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The Housing Market and the Macroeconomy: Evidence From Ireland

by

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The views expressed in this paper are not necessarily those held by the Bank and are the personal responsibility of the author. Comments and criticisms are welcome.

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1. Introduction[1]

For the vast majority of individuals, the purchase of a house is by far the largest single economic transaction made in their lifetime. It is, therefore, far from surprising to find a strong public reaction following large movements in the price of housing relative to other goods and services. In Ireland, such sharp movements have taken place in the last few years. In the period since the beginning of 1994, the price paid by the average home-buyer in Ireland has risen by approximately 42 per cent.[2] This compares with a total increase of only 5.6 per cent. in the consumer price index over the same period. Given the large proportion of total economic wealth which is held in the form of housing, it has often been argued that such dramatic changes in the price of housing relative to other goods and services can have a significant effect on consumer behaviour. As a result, most economists now see developments in the housing market as being of significant importance to the wider macroeconomy and several studies have been undertaken of the impact of developments in the housing market on macroeconomic activity.[3] There has, however, been little or no recent research into either the macroeconomic effects of house price movements or -conversely - the macroeconomic factors which may lie behind changes in house prices in Ireland. This is particularly unfortunate because it means that discussions of the well-documented recent rise in Irish house prices are taking place without reference to any empirical research which could act as a guide to policy makers.

In order to address this dearth of empirical research, this paper will examine the factors behind house price movements in Ireland over the period 1975 - 1997. As a natural starting point, Section 2 discusses the relevance of the housing market from a monetary policy perspective. This discussion is largely exploratory with particular

[1] I would like to thank John Frain, Danny McCoy and participants at an internal Central Bank seminar for helpful comments and suggestions. All errors and omissions are my own.
[2] Based on country-wide estimates of new house prices up to the third quarter of 1997.
[3] On this see Miles (1994), p. 3-4. For recent contributions analysing the macroeconomic impact of various changes in the housing market see Mankiw and Weil (1989), Manchester and Poterba (1989), Muellbauer and Murphy (1990) and Wheeler and Chowdhury (1993). Borio, Kennedy and Prowse (1994) explore the monetary policy implications of an index of aggregate asset prices. The price of residential property is, however, by far the most significant component in this index.

emphasis being placed on clarifying the factors which connect house price movements and economy-wide inflation. Potential impacts on the health of the banking sector are also discussed. While the emphasis in the paper is on the macroeconomic relevance of developments in the housing market, it is felt that this cannot be achieved without a basic understanding of the microeconomic factors which determine the price at which the average house actually trades. Therefore, Section 3 briefly reviews the main determinants of housing demand and supply as well as the nature of "equilibrium" in the housing market. Following on from this, Section 4 adopts an aggregate perspective and attempts to model house price movements using cointegration analysis in order examine the interaction between house prices and several key macroeconomic variables such as income, interest rates and also consumption. Finally, Section 5 concludes with some policy implications and suggestions for further research.

2. Monetary Policy and the Housing Market

The primary objective of this paper is to take a macroeconomic perspective on the role of house prices in the Irish economy. In particular the implications of house price movements will be investigated from a monetary policy perspective. As noted in Bowen(1994), the concern of a monetary authority with developments in the housing market arises naturally out of its dual mandate for maintaining price stability and also overseeing the operations of the banking sector. Below, we probe more deeply into the factors which lie behind this concern by first discussing the main channels through which house prices might be related to aggregate consumer price inflation. Following on from this, the potential impact of house price movements on the overall health of the financial sector is also considered.

2.1 House Prices and Irish Inflation

In many industrial countries, sharp increases in house prices have often been blamed for subsequent periods of high and volatile inflation. Economic theory regarding this relationship is, however, not very plentiful. Many of the arguments put forward for expecting a relationship between house price inflation and overall consumer price inflation tend to be based on casual economic intuition rather than formal economic theory. From a purely arithmetic point of view, the price of housing does not enter directly into the consumer price index (CPI). This exclusion is justifiable because house prices represent the value of a capital asset and the CPI is intended to measure changes in the cost of a representative basket of consumer (as opposed to capital) goods and services. The housing costs sub-index of the CPI captures increases in the cost of various housing items and not the price of actual houses *per se*. While many of these items would be expected to exhibit a reasonably strong correlation with house prices themselves, the overall effect is somewhat muted because the housing sub-index only accounts for a relatively small fraction (about 8 per cent.) of total consumer

expenditure.[4] For this reason, one needs to search for additional reasons as to why house price inflation might tend to precede - or indeed be the cause of - consumer price inflation.

There are number of possible channels, other than through the housing cost sub-index, through which house price inflation may help predict, and possibly give rise to (in a causal sense), an increases in the prices of other consumer goods and services in the economy. Before examining these in detail, it is worth stating briefly a mainstream view of the determinants of Irish inflation. As discussed in Kenny and McGettigan (1997), this approach makes uses of the purchasing power parity relationship together with a small country assumption. Under this view, Irish inflation adjusts over the longer-term in a manner which ensures the restoration of a stable relationship between the domestic price level, the nominal effective exchange rate and a measure of external prices. With some possible adjustment for differential productivity growth between Ireland and its main trading partners, the SOE model posits that movements in the Irish price level are constrained such that this relationship is satisfied in the long-run. For this reason, it is tempting to conclude that any causal relationship between house prices and the CPI must be conceived as being short-run or transitory in nature.

There are, however, good reasons why the implications of the small open economy model should not be used to completely dismiss the relevance of developments in the housing market for movements in aggregate consumer prices. Firstly, the Irish nominal exchange rate while constrained within the bands of the European Exchange Rate Mechanism (ERM) is not rigidly fixed. In such a context, there is always the possibility that domestic inflationary impulses (such as heightened inflation expectations driven by rising house prices) could exert a lasting effect on Irish inflation. A second reason not to underestimate the potential significance of the

[4]The main housing items included in the housing costs sub-index are rents, local authority charges, mortgage interest, house insurance and repairs and decorations. Together, according to the 1994-95 Household Budget Survey (HBS), these items accounted for approximately 8.03 per cent. of total household expenditure.

housing market from an inflationary viewpoint is that empirical investigation of the SOE model (Kenny and McGettigan ,1997) has found that short-run deviations from long-run PPP can be of significant duration. The so-called "short-run" can, therefore, be conceived of as referring to a period which could last for several years.[5] As a result, even under the extreme small open economy view with a fixed exchange rate, the possibility that house price inflation could have a long-lasting effect on the domestic rate of inflation cannot be ruled out *a priori*. Interestingly, were such effects to be uncovered, it would signal the possibility of significant deviations in the rate of Irish inflation from that of our main partners within Economic and Monetary Union (EMU) with resultant negative implications for Irish competitiveness.[6]

A final reason not to discount the relevance of the housing market from an inflationary point of view is the extreme non-traded character of housing goods. Once allowance is made for non-traded goods, as discussed in Balassa(1964), long-term deviations from PPP become more probable. This idea was taken up in the Scandinavian model of inflation associated with Lindbeck(1979) and Aukrust(1977) and has been applied more recently by Mellis (1993) in the case of the UK and Kenny and McGettigan(1997) for Ireland. These models generally posit non-traded consumer goods rather than capital goods such as housing. However, it would seem only a small step, especially if one allows for a long-term relationship between some non-traded consumer goods (such as rental accommodation) and the price of housing, to come to similar conclusions.

2.2 Leading Indicator Role of House Prices

In light of the above discussion, the issue of a relationship between house prices and aggregate consumer prices warrants closer consideration - particularly in the short-run.

[5] The simulations reported on in Kenny and McGettigan (1997) suggest that following a suddden shock to the economy it can take over 20 quarters for 90% of the deviation from PPP to be corrected.
[6] Indeed, as has long been recognized, a common money does not imply a common rate of inflation at all points in time across differing economic regions. On this, see MacLean (1994) who investigates the role of house prices in explaining differential rates of inflation in different geographical regions in Canada.

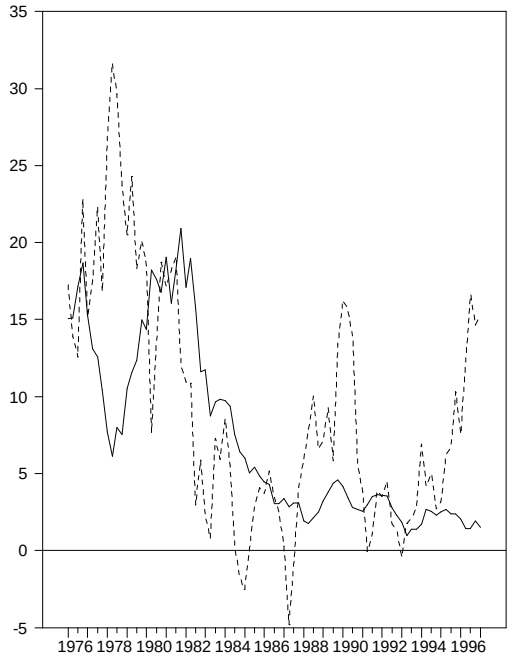
The expectations augmented Phillips curve as put forward by Friedman(1968) and Phelps(1967) provides a useful analytical framework within which to consider a potential short-run relationship between house price inflation and economy-wide inflation. Under the expectations augmented Phillips curve the actual rate of inflation is related to the expected rate of inflation plus some measure of aggregate excess demand.[7] One view of the role of house prices suggests that the housing market is a useful "nerve centre" for detecting aggregate excess demand. In the housing market, because of the length of time required in the construction of new dwellings, supply is almost completely fixed in the short-term. As a result, economy-wide excess demand will be particularly noticeable in the housing market and house price increases will be expected to precede those in other sectors of the economy which have less binding short-term supply constraints. This type of reasoning suggests that house price inflation may prove useful as a "leading indicator" of inflationary excess demand pressure which ultimately can feed through to the prices of other goods and services.

