1t} = 1)$, a 1 percentage point unexpected increase in real interest rates $(\varepsilon_{2t} = 1)$ and a 10% increase in stock prices $(\varepsilon_{3t} = 10)$.

The ordering of the variables (Δy_t, r_t, Δs_t, Δp_t) reflects potential contemporaneous influences. The growth rate of real national income is the first variable in the ordering because it is assumed that innovations in the growth rate of GNP influence the other variables in the model within the same quarter. The real interest rate is placed second in the ordering because it is assumed that innovations in the real rate influence stock prices and housing prices within the same quarter but do not influence GNP within the same quarter. Housing prices are last in the ordering because it is assumed that innovations in house prices do not impact on the other variables within the same quarter.

The empirical results of course depend upon the chosen form of the model, which includes the identifying assumptions embodied in the ordering of the variables. Within the class of triangular representations for the reduced-form errors, however, there is reason to suspect that the chosen ordering has only minimal consequences for the empirical results. This is because the correlation between the reduced-form error terms in the stock price and interest rate equations is for most countries essentially zero, so that the results would not change significantly if the order of stock prices and interest rates was reversed. The correlations between the reduced-form error term in the house price equation and that of the stock price and interest rate equations are also low, suggesting that moving housing prices up in the order would also not significantly affect the results. Nevertheless, there remains the possibility that a VAR model identified with other assumptions would yield different empirical results.

The estimated VAR model can also be used to formally evaluate the statistical significance of the results. In particular, confidence intervals for the impulse response functions can be computed by Monte Carlo simulation. In the present context, this was achieved by drawing random errors from a normal distribution and then computing impulse response functions from the simulated data for the four variables in the model. The results of this exercise indicate that, for each country, the response of housing prices to GNP shocks is different from zero at the 10% level of confidence. However, with a few exceptions, this test could not reject the null hypothesis that the estimated cumulative responses to interest rate and stock market shocks were in fact zero.