To provide a preliminary assessment of this prediction, Figure 2.1 and 2.2 below graph the year on year change in average house prices with the average rate of consumer price and wage inflation (*i*th quarter of one year to the *i*th quarter of the preceding year). From the graphs, it would certainly appear to be the case that house prices acted as a reasonably useful leading indicator of inflation up until about 1986. The peak in house price inflation in 1979 lead the peak in CPI inflation by about six quarters. In addition the deceleration in both aggregate wage and CPI inflation - which took place over the period 1981-1986 - was preceded by a large deceleration in house price inflation. A recent analysis of leading indicators of Irish inflation (Quinn and Mawdsley, 1996) is largely consistent with these observations. In constructing a composite leading indicator, Quinn and Mawdsley assess the usefulness of new house prices as a candidate component. Interestingly, at a lead of ten quarters, house prices

[7] The Phillips curve has largely been dismissed as a useful tool for analysing inflation in an Irish context. However, since the standard Phillips curve equation includes two unobservable economic variables (the natural rate and the expected rate of inflation) this empirical failure may reflect shortcomings in the variables chosen to proxy (or estimate) these unobservables.

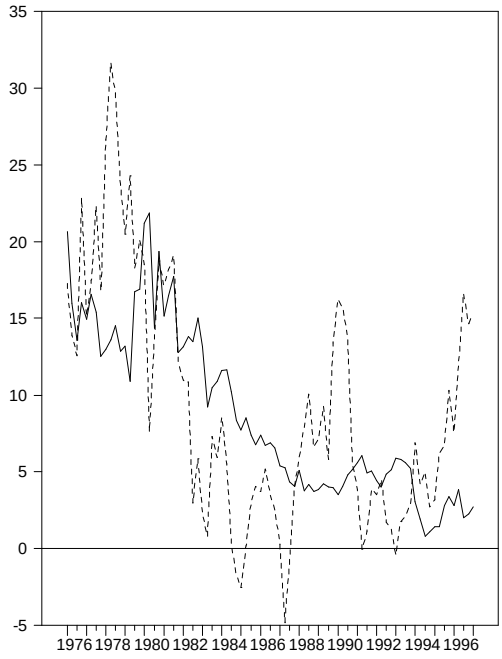
are shown to have a peak correlation of 0.73 with the rate of CPI inflation. However, the reliability of house prices as a leading indicator of inflation would appear to have declined significantly since the latter half of the 1980s.[8] In particular, there have been two periods (1988-1990 and 1994-1997) during which house price inflation bore very little (if any) relationship to either the rate of inflation in consumer goods and services or nominal wages.[9] This leads one to the unavoidable conclusion that

Figure 2.1
CPI and House Price Inflation: 1975 - 1997



— CPI Inflation , - - - House Price Inflation

Figure 2.2
House Price and Wage Inflation: 1975 - 1997



¾ Wage Inflation , - - -House Price Inflation

conditions in the housing market - in particular market "tightness" and hence pricing behaviour - can differ significantly from those in the rest of the economy. There may therefore be good reasons for the equilibrium price of housing to rise relative to other goods and services. The current expansion, where there is strong evidence of excess

[8] As a result Quinn and Mawdsley (1996) do not use house prices as a component in their final indicator.

[9] Both CPI inflation and nominal wage inflation did pick-up somewhat over the period 1988-1991. To date, however, the current boom in the housing market has not been associated with any noticeable response in either wages or prices.

demand in the housing market but little or no evidence of supply constraints at a macroeconomic level (in terms of rising consumer prices) is perhaps a case in point.

2.3 House Prices and Inflation Expectations

A second reason for expecting a relationship between the rate of house price increases and the rate of aggregate inflation can again be considered within the context of an expectations augmented Phillips curve. Under this view, variations in house prices have a fundamental impact on expectations concerning future movements in the price of other goods and services (particularly wages). As a result an increase in house prices can effect the CPI because it raises price expectations generally and this higher expected rate of inflation, because it is embedded in wage expectations, becomes in some sense self-fulfilling. Of course, under the SOE model, without some accommodation in the nominal exchange rate, such effects - while they could persist for some time - should ultimately prove to be transitory in nature. However, the effect of house prices on aggregate price expectations may give rise to a long-run impact on consumer prices if the nominal exchange rate depreciates (or is devalued) in response to increased inflationary expectations and/or higher wages and prices.

2.4 House Prices and Consumption

A third rationale for expecting a relationship between house price inflation and aggregate inflation can again be considered within the context of the expectations augmented Phillips curve. This view is based on the proposition that variation in aggregate housing wealth (driven by rising house prices) can itself be a source of excess demand in the economy. In particular, it has been argued that sharp increases in house prices have been a source of increased consumer demand. This view, has been put forward by, among others, Muellbauer and Murphy (1997) in the context of the consumer lead boom in the UK economy during the late 1980s. These authors argue that the absence of housing wealth as an argument in UK consumption function was a major factor in the predictive failure of many models and, consequently, gave rise to costly errors in macroeconomic policy.

It is, however, far from certain that increased housing wealth (due to real house price appreciation) will have an unambiguously positive effect on current consumption (or a negative impact on savings). The fact that the housing boom in the UK coincided with a boom in consumer expenditure does not by itself imply direct causation. Indeed, both phenomena could be explained by other factors such as rising real income expecations or financial innovation. For both the US and the UK, Miles (1992) argues against a simple wealth effect of real house prices on consumption. Instead, he puts forward the view that it was the increased ease with which consumers could access mortgage credit that gave rise to both increased consumption and higher real house prices. Another reason to be suspicious of arguments in support of a simple wealth effect on consumption is that while increases in real house prices benefit those who intend to trade down, they directly harm both individuals aiming to trade up and also homebuyers entering the housing market for the first time. As a result, Miles (1994) argues that unless the overall economy has scope for substituting out of housing *en masse* then aggregate wealth effects on consumption will tend to be negligible.[10]

Recent international studies have attempted to examine the validity of the hypothesis of a housing wealth effect on personal consumption. In an empirical analysis of US data, Skinner (1994) finds that the impact of housing wealth on consumption depends on the age profile of economic agents. His results suggest that housing wealth can influence the savings/consumption decision of the younger age groups in society but it is rarely used by the elderly or retired to finance consumption. Housing wealth, while far from being a "side-show", is therefore likely to be more significant in an economy with a relatively large young working cohort. This is particularly interesting from an Irish point of view because, according to Fahey and Fitzgerald (1997), the share in the total Irish population of the working cohort aged between 25 and 64 is expected to rise from 47% in 1996 to 54% by 2011. This contrasts with many other "greying

[10]As discussed in Miles (1994), the only way for an economy as a whole to substitute away from housing is for domestic residents to sell some of domestic housing wealth to foreigners.

economies" in the OECD where this share is expected to decline significantly over the next few decades. Based on Skinner's (1994) results therefore, one might be tempted to conclude that the conditions are ripe for significant housing wealth effects on real consumption in Ireland. Importantly, however, the micro-estimates of consumption effects that Skinner (1994) presents are much lower than the estimates attained using aggregate data.[11]

In the case of the UK, Miles (1992,1994) investigates housing wealth effects on consumption using a multi-period model of consumer behaviour where economic agents are assumed to maximise the discounted value of expected future utility. Using this framework, he is able to show that the optimal response of consumption to a rise in housing wealth depends on a variety of factors including how forward looking household behaviour is and the extent to which households are willing to substitute housing for other consumption. The response of consumption also appears to be related to the type of shock hitting the housing market. For reasonable choices of structural parameters in the model, it is shown that a once-off shock to the level of house prices has only a small effect on consumption for economic agents with a very long time horizon. For myopic agents with shorter planning horizons, the effects on consumption are much greater because they pay less attention to expected future increases in the user cost of housing. Another result which emerges from this analysis is that shocks to the growth rate of real house prices (or shocks which combine both level and growth rate effects) have a more substantial effect on the level of current consumption.[12]

[11] The empirical section of this paper employs aggregate data to test for feedback from real house prices to real consumption.

[12] While this is an interesting result, it is not at all certain that permanent shocks to the growth rate of real house prices occur in practice. From a time series perspective, this would require that the first difference of real house prices be integrated of order one (I(1))and thus the level of real house prices be integrated of order two (I(2)). Despite significant observed volatility in real house prices (see Figures 2.1 and Figure 2.2), shocks to their growth rate would appear to exhibit only moderate persistence. The 1988-1990 period of sharp increases in real house prices in Ireland would appear to fit into this category of shock because, by 1991, the growth rate of real house prices had almost completely returned to its pre-shock level. Further evidence on the time series properties of real house prices in Ireland is given in the empirical section of the paper.

2.5 House Prices and the Banking System

Apart from its mandate for price stability, a Central Bank's role as supervisor of the banking system offers an additional reason for understanding the behaviour of house prices and their economic implications. The banking sector is *directly* exposed to developments in the housing market because mortgage debt represents a significant component of the total asset base for most financial intermediaries and variations in house prices alter the value of mortgaged assets.[13] As discussed in Lindgren, Garcia and Saal (1996), however, banks are very much "derivative" institutions. In other words, their health primarily reflects the health of their customers which in turn mirrors the performance of the overall macroeconomy. As a result, a sharp speculative movement in house prices may endanger the health of the banking sector *indirectly* because it results in an overall decline in macroeconomic stability (due to rising inflation expectations, consumer booms etc.). A rise in economy-wide inflation is likely to impact negatively on the banking sector in the long-run because it can give rise to long-term negative effects on economic growth, as well as interest and exchange rate volatility and an increase in relative price variation.[14] In addition, a period of high real interest rates may be required in order to disinflate the economy. Such high interest rates directly increase the cost of financing to both businesses and households and, because borrowers are budget-constrained, this can result in an increase in mortgage defaults with negative implications for the banking sector.

In light of the above remarks, it is not at all surprising to find that sharp variation in house prices have tended to be associated historically with both macroeconomic

[13] In Ireland, the nominal value of mortage debt accounts for approximately 25 per cent. of the total assets of all credit institutions vis-a-vis residents. See Table C3, Central Bank of Ireland, Quarterly Bulletin (various issues).

[14] In the short-run, it is commonly argued that the banking sector can benefit from increased profitability in a moderately inflationary environment. One reason for this is that inflation is more often than not associated with a loose monetary policy and this leads to an expansion in the aggregate balance sheet of the banking sector. Since a banks operating costs (wages etc.) respond more slowly to a lax monetary environment, a transitory increase in bank profitability often takes place in an inflationary environment. In addition, because banks are primarily financed with short-term liabilities (deposits) but purchase longer term assets (loans), they can benefit from the upward sloping yield curve that is associated with an inflationary environment.

instability as well as problems in the banking sector in many countries[15]. While house price volatility has damaged financial institutions in the US, the UK, Japan and Australia, the negative effects of adverse housing market conditions were particularly acute in Scandinavia: the bursting of bubbles in the housing market directly contributed to the banking crises which occurred in Finland and Sweden in the early 1990s. Despite such experiences, and the inherent risk associated with large speculative movements in house prices, it is a common finding that financial institutions do not adopt a prudential approach to lending until it is too late. This may stem from the fact that it is very difficult to be certain that a bubble does indeed exist. However, both internal and regulatory structures may also contribute toward a lack of prudential lending in the context of speculative activity. In particular, if bank managers are given incentives to maximise the paper value of their loan book they may do so while giving little concern to its risk characteristics.

2.6 Conclusion

This section has addressed the factors which link developments in the housing market and monetary policy. It was pointed out that a Central Bank has a natural concern for outcomes in the housing market given its dual responsibility for maintaining price stability and overseeing the operations of the financial sector. Most importantly, it was show that significant variations in house prices can be expected to provide useful information to a Central Bank concerning inflationary pressures in the economy. This information content stems from the short-run fixity of supply in the housing market, the potential impact of house prices on inflation expectations and also the possibility that increased housing wealth might give rise to a consumer boom. Against this, however, it was argued that there are factors - specific to the housing market - which can lead to a shift in the price of housing relative to the price of other goods and services.[16] This tends to weaken the link between house price inflation and consumer price inflation.

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[15] See Lindgren, Garcia and Saal (1996) , Ch. 4, for a complete discussion.
[16] These factors are discussed in more detail in section 3 below.

What then are the implications of the above analysis for the monitoring of inflationary pressure in the Irish economy? Unfortunately, the analysis suggests that there is no absolute "monitoring range" or "rule" which could be used to justify a particular policy response. In the absence of such a rule, the approach of a central bank should therefore be to try and identify warranted as opposed to purely speculative changes in the price of housing since the latter present the greatest threat to macroeconomic stability and the banking system. This, of course begs two further issues. In the first instance, there is the question of whether or not a monetary authority has the ability to influence outcomes in the housing market should it perceive them to represent a threat to macroeconmic stability. As will be alluded to in section 3 below, economic theories of the housing market suggest that a monetary authority does indeed possess a potent tool for "taking the heat out of the housing market" through the interest rate mechanism.[17] Secondly, however, there is the more complex normative issue of whether or not a macroeconomic policy response (such as an interest rate change) represents an *appropriate* response to systemic threats posed by the housing sector. To examine these issues more closely, it is necessary to take a closer look at the nature and functioning of the housing market in general.

[17]The empirical section of the paper will, therefore, test for the impact of interest rates on house prices. Ireland's commitment to Economic and Monetary Union (EMU) will, however, involve the sacrifice of the independent use of this tool.

3. The Nature of the Housing Market

For a variety of reasons, the housing market is unlike the markets for many other goods and services. One reason for this is the dual function of housing goods as both commodities - yielding a flow of consumer services - and also as an investment asset which accounts for a large portion of household net worth. The analysis of the housing market is further complicated by several other features which, when taken together, set housing apart from other goods and services. According to Quigley (1992), the principal features that distinguish housing from other goods and services in the economy are i) its relatively high cost of supply, ii) its durability, iii) its heterogeneity (no two houses are identical in every respect) and iv) its locational fixity.[18] These features of housing, in particular its durability, heterogeneity and locational fixity, together imply that the housing market is really a collection of loosely connected but segmented markets.[19] As a result, it is somewhat misleading to talk of the price of housing or house prices in aggregate. This is, however, an abstraction that will be made for the purpose of this paper.

Economists have traditionally taken the orthodox view that the evolution of house prices can be thought of as the natural outcome of the demand for housing equating with its supply. Under this view, the demand and supply for housing interact to determine the price of housing relative to other goods and services. Many reasons have, however, also been put forward as to why enduring deviations from such an equilibrium might take place. In order to inform the macroeconomic analysis which follows, the key micro factors effecting house prices, on both the demand and supply side of the housing market, are reviewed below.[20]

[18] Smith, Rosen and Fallis (1988) add to this list the extensive involvement of government.
[19] Various sub-markets of the housing markets are differentiated by location, dwelling type, tenure form, age, quality and financing. These markets are, however, connected insofar as prices in different segments of the housing market tend to be related to each other in a predictable way.
[20] For a comprehensive survey of developments in economic models of the housing market see Smith, Rosen and Fallis (1988).

3.1 Housing Demand

In the housing economics literature, the demand for housing is normally derived in a multi-period (or "life-cycle") model where consumers maximise utility, with housing as an argument in the utility function, subject to an intertemporal budget constraint.[21] These models incorporate various features of the housing market including the large cost of housing relative to current disposable income and, hence, the dependence of housing demand on savings accumulated in earlier periods and also the price and availability of mortgage credit. Table 2.1 below lists several factors, which are commonly cited as arguments in the housing demand function. The effect of each argument is signed according to whether a rise in the variable results in an increase (+) or a decrease (-) in housing demand.[22] The effects are signed on a priori economic grounds and are not based on an estimated demand function.[23]

Interestingly, as clearly illustrated in Salo (1994), the sign of the effect of various variables on housing demand is contingent on whether or not there are any restrictions facing borrowers in the capital market. Under reasonable assumptions, it can be shown that the demand for housing is downward sloping and, hence, negatively related to real house prices. Under the assumption of perfect capital markets (no credit restrictions), both current and future income and the expected increase in real house prices have an unambiguously positive effect on housing demand. Conversely, the demand for housing is a negative function of the interest rate because higher interest rates increase the cost of consuming housing services (mortgage interest costs rise) all

[21] See Artle and Varaiya (1978) for an early application to the housing market of the life-cycle approach to decision making. For other useful examples of this approach see Salo (1994) or Miles (1994), Ch. 2.

[22] It should be pointed out that Table 2.1 represents a simplification when compared with most empirical models of the housing market where the distinction is usually drawn between the flow demand for housing and the desired stock of housing given the level of various exogenous factors. In such models it is usual to assume that economic agents can adjust toward their desired stock of housing only gradually within each period following a change in an exogenous variables. In their empirical model of the Irish housing market, this stock-flow adjustment mechanism was used by Kenneally and McCarthy (1982). The empirical section of this paper also incorporates the slow adjustment toward a desired or equilibrium stock of housing.

[23] The table is based on the comparative statics analysis in Salo (1994) and does not take account of several other variables, e.g. demographics, inflation and the impact of various variables on housing demand by way of inducing a shift away from renting towards owner occupation.

other things being equal. The effect of a fall in income tax rates on the demand for housing is, however, ambiguous depending on whether or not the induced rise in disposable income outweighs any rise in the cost of consuming housing services.[24]

In an economy with *binding* quantitative restrictions imposed on borrowers, as discussed in Miles (1994), the impact of changes in many of the above variables on the demand for housing is less clear cut, however.[25] Under such conditions, an easing of credit restrictions will raise the demand for housing. In addition, while an increase in current income exerts the expected positive effect on housing demand, a rise in future income has an apparently perverse (i.e. negative) effect on the demand for

Table 3.1 : Various Components of Additional Housing Demand

	Perfect Capital Markets	Credit Restricted Market
Real House Prices	-	?
Current Income	+	+
Future Income	+	-
Expected Capital Gain	+	?
Income Tax Rates	?	?
Interest Rates	-	+
Credit		+

housing. Salo (1994) explains this in terms of a *hedging effect* in which the role of house prices as an investment becomes more important in determining the demand for housing. Consider, for example, a fall in future income. Such a decline has the immediate effect of reducing expected consumption in future periods. Economic

[24] A fall in tax rates increases the cost of consuming housing services by lowering the benefit which derives from mortgage interest tax relief. In Ireland, mortgage interest tax relief is available only at the standard rate and, as a result, the likelihood that a fall in income tax rates would raise the demand for housing is increased.

[25] A credit restriction is binding if at the prevailing level of interest rates, borrowers would prefer to take on more debt than lenders are willing to lend. The study of the Irish housing market by Thom (1983), which covered the period 1971- 1981, examined the effects of restrictions in the Irish mortgage market and found them to be significant.

agents, who seek to smooth consumption over their life, will tend to increase savings in order to counteract the expected decline in future consumption. However, due to credit restrictions in the capital markets, there is a shortage of alternative savings outlets (other than the housing market), and hence, demand for housing tends to increase when future income falls. This hedging effect is also reflected in the signs of the effect of other variables on housing demand. As a result, the effect of variation in real house prices, changes in tax rates and expected capital gains have - *a priori* - an indeterminate effect on housing demand in a credit restricted economy. Under such conditions, a rise in real house prices may enhance the borrowing capacity of households so dramatically that it results in an increase in both non-housing *and* housing consumption (implying an upward sloping demand schedule.[26] Not surprisingly, since binding credit restrictions impede the speculative demand for housing, the effect of expected capital gains is no longer necessarily positive. Finally, a rise in interest rates can be shown to have a positive impact on housing demand because it increases the demand for savings outlets and, hence, the demand for housing.

The above brief discussion of housing demand in a standard model of consumer behaviour is intended to emphasise the complexity of the relationships which may exist between variables such as interest rates, income, and expected capital gains on the demand for housing. Importantly, the effects of changes in these "exogenous" demand factors on the equilibrium level of house prices will depend on the manner in which the supply of housing adjusts both in response to changes in demand and also other exogenous factors. It is therefore worthwhile to briefly consider a mainstream view of the supply side in the housing market.

[26] In the dynamic model discussed in Miles (1994), Ch.2, credit restrictions give rise to an upward sloping locus along which house prices are unchanging. As a result the housing market will be inherently unstable, i.e. there may not exist a unique saddle point path leading the market toward equilibrium.

3.2 Housing Supply, Equilibrium and Adjustment

The evolution of the stock of housing over time is commonly represented using the "perpetual inventory" equation below:

$$H_t = (1 - \delta)\, H_{t-1} + A_t \qquad (2.1)$$

According to (2.1), the current housing stock (H_t) is related to last periods housing stock (H_{t-1}) adjusted for the depreciation of dwellings ($\delta\, H_{t-1}$) and the number of housing completions (A_t). As discussed in Hendry (1984), since A_t is very small relative to the total housing stock, and since it is also relatively predetermined by the volume of construction in progress, it is a common assumption that housing supply is very much fixed (or inelastic) in the short-run. Under such conditions, the demand

Figure 3.1A

Short-run Equilibrium in the Housing Market

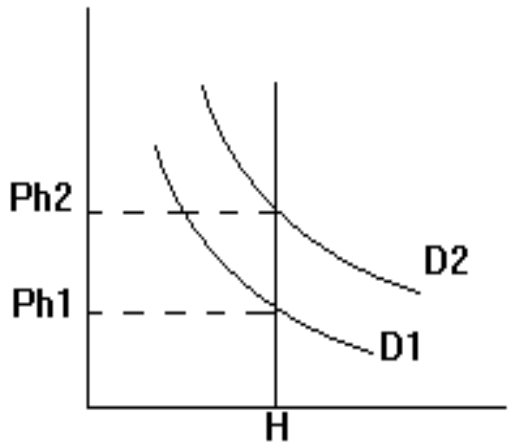
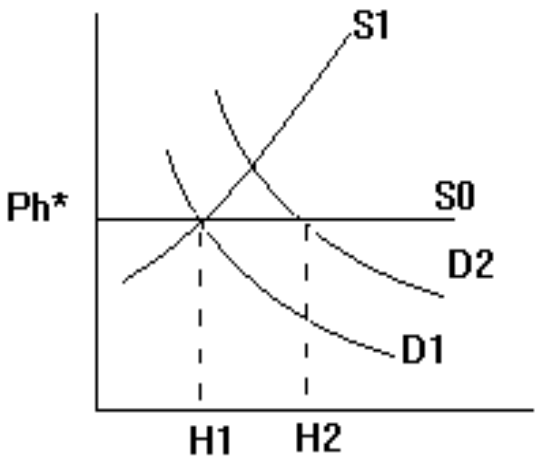


Figure 3.1B

Long-run Equilibrium in the Housing Market



for housing (driven by the exogenous factors discussed in Table 3.1) will determine the price of housing relative to other goods and services. This situation is depicted in Figure 3.1A where the stock of housing available to economic agents is fixed at H. Initial equilibrium in the housing market (in the sense that the entire stock of housing is willingly held) is at the point (H,Ph1). For any level of house prices below Ph1, there

is an excess demand for housing and for any level of house prices above Ph1 there is an excess supply of housing.[27] From the graph, it is quite clear that under conditions of short-run equilibrium, any stimulus to housing demand will result in a rise in house prices relative to other goods and services. The graph shows a rise in housing demand from D1 to D2 due to, for example, a rise in income. The immediate short-term effect of stronger housing demand is to raise the price of housing relative to other goods and services from Ph1 to Ph2. Hence, the microeconomic theory of the housing market predicts a very strong relationship between the arguments of the housing demand function (income, interest rate) and the real price of housing in the short-run.

It is, however, not at all suitable to assume completely inelastic supply in the housing market over the medium to long-run. Following a sudden increase in demand, and the resultant rise in house prices relative to the price of other goods and services (including the price of labour), construction firms will find it profitable to supply more housing units to the market. One possibility is that supply is completely elastic over the very long-run.[28] This situation is depicted in Figure 3.1B where the housing supply curve (S0) intersects the vertical axis at Ph*. Ph* can be interpreted as the relative price of housing which provides a "normal profit" to the construction industry. Any rise in real house prices above Ph*, as would occur following a sudden shock to housing demand from D1 to D2, should induce firms (both existing and new firms entering the market) to supply more housing units in order to exploit the enhanced scope for profit. In a perfectly competitive market, where the supply of the factors of production is completely variable over the long-run and where there are no barriers to entry, this process could be expected to continue until real house prices returned to Ph*, i.e. that level which provides construction firms with a normal level of profit. Under these conditions of completely elastic supply, there is no long-run effect of the exogenous

[27] Consistent with the Walrasian view that relative - as opposed to absolute - prices adjust to clear markets, the vertical axis in Figures 3.1.A and 3.1.B measures the price of housing relative to the price of an aggregate consumer good, i.e. the real price of housing.

[28] As in Hendry (1984) such a long-run equilibrium could correspond to a steady state in which construction companies are earning normal profits and house completions exactly match the depreciation in the housing stock.

variables of the housing demand function on the real price of housing. Instead, housing demand determines the quantity and not the price of housing in equilibrium.

In practice, the elasticity of housing supply is surely positive but not infinite even in the long-run. This gives rise to an upward sloping long-run housing supply schedule (depicted by the curve "S1" in Figure 3.1B) as discussed in Miles (1994) and Poterba (1984). In the model of supply suggested by Poterba (1984), the production decision of firms is based on the comparison of the current (real) market price of housing and the production costs of housing.[29] Within this framework, an upward sloping supply schedule for housing can be derived under the assumption of diminishing returns to scale or, alternatively, under constant returns to scale, when the availability of building land is in fixed supply.[30] Given the upward sloping nature of housing supply, one should expect a long-run response of house prices to changes in the demand for housing. A rise in current and expected future income would under such circumstances give rise to a *permanent* increase in the price of housing relative to other goods and services.

The assumption that construction firms make production decisions solely based upon a comparison of the current market price of housing and the current costs of production is perhaps naive. Other models, e.g. Salo(1994), directly incorporate the uncertainty facing construction firms about the future price at which a house will be sold. In this setting, the supply of housing can again be derived in terms of several exogenous variables. These are listed and signed in Table 3.2 for the two cases of freely available inputs and binding land constraints.[31] Not surprisingly, a rise in the price of land, interest rates or the price of other inputs (labour and materials) into the production of

[29] This approach is very much in the same spirit as Tobin's q-theory of investment and it is employed in the empirical section of this paper.
[30] Of course the land availability constraint must be binding for it to impart an upward slope on the housing supply schedule.
[31] When land is freely available, diminishing returns to scale are assumed. When the supply of building land is constrained, constant returns to scale technology is assumed.

housing reduces the quantity of housing units that is supplied at a given price.[32] In contrast, housing supply is increasing in current and future house prices, the proportion of production that is pre-sold (i.e. sold off the plans) and also in the probability of pre-selling a fixed proportion of current production. In the case of binding land constraints, supply unambiguously increases if the land constraint is relaxed due to, for example, a re-zoning decision which makes available a new tract of land for housing development.

Table 3.2: Factors which Effect the Supply of Housing Units

Housing Supply	No Land Constraints	Binding Land Constraint
Real House Prices	+	+
Future House Prices	+	+
Land Prices	-	
Price of Other Inputs (Labour, Materials)	-	-
Probability that a% of Production is Pre-sold	+	+
Proportion that is Pre-sold	+	+
Interest Rates	-	-
Land		+

3.3 House Price Volatility

The above view that both the demand and supply sides of the housing market interact to determine an equilibrium level for real house prices should not be taken to imply that house prices are necessarily stable. In many countries, it is commonly observed that house prices are significantly more volatile than would be predicted by variation in the determinants of either demand or supply alone.[33] One possible explanation for such volatility is that both purchasers and sellers of housing units face significant transactions costs when they engage in trade. Examples of such costs include, from a buyers point of view, the costs of identifying and accumulating information about

[32] A monetary authority intent on taking the heat out of the housing market by means of the interest rate mechanism should therfore consider the potential impact of its actions on the supply as well as the demand side of the housing market.
[33] The current boom in the Irish housing market is perhaps a case in point.

prospective dwellings (search costs), the time spent arranging finance, the legal costs of buying a house, taxes on home transfer (stamp duty) as well as the physical costs of moving.[34] From a sellers point of view, many of these costs also apply but in addition there are the added costs of identifying and informing prospective buyers (property agents are normally paid a fee to perform this service).

It is often argued that the presence of such "lumpy" transaction costs can impede the adjustment of supply and demand to changing market conditions. For example, households are unlikely to increase the quantity of housing units demanded following an increase in income (or a fall in interest rates) until the present value of expected benefits from doing so exceeds the associated transactions costs. This type of inertia or sluggish demand adjustment can give rise to a period where actual house prices deviate from the market clearing price followed by a subsequent period in which house prices increase rapidly. In the model developed in Muellbauer and Murphy (1997), such transaction costs give rise to "threshold effects" where appreciation in house prices pull more households over the transaction costs hurdle to engage in trade and, as a result, house prices increase dramatically. This idea is generally incorporated into house price models by allowing for non-linearity in the relationship between the change in house prices and the level of excess demand. Hendry (1984), for example, suggests a cubic function to approximate the relationship between excess demand and house price changes. Under this specification, large disequilibria result in large and rapid changes in house prices. In contrast, small levels of excess demand do not result in significant changes in house prices. Such small disequilibria are, in Hendry's terminology, "indistinguishable from noise".

A slightly different perspective on house price volatility is presented in the model of housing market dynamics presented in Miles (1994). Miles considers the impact of a change in the taxation system which increases the demand for housing, e.g. an abolition in property taxes or the introduction of more favourable mortgage interest

[34] MacLean (1994) adds to this list the "psychological" costs of moving house.

tax relief. When such tax changes are unanticipated, it can be shown that house prices will overshoot their long-run equilibrium level, i.e. house prices jump upwards in a discontinuous manner and then fall steadily to their new long-run equilibrium level which is above the level prior to the change in tax policy. The root cause of this observed "volatility" is the sluggish nature of supply adjustment in the housing market noted in section 3.2. Such overshooting is, however, both a rational and an efficient response: the discontinuous rise in house prices has the effect of choking-off the excess demand for housing which results from the unanticipated policy change. Gradually, as net housing investment comes on line in response to higher prices, real house prices fall slowly.[35] Miles (1994) also shows that the same overshooting effects are unlikely to occur in response to an anticipated change in tax policy because demand increases *before* the tax change is actually implemented. As a result, the anticipated policy change gives rise to a continuous upward movement in real house prices. The analysis thus suggests that should the authorities wish to avoid house price overshooting they should refrain from sudden unanticipated policy actions which shift the demand for housing.

The above explanations of volatility in the housing market are grounded in optimal household behaviour in the presence of significant adjustment lags and transaction costs on both the demand and the supply side of the market. Another possible explanation for deviations in house prices from the market clearing price is the possibility that the housing market is inefficient due to the existence of speculative bubbles. If investors purchase housing *only* because of the expectation that the price of housing will increase and without regard to the fundamental equilibrium value of housing, then a bubble in house prices can be said to exist.[36] While such bubbles can

[35]As long as supply is not perfectly elastic (as surely it is not) the new convergent path to housing market equilibrium must involve falling prices. This type of analysis is very similar to the dynamic IS/LM framework employed by Blanchard (1981) in analysing the effects of both fiscal and monetary policy on output and the stock market.

[36] There is enormous lack of consensus concerning the possible existence of speculative bubbles. In part this derives from the difficulty associated with estimating the fundamental equilibrium value of any asset. Blanchard and Fischer (1989), Ch. 5, provide a useful discussion of the theoretical conditions necessary for bubbles to exist.

be entirely rational from an individual investor's point of view, they are likely to result in large-scale inefficiencies for the economy as a whole. A housing market bubble could, for example, result in over-investment in housing with a consequential negative impact on productive potential in other sectors of the real economy.[37] In addition to this, however, as discussed in section 2.5, there is the potentially large inefficiency due to a negative impact on the banking sector when (and if) a bubble bursts. Case (1986) argues that the housing market is particularly susceptible to bubbles because of information problems such as the lack of full knowledge of the fundamental "yield" of a housing unit. The use of property agents may also give rise to "bubble" activity in the housing market. This is because agents may not convey impartial information since they know that property will trade more frequently (and hence their commission will rise) when buyers expect prices to be higher in the future. Sellers may also have an incentive to test the upper limits of the market because a sale price can always be reduced but a sale agreed at too low a price cannot be reversed.

The issue of housing market efficiency has been examined empirically by Case and Shiller (1989) in the case of the US housing market and by Ito and Hirono (1993) who look at house prices in Tokyo. The former study cites positive serial correlation in real house prices as evidence of housing market inefficiency: a change in real house prices in a given year is shown to predict a change of one quarter to one half as large in the following year. In addition, house prices in several regions of the US do not appear to incorporate predictable changes in real interest rates. Ito and Hirono (1993) find evidence of significant predictability in excess returns which are defined as the difference between the returns from investment in housing less the return on various financial assets. Although the authors suggest that their results are highly tentative given data constraints, such predictability is inconsistent with weak-form market

[37] Browne and Fagan (1992) cite the real estate bubbles in both the US and the UK as examples of economies where overinvestment in housing was matched by corresponding underinvestment in other sectors.

efficiency in the sense of Fama (1970).[38] Finally, the possible existence of a land price bubble has been investigated by Fagan and Browne(1994) for Ireland. Using a cointegration analysis of land prices and rents, the results of this study support the hypothesis of a bubble in Irish land prices in the 1970s.

3.4 Conclusion

This section of the paper has reviewed the fundamental nature of the housing market from a microeconomic perspective. Of particular interest was what the microeconomic theories had to say concerning the relationship between house prices and other variables of macroeconomic relevance such as income and interest rates. Theory predicts that housing demand will increase in a period of rising current or expected future incomes, falling interest rates or rising expected capital gains from investment in housing. In the presence of a sluggish short-run supply response, these factors will be reflected in an immediate rise in current house prices relative to other goods and services. In the long-run, however, it is likely that housing supply will respond gradually in response to the increased profit potential from investment in housing. This tends to weaken the impact of demand variables such as income and interest rates on house prices in the long-run. It was also pointed out that large transaction costs may also weaken the relationship between house prices and the arguments of the housing demand schedule. Lastly, it was shown that inefficiency in the housing market, including the possible development of a speculative bubble, might also give rise to a departure in house prices from their fundamental equilibrium value given by the interaction of the housing demand and supply schedules.

[38] House prices are weak-form inefficient if the expected value of excess returns in the housing market is non-zero or not equal to a constant if allowance is made for a risk premium demanded by investors in housing assets.

4. Modelling House Prices in a Macroeconomic Context

This section takes up the issue of empirically investigating some of the economic relationships outlined in Sections 2 and 3. The econometric analysis will take a very aggregate or macroeconomic perspective on the housing market and attempt to identify equilibrium relationships using key macro variables such as income and interest rates. In particular, the analysis will examine (i) the impact of monetary policy, i.e. interest rates, on developments in the housing market, (ii) the effects of rising real incomes on house prices, (iii) the nature and speed of price adjustment in the housing market, (iv) the nature and speed of stock adjustment in the housing market and (v) potential impacts of rising house prices on real consumption.[39] One approach to examining these issues would be to construct a theoretical model of supply and demand in the housing market with parameter restrictions implied by the optimising behaviour of both the suppliers and consumers of housing units. Such a model could then be fitted to and tested against the available data.

An alternative approach - and the one which is adopted here - is to examine the data directly to uncover the extent to which it is consistent or inconsistent with the basic economic relationships suggested by theory. One such relationship is the housing demand function, discussed in section 3. This relates the number of housing units demanded (H_Q) to the price of housing (P_H), and a vector of demand variables (**X**). When the variables are logged, the demand relationship can be approximated by the linear form given below:

$$H_Q = \beta_o + \beta_1 P_H + b_3\mathbf{X} \qquad (4.1)$$

In a well behaved market (as discussed in section 3.2), one would expect to find a negative relationship between the price of housing and the quantity of housing units demanded, i.e. $\beta_1 < 0$. In addition, variables such as income and interest rates should enter the vector **X** with positive and negative signs respectively. Another fundamental

[39] Topics (i) through (v) are issues of obvious interest and importance from a monetary policy perspective.

relationship suggested by economic theory is a supply adjustment equation. As was pointed out in the discussion in section 3.2 of the paper, this relationship suggests that when the price of housing rises relative to that level which provides a "normal" profit to firms in the construction industry, then this induces an increase in the quantity of dwellings supplied to the market. Empirically, the level of house prices consistent with normal profits can be approximated by the ratio of house prices to the costs (including land) of constructing a house. This suggests the logarithmic supply adjustment equation given below:

$$\Delta H_Q = \alpha(P_H - \mathbf{W}) \tag{4.2}$$

where $\alpha > 0$ and **W** represents a vector of cost variables (labour, land, materials, interest costs etc.) . While stock adjustment should ensure that the ratio of house prices to costs is reasonably stable over the long-run (stationary in the time series sense), this is not the only adjustment which could restore normal profits. In particular, if supply was severely constrained due to a lack of available land for housing development, one might also expect that "normal profits" would be restored via an endogenous response of costs, e.g. due to rising land prices. The econometric analysis below will test for these alternative responses. In particular, an attempt is made to identify demand and supply side relationships consistent with equations (4.1) and (4.2) within a cointegration framework. This provides the economically meaningful distinction between the long and the short-run information in the data - a distinction which is likely to prove particularly relevant in the housing sector where it is commonly believed that supply adjusts only gradually to changing market conditions.

4.1 Econometric Methodology

The Johansen multivariate approach to cointegration analysis seems particularly suited to the analysis of the above relationships because it is a multivariate technique which allows for the potential endogeneity of all variables considered. In common with other cointegration techniques, the objective of this procedure is to uncover stationary

relationships among a set of non-stationary data. Such relationships have a natural interpretation as long-run equilibrium relationships in the economic sense. In addition, the Johansen procedure allows the simultaneous estimation of the speed with which the variables adjust in order to re-establish any equilibrium in the system and such estimates should prove particularly useful as a guide to housing market policy. To conserve space a detailed presentation of the Johansen methodology is not provided here.[40] Briefly, however, if Z is a *p* x *1* vector of stochastic variables, the Johansen procedure entails the estimation of the vector error correction model (VECM) below:,

$$\Delta Z_t = \Gamma_1 \Delta Z_{t-1} + \ldots + \Gamma_{k-1} \Delta Z_{t-k+1} + \Pi Z_{t-1} + \mu + \Psi D_t + \varepsilon_t, \quad t = 1, \ldots, T. \qquad (4.3)$$

where Δ is the difference operator, k is the chosen lag length, μ is a constant term, D is a vector of non-stochastic variables such as seasonal dummies and ε is a vector of disturbance terms. The hypothesis of cointegration among the variables can be formulated as a hypothesis about the rank (r) of the matrix Π.[41] Π in turn can be decomposed into a matrix of long-run cointegrating coefficients (β) and a matrix of adjustment coefficients (α), i.e.

$$\Pi = \alpha\beta', \qquad (4.4)$$

where α and β are *p* x *r* matrices and $r < p$. In practice, the lag length (k) is normally chosen such that the vector of error terms is well behaved, i.e.

$$\varepsilon_t \sim \text{Niid}_p\,(0, \Sigma) \qquad (4.5)$$

In common with other vector autoregressive models, one shortcoming of the methodology is that there are significant constraints in terms of the number of non-stationary variables that can be considered in the analysis. In the econometric analysis

[40] Further useful discussions, together with relevant references, are provided in Hamilton(1994), Hansen and Juselius (1995) and Harris (1995).

[41] If Π was of full rank, this would imply that all variables were I(0). If Π has zero rank the term Πz_{t-1} drops out of the equation and the variables in question are not cointegrated. If 0 < rank of Π < P, there is at least one cointegrating vector. In the absence of I(0) variables, the rank of Π equals the number of stable long-run relationships which exist among the data.

below, the vector of demand side variables is constrained to include only income and interest rates, i.e. **X** = {Y, R} in (4.1)[42]. On the supply side, costs are proxied by a composite index of average costs in the construction industry (BC) and interests rates, i.e. **W** = {BC, R}in (4.2).[43] Adding to these the house price variable (P_H) and housing stock variable (H_Q), this results in the five variable system given below:

$$Z = \{P_H, H_Q, Y, R, BC\} \tag{4.6}$$

As discussed above, based on economic arguments alone, one might expect to uncover two long-run cointegrating relationships in such a data set. Firstly, if the housing market is well behaved, the data should reveal a downward sloping demand locus consistent with (4.1). Such a relationship could then be interpreted as capturing the equilibrium (or desired) stock of housing demanded given the level of house prices, income and interest rates. Secondly, the log of the ratio of house prices to construction costs should be stationary since theory predicts that housing quantities (or costs) adjust over the long run in order to ensure a normal level of profit to the average construction firm.[44]

The results from the analysis of the above five variable system are reported below. All variables are quarterly and logged and the sample period covers 1975:4 to 1997:1.[45] The analysis is undertaken under the assumption that all variables in Z are integrated of order one or I(1). This assumption was largely confirmed by univariate unit root tests undertaken as a precursor to the multivariate analysis. However, the time series

[42] The study does not therefore explicitly model the impact of demographic change on housing demand. Importantly, however, real GNP is employed as the relevant income variable and not real *per capita* GNP. Since the change in real GNP can be decomposed into a component which reflects growth in per capital income and a component which reflects population growth, the effects of population growth are to some extent modelled via the income variable.
[43] The index of construction costs incorporates the costs of materials, labour and an estimate of the price of developmental land per housing unit. See the Data Appendix.
[44] Previous studies - including the analysis of Knudsen (1993) using Danish data - have attempted to uncover similar relationships using cointegration analysis. Similar systems have also been considered by Salo (1994), Wheeler and Chowdury (1993), Drake (1993) and Hakfoort and Matysiak (1997).
[45] The data are described in more detail in the Data Appendix.

properties of the variables can also be tested within the multivariate system and the results of these tests are reported below. Finally, as mentioned above, it is also intended to test for possible effects of house prices on real personal consumption. This is undertaken in a supplementary analysis (the results of which are reported in section 4.6) by including real consumption as an additional variable in the analysis.

4.2 Lag Length and Rank Tests

The primary objective of cointegration analysis is to uncover the long-run economic relationships between the non-stationary variables under consideration. This, however, can only be achieved within a well specified model. Hence, the lag length (k) is chosen such that the error terms in equation (4.3) are well behaved. Table 4.1 below reports various multivariate diagnostic statistics for serial correlation and normality of the errors in the VECM.[46] In each case the null hypothesis is one of well behaved residuals. Hence, the lower the test statistic (the higher P-value) the more acceptable the corresponding lag length. From the Table, it can be seen that the hypotheses of no first and fourth order residual autocorrelation are not rejected for a lag length of two, three and four (at the 10% level). Normality of the residuals is, however, rejected for all lag lengths from one to five.[47]

Given that the asymptotic theory used to derive the rank tests for the matrix Π (see below) is valid only when the number of parameters to be estimated is small relative to the sample size, it was decided that the analysis should proceed on the basis of a lag length of three. This lag length corresponds to the model with the lowest test statistic for normality among all models with non-autocorrelated errors.[48] In addition, with quarterly data, a lag length of three has a good deal of economic appeal. It implies two lags of the first difference terms in the VECM specification of the model with the remaining short-term dynamics being captured by adjustment of the variables to restore any equilibrium cointegrating relationships which exist among the variables.

[46] See Hansen and Juselius (1995) for a detailed discussion of these test statistics.

[47] It is, however, important to note that two recent studies, Cheung and Lai (1993) and Gonzalo (1994), demonstrate the robustness of the Johansen procedure in the presence of non-normal residuals.

[48] A lag length of three was also supported by both the Akaike Information Criterion (AIC) and the Schwarz Bayesian Criterion (SBC).

Table 4.1: Testing for the appropriate lag length (k)

Lags	First order autocorrelation		Fourth order autocorrelation		Normality	
	c^2 (25)	P-Value	c^2 (25)	P-Value	c^2 (10)	P-Value
1	75.5*	0.00	40.9*	0.01	81.2*	0.00
2	25.9	0.41	15.9	0.92	74.0*	0.00
3	31.25	0.18	18.9	0.80	66.7*	0.00
4	34.5	0.10	15.9	0.92	82.1*	0.00
5	24.8	0.47	42.6*	0.02	56.2*	0.00

*Significant at the 5% level

Table 4.2: *l* max and Trace Tests

H_o: r	Eigenvalue	*l* max	Critical Value.		Trace	Critical Value	
			90%	95%		90%	95%
0	0.4564	52.41*	20.90	33.5	95.17*	64.74	68.5
1	0.1917	18.30*	17.15	27.1	42.75	43.84	47.2
2	0.1635	15.35*	13.39	21.0	24.45	26.70	29.7
3	0.0971	8.79	10.60	14.1	9.10	13.31	15.4
4	0.0036	0.31	2.71	3.8	0.31	2.71	3.8

* H_o rejected at the 10% level

Conditional on a chosen lag length of three, the hypothesis of cointegration among the variables can be tested using the well known maximum eigenvalue (λ max) and Trace tests reported in Table 4.2.[49] The Trace test statistic tests the null hypothesis that r = q (for q= 0, 1, 2, 3, 4) against the unrestricted alternative that r=5. In contrast, the λ max statistic tests that there are r cointegrating vectors against the specific alternative that r+1 exist. From the Table, it can be observed that there is some ambiguity concerning the number of cointegrating relations depending on which test is used. Both tests, however, reject the hypothesis of no cointegration (i.e. r = 0) at the 90% level. The hypothesis of there being two cointegrating vectors is rejected by the λ max statistic in favour of the alternative that there are three. With the Trace test, the hypothesis of only a single cointegrating vector is *marginally* accepted using normal statistical criteria. In general, however, these results are encouraging insofar as they are broadly consistent with the economic arguments given above that there should be two equilibrium relations among the data, i.e. an equilibrium demand relation (4.1) and a stationary supply side ratio (4.2) of house prices to construction costs. To provide further evidence on the number of cointegrating relationships between the variables in the model, the roots of the "companion matrix" were also examined. Since three of

[49] These test are discussed in more detail in Hansen and Juselius (1995).

the roots lie on or very close to the unit circle, this provides further evidence in support of the hypothesis of two (= 5 - 3) cointegrating vectors. Lastly, a graphical analysis of each of the vectors also supported the hypothesis of a rank of two.

Before proceeding directly to a structural analysis of the two long-run cointegrating vectors, it is important to test the time series properties of the individual variables within the multivariate framework and conditional on the chosen rank.[50] These tests are reported in Table 4.3 below. Under the null hypothesis, the particular variable under consideration is stationary. From the Table, it is clear that the null is rejected at the 95% level in all cases. However, the hypotheis is *strongly* rejected for house prices, the housing stock, real income and the building costs index. In the case of interest rates the results also favour non-stationarity although the evidence is less convincing. This is not at all surprising because there are strong economic reasons why the interest rate will exhibit mean reversion. Given the test value, however, it would appear that there is sufficient non-stationarity in the interest rate process such that it cannot - on its own - account for one of the stationary relations in the data. The Table also reports a test, again conditional on the chosen rank of two, for the exclusion of each of the variables from the cointegration space. Consistent with the view that the model is well-specified - insofar as it is comprised of relevant variables - these tests support the inclusion of all variables in the model.

Table 4.3: Testing for Stationarity and Exclusion of Variables conditional on r = 2

	95% Critical Value	P_H	H_Q	**Y**	**R**	**BC**
Stationarity	7.81	26.64*	27.67*	26.21*	8.68*	26.56*
Exclusion	5.99	7.10*	30.05*	9.86*	22.78*	6.53*

* H_o rejected at the 5 level

[50] One reason for this is that if one of the variables is stationary, then it accounts for one of the cointegrating vectors.

4.3 Identifying Long-run Relationships

Having determined the number of cointegrating relationships in the model it is important to consider whether these relationships are unique and, consequently, whether they tell us anything at all about the underlying long-run economic structure in the housing market.[51] Therefore it is necessary to impose restrictions - motivated by economic arguments - in order to "identify" the two cointegrating vectors. The economic assumptions underlying the relations in equations (4.1) and (4.2) can provide the necessary restrictions in order to identify unique cointegrating vectors. These over-identifying restrictions (on each of the cointegrating relationships) are tested below against an exactly identified model (EIM) using the likelihood ratio test described in Johansen and Juselius (1994).[52] The maximum likelihood estimates for the long-run parameters in the exactly identified model are reported in the first row of Table 4.4 where the two cointegrating vectors are denoted by $b_1 = (\beta_{11}, \beta_{12}, \beta_{13}, \beta_{14}, \beta_{15})$ and $b_2 = (\beta_{21}\ \beta_{22}, \beta_{23}, \beta_{24}, \beta_{25})$. In the EIM, the first vector (which is intended as the demand relation) is normalised on the housing stock variable and excludes the composite index of house building costs which should (in theory) only appear on the supply side of the model. The second vector (which is intended as the stationary ratio consistent with normal profits) is normalised on P_H and excludes the housing stock variable.

Over-identifying restrictions, suggested by economic theory, are tested under the hypotheses H_1 to H_6 in Table 4.4.[53] The first interesting hypothesis which is tested (H_1) is that (i) the first vector is an equilibrium demand relation capturing the desired

[51] The reduced rank estimation only determines *how many* unique cointegrating vectors span the cointegrating space. Since any linear combination of a stationary vector is also a stationary vector, the long-run parameter estimates given by the collumns of the matrix β are not necessarily unique. This is the identification problem discussed in Johansen and Juselius (1994).

[52] The exactly identified model includes one arbitrary normalisation plus one other restriction on each of the cointegrating relations. It does not impose any restriction on the maximized likelihood function. In general, exact identification of β requires at least r restrictions for each of the r cointegrating relations.

[53] It is important to note that the hypotheses reported in the Table represent only a subset of all the interesting economic hypotheses that were actually tested. For example, the original analysis attempted to first identify the stationary supply relation leaving the second vector unrestricted. Subsequently, the analysis tested for a demand side relation leaving the other vector unrestricted. The results of these tests strongly supported the conclusion (drawn below) that both of these relations are stationary.

Table 4.4: Long-run Hypothesis Tests: Z = {P_H, H_Q, Y, R, BC}

Test		**Restricted** b						
		P_H	**H_Q**	**Y**	**R**	**BC**	**LR Statistic**	**P-Value**
EIM	b_1	-1.265	1	0.393	0.054	0		
	b_2	1	0	-0.519	-0.0324	-0.132	n.a.	n.a.
H_1	b_1	-0.366	1	-0.115	0.084	0		
	b_2	1	0	0	-0.754	-1.584	$\chi2(1)=1.40$	0.24
H_2	b_1	0.839	1	-1	0.061	0		
	b_2	1	0	0	-0.128	-0.562	$\chi2(2)=4.62$	0.10
H_3	b_1	1	1	-1	0.086	0		
	b_2	1	0	0	-0.176	-0.655	$\chi2(3)=4.66$	0.20
H_4	b_1	1	1	-1	0.084	0		
	b_2	1	0	0	-0.340	-1	$\chi2(4)=5.65$	0.23
H_5	b_1	1	1	-1	0	0		
	b_2	1	0	0	-0.155	-1	$\chi2(5)=13.01$	0.02
H_6	b_1	1	1	-1	-0.074	0		
	b_2	1	0	0	0	-1	$\chi2(5)=18.45$	0.00

stock of housing given the level of house prices, real income and interest rates and (ii) the second vector is a stationary relationship between house prices and costs (R and BC). As can be seen from the Table, the very low test statistic of 1.40 indicates that this restriction is strongly accepted by the data with a probability value of 0.24. The estimated vector (β_1) exhibits a positive and negative sensitivity of housing demand to income and interest rates respectively. The implied elasticity of housing demand with respect to house prices is, however, positive and not consistent with demand behaviour in a well behaved market (recall Table 3.1). In the second vector (β_2), the signs on the cost variables are consistent with those suggested by the economic theory of the supply side, i.e. positive elasticities of house prices with respect to both the composite cost index and interest rates.

The second hypothesis in the Table (H_2) extends H_1 by imposing the further restriction of a unitary coefficient on the income variable in the demand relation. Again this

restriction is acceptable to the data under normal statistical criteria. This restriction implies that, if we take the level of interest rates and the price of housing as predetermined (i.e. completely fixed) then increases in income give rise to equiproportional increases in the desired stock of housing. Interestingly, having imposed this restriction, the first vector takes the form of a downward sloping demand schedule with housing demand responding negatively to an increase in the price of housing. The imposition of a unit coefficient in the demand relation gives rise to an estimate of 0.839 for the long-run price elasticity of housing demand. While one would expect a negative response of housing demand to increases in house prices *ceteris paribus*, it is perhaps surprising to find that the estimated parameter is so close to unity.[54] The hypothesis that the long-run price elasticity of demand is unity is tested under H_3. This further restriction imposes very little additional constraint on the maximised likelihood function and it is, therefore, not rejected (P-Value = 0.20). Since now both P_H and Y enter the cointegrating relationship with equal but opposite signs, this restriction implies that if the economy experiences a 10% rise in real incomes then house prices must also rise by 10% if a given level of the housing stock is to be willingly held (assuming constant interest rates).[55]

The estimated coefficients under the two cointegrating vectors associated with the above over-identifying restrictions (under H_3) are - in general - very satisfactory. It is interesting to observe that as the demand side of the market is gradually identified, the estimated coefficeints on the supply-side ratio conform more closely to those that would be expected on economic grounds, i.e. the long-run elasticity of house prices with respect to construction cost is 0.655. The fourth hypothesis in Table 4.4 imposes the homogeneity restriction that any change in the composite cost index is fully reflected in equilibrium house prices. This restriction, together with the above restrictions on the demand relation, imposes four testable restriction on the model and once again it is not rejected by the data (P-Value 0.23). As implied by economic

[54] Since, for most people, a house is a "necessary" good with very few long-run substitutes, one might expect that the long-run price elasticity of demand would be smaller.
[55] An earlier study by Thom (1983) had estimated the equilibrium elasticity of real house prices with respect to income at 1.63.

theory, it suggests that building firms fully pass on any increase in costs to house purchasers in order to preserve profit margins.[56]

The two cointegrating vectors associated with H_4 above are accepted by the data and appear to have a very rich economic interpretation as (i) a well-behaved housing demand function increasing in income and decreasing in both interest rates and house prices and (ii) a stationary ratio of house prices to suppliers costs consistent with "normal profits". These are given by (4.7) below (standard errors on the interest rate coefficients are in parentheses):

$$\mathbf{b_1Z_t}\mathbf{:}\ \ H_Q + P_H - Y + \underset{(0.023)}{0.084}R$$

$$\mathbf{b_2Z_t}\mathbf{:}\ \ P_H - BC - \underset{(-0.059)}{0.340}R \qquad (4.7)$$

From a monetary policy perspective, the appearance of the interest rate in *both* cointegrating vectors (but with opposite signs) is of particular interest. As can be recalled from section 3, interest rate changes can effect house prices via both the demand and supply sides of the market. Since the interest rate variable is not logged, the estimated coefficients can be interpreted as semi-elasticities which give the percentage change in housing demand or house prices for a given *absolute* change in interest rates. As a first interpretation, the negative elasticity implied by the coefficient on interest rates in $\beta_1 Z_t$ can be interpreted as capturing the depressing effects of higher interest rates on house prices (due to their depressing effects on housing demand). On the other hand, the positive elasticity implied by the interest rate coefficient in $\beta_2 Z_t$ may be capturing the positive effects of higher interest rates on equilibrium house prices due to their contractionary effects on supply or, alternatively, as a cost-push factor for the average firm in the house building sector.

While the above interpretation of the interest rate semi-elasticities is reasonably intuitive, it should be recalled that an average of the *nominal* interest rate on mortgages is used as the interest rate variable in the model. Hence, variation in R can

[56] Given the extreme non-traded character of housing (discussed in section 3), this form of mark-up pricing is exactly what would be expected in the housing market over the long-run.

be decomposed into a component due to changing inflation expectations and a component due to variation in the real interest rate. If the real interest rate is assumed constant, the negative elasticity in $\beta_1 Z_t$ may also reflect the depressing effect of inflation (on housing demand) due to repayment tilt.[57] Conversely, the positive response of house prices to interest rates which is implied by $\beta_2 Z_t$ may also capture the effects of inflation risk premia in asset markets generally. Under this view, assets which are perceived as providing a good hedge against inflation can become more valuable during periods of high inflation uncertainty (high interest rates).[58] Since the housing market is generally perceived to provide a good hedge against future inflation, some of the positive correlation between nominal interest rates and real house prices implied in the second cointegrating vector might also be explained by increased demand for housing as a hedging instrument.

Unfortunately, it is beyond the scope of this study to provide a clear decomposition of the interest rates coefficients into the real and inflation-induced effects discussed above. However, it is possible to test the significance of the interest rate terms on both the demand and supply side of the market. The last two rows of Table 4.4 report the results from tests to exclude the interest rate variable from either of the two cointegrating vectors. From the Table, it is clear that the interest rate term cannot be excluded from either of the long-run vectors. This is consistent with the low standard errors on the interest rate coefficients in (4.7) and it would seem to confirm the strong impact of interest rates on *both* the demand and the supply sides of the market. As a result, the analysis would seem to suggest that the net long-run effect of a rise in nominal interest rates is ambiguous because it depends on which of the two effects (demand or supply side) dominates.[59] Based on the relative size of the long-run interest rate elasticities in (4.7), the long-run upward pressure exerted on house prices following an increase in interest rates (due to diminished supply, higher interest costs

[57] This is discussed in Thom (1983). Repayment tilt refers to the front-loading of the real burden of repaying mortgage debt which occurs in an inflationary environment.
[58] In general equilibrium assets which have low inflation risk (or provide a good hedge) should offer lower yields while assets with high inflation risk , e.g. long-term bonds, should offer higher returns. For a recent study examining this issue see Corkish and Miles (1994).
[59] The ambiguous effects of interest rates changes is also debated in the macroeconomics literature. Allen and Nixon (1997), for example, point out that while a policy of raising short-term interest rates will reduce aggregate demand it also has negative implications for supply.

or higher demand for housing as an inflation hedge) would appear to outweigh the downward pressure on house prices due to lower housing demand.

In conclusion, the above modelling of the long-run vectors suggests that the most economically meaningful relationships are given by the estimated parameters under hypothesis four (H_4) and given by the relationships in (4.7). These *restricted* cointegrating vectors are graphed in Charts 4.1 and 4.2 below. Both vectors appear reasonably stationary although there is some evidence of a moderate downward trend in the first vector. However, the evidence of a downward trend would appear to be driven solely by the post 1994 expansion. When the vector is considered prior to this date, it exhibits a remarkable degree of mean reversion. The graph suggests that there have been three periods (1975-1978, 1987-1989, 1994-1997) during which the stock of housing appears to have been below its desired level, i.e. that level which was consistent with the prevailing level of house prices, income and interest rates.[60] The most recent period of macroeconomic growth, since about 1994 is of particular interest. From the graph, it can be seen that since 1994 high levels of income coupled with historically low levels of mortgage interest rates have pushed the vector well below its equilibrium level. For the economy to return to equilibrium either the housing stock or house prices (or both) must rise significantly (assuming interest rates and income constant). Accordingly, based on this characterisation of equilibrium, unless the current stock of dwellings expands significantly one should continue to expect further increases in house prices in order to ensure that the existing stock is willingly held.[61]

Looking next at the stationary supply ratio ($\beta_2 Z_t$), there would appear to have been three main periods during which house prices were above their equilibrium given the level of construction costs and interest rates. These correspond to the current period 1994-1997, 1988-1989 and 1977-78. The most recent period - since about 1994 - is of particular interest and it can be seen that house prices are at a historical high relative

[60] During these three periods of excess demand the price of housing increased significantly relative to the price of other goods and services (recall Chart 2.1).
[61] Since the first quarter of 1997 (the last observation point in the sample period used in the estimation) house prices have risen further. This would have the effect of restoring the demand vector back toward equilibrium.

Chart 4.1: b_2Z_t **:** $H_Q + P_H - Y + 0.084R$

Chart 4.2: $b_2Z_t = P_H - BC - 0.340R$

to the cost base of the average construction firm. During periods such as these one would expect that housing supply would adjust upwards in order to restore the economy back to equilibrium. Alternatively house prices could decline or building costs such as land prices could rise. The next section of the paper examines the empirical evidence concerning the nature and speed of these adjustment processes. Finally, it is important to stress that the existence of a cointegrating relationship between house prices and costs, while consistent with the concept of "normal profits" in the long-run, does not rule out the possibility of a speculative bubble in Irish house prices. In particular, this relationship could still exhibit stationarity if there was a bubble component in *both* house prices and the price of certain cost items (such as land). Furthermore, even if costs such as land prices did not contain a bubble component, the presence of cointegration could not be used to rule out speculative behaviour in property prices because (as discussed in Hall et al, 1997) periodically collapsing bubbles can appear to unit root and cointegration tests as stationary processes.

4.4 Adjustment

The analysis thus far has established the existence of two unique cointegrating relationships which on the surface suggest that the housing market conforms reasonably well with the basic relationships predicted by economic theory. The characterisation of the long-run or equilibrium relations in the data is, however, not sufficient if the analysis is to be of some use in helping to guide policy.[62] It is therefore important that the cointegration analysis be accompanied by some estimate of the speed of adjustment with which the housing market returns to its equilibrium level. Arguably, impulse response analysis of the cointegrated system is the most appropriate manner in which to assess the dynamic interaction among all the variables in the system and the resulting speed with which equilibrium is restored. This approach is adopted in section 4.5 below. However, a first step in assessing the

[62] In this regard, Pesaran and Shin (1996) cite Keynes' view that " . . .*In the long run* we are all dead. Economists set themselves too easy, too useless a task if in tempestuous seasons they can only tell us that when the storm is past the ocean is flat again." The current housing market boom is perhaps one such "tempestous season".

adjustment issue is to examine the matrix of coefficients (α) in the VECM. These are reproduced in Table 4.5, for a parsimonious representation of the data where the system is reduced by removing insignificant regressors from each equation. In addition, the system was estimated conditional on both income and the interest rate as exogenous variables.[63] This gives rise to a three equation system in which the endogenous response of house prices, the stock of dwelling and construction costs can be examined. Looking first at the equation for house prices, the demand vector enters with a significant negative sign. It can be concluded therefore that house prices do adjust in order to ensure the existing stock of dwellings is willingly held. When the stock of dwellings is above equilibrium given the level of income, interest rates and real house prices, i.e. when there is an excess supply of housing, house prices have a tendency to fall. Conversely when income is high relative to the other variables in $\beta_1 Z_t$, i.e. when there is excess demand for housing, house prices have a tendency to

Table 4.5: Adjustment Coefficients in the Parsimonious VAR (PVAR) Representation

Dependant Variable	Adjustment Coefficient $b_1 Z_t$ (t-statistic in brackets)	Adjustment Coefficient $b_2 Z_t$ (t-statistic in brackets)	Long-run Cointegrating Vectors
D P_H	-0.055	-	
	(-3.28)		$\beta_1 Z_t = H_Q + P_H - Y + 0.084R$
D H_Q	0.006	0.002	
	(4.23)	(4.61)	$\beta_2 Z_t = P_H - BC - 0.340R$
D **BC**	-	0.007	
		(2.080)	

Diagnostics

Vector AR 1: F(9,163) = 0.974[0.46]

Vector Normality: $\chi^2(6)$ = 45.48[0.00]

Vector AR 1 - 4 : F(36,172) = 1.26 [0.16]

[63] The hypothesis that income was exogenous was supported by the data. While the hypothesis of interest rate exogeneity was rejected by the data, there are good economic reasons why the dynamics of the interest rate process should not be modelled within this system. The system reduction was undertaken using full information maximum likelihood estimation in PCFIML.

rise.[64] While the adjustment coefficient is significantly different from zero, it is smaller than expected and implies that only 5.7% of any deviation from equilibrium is corrected each quarter. One possible explanation for this low coefficient is that there are non-linearities in the relationship between excess demand and price adjustment as suggested in Hendry (1984) and numerous other studies. Other possible explanation for this reasonably slow adjustment is the high level of aggregation used in the study and also inefficiencies due to information asymmetries between buyers and sellers in the housing market.[65] Given the absence of the second cointegrating relationship from the equation for house prices, it can be concluded that house prices do not adjust downwards (significantly) when they are above their equilibrium with the cost base of the average construction firm. This is perhaps a further indication of potential inefficiencies in the market.

From the Table it can also be seen that the second cointegrating vector enters the housing stock equation with a positive sign. Such a finding accords well with the economic prediction that the stock of housing should adjust upward in order to restore the normal level of profits to the average construction firm, i.e. $\alpha > 0$ in (4.1). However, the speed of adjustment while significantly different from zero is extremely slow with only 0.2% of any deviation being corrected each quarter. This finding is consistent with the widespread belief that there are binding constraints operating on the supply side of the housing market. The finding that the first vector enters the housing stock equation with a positive sign is somewhat troublesome. While this result may simply represent a statistical anomaly (or possible misspecification due to omitted variables), it is highly counter-intuitive. It suggest, for example, that when the housing market is in a state of excess supply, the housing stock does not tend to adjust downward in order to correct this deviation. Conversely, excess demand, as

[64] If the first vector was normalised on income, the adjustment coefficient would enter the equation for house prices with a positive sign.
[65] Of course the full dyanamic interaction of the variables in the system could result in faster adjustment. The impulse response analysis in section 4.5 investigates this issue more closely.

proxied by excessive levels of income relative to equilibrium, puts downward pressure on the housing stock.[66]

Table 4.5 also reports the adjustment coefficients on the error correction terms in the equation for building costs. It can be seen that costs adjust upwards in order to restore the equilibrium ratio of real house prices to construction costs which is consistent with a "normal" level of profits. This cost-push pricing behaviour is not at all surprising given the extreme non-traded nature of housing goods and the sluggish supply adjustment noted above. Once again, however, the adjustment coefficient is quite small suggesting that only 0.7% of any deviation is corrected within each quarter. Finally, the regression diagnostics show that the PVAR passes standard multivariate tests for both first and higher order residual autocorrelation. However, the hypothesis of normality of the residuals continues to be rejected. This is a troubling result but one which is common in empirical studies. It may reflect the exclusion of a relevant variable. Alternatively, the lack of normality may result from the inability of a *linear* error correction model to explain large movements in real house prices. A useful extention of this model would therefore be the consideration of non-linearities in the adjustment process.

4.5 Impulse Response Analysis

The above analysis of the adjustment coefficients in the parsimonious VAR provides interesting insights into the nature and speed of adjustment following a disturbance which pushes the system away from equilibrium. However, given the endogeneity of some of the variables in the system and the fact that there exists two equilibrium relationships in the data, a simple analysis of the adjustment coefficients can provide only a partial account of this process. Recently, Pesaran and Shin (1996) have proposed the analysis of the *persistence profile* for each of the cointegrating vectors

[66] It is important to stress that these effects are partial and, hence, and they do not necessarily imply that the system as a whole adjusts in this manner. A full appreciation of the dynamics of the system is more easily obtained from the impulse response analysis below.

following a system wide shock.[67] This provides a useful estimate of the speed with which the economy or market under consideration returns to equilibrium once shocked.[68] Formally, the persistence profile (H_Z) for the *ith* cointegrating vector is defined as the difference between the conditional variance of the n step and n-1 step ahead forecasts, i.e.

$$H_Z(n) = V(\beta_i Z_{t+n} \mid I_{t-1}) - V(\beta_i Z_{t+n-1} \mid I_{t-1}) \qquad \text{for } n = 0, 1, 2, \ldots \tag{4.8}$$

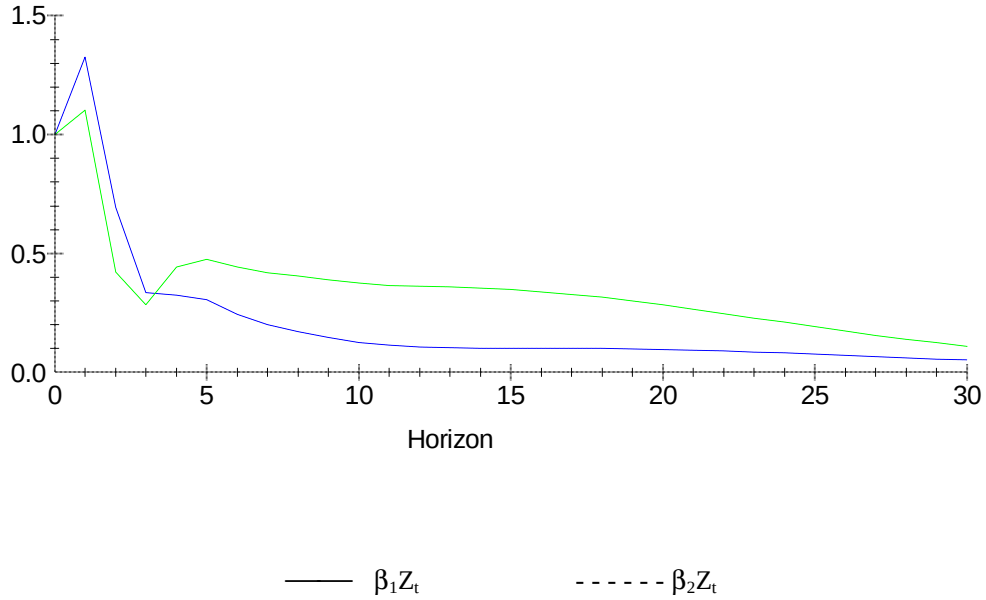
where I_{t-1} is the information set up to time t-1 and $V(\beta_i Z_{t+n} \mid I_{t-1})$ is the conditional variance of $\beta_i Z_{t+n}$ based on this information set.[69] When the above profile is scaled, i.e. normalised by dividing by $H_Z(0)$, it will take a value of unity at impact or n = 0. In the case where $\beta_i Z_{t+n}$ represents a cointegrating relationship, the effect of a system-wide shock should eventually disappear as the market returns to its long-run equilibrium (as "n" increases). Conversely, in the case of relationships among I(1) variables that are not cointegrated, the effects of a system-wide shock will tend to persists forever. Using this reasoning, Peseran and Shin (1996) argue that a graphical analysis of the above profile provides further visual evidence about the stationarity of the economic relations identified above together with an estimate of the number of periods before equilibrium is restored.

[67] By focussing on the impact of a system-wide rather than variable-specific shocks, Pesaran and Shin (1996) attempt to overcome the non-uniqueness problem associated with orthogonalised impulse responses. Such system-wide shocks can be interpreted as the response of the equilibrium relations to shocks drawn from the multivariate distribution of the errors.

[68] As pointed out in Pesaran and Shin (1996), where there are two or more equilibria one must consider the possibility that the market under consideration could get shocked away from one equilibrium and onto the other.

[69] Since $V(X_{t+n} \mid I_{t-1}) = V\{[X_{t+n} - E(X_{t+n} \mid I_{t-1})] \mid I_{t-1}\}$, equation (4.8) can be viewed as the change in the variance of forecasting $\beta_i Z_{t+n}$ as compared with that of forecasting $\beta_i Z_{t+n-1}$ given the information available at time t-1.

Chart 4.3: Persistence Profiles for the Restricted Cointegrating Vectors



The persistence profiles for the two restricted cointegrating vector are graphed in Chart 4.3. From the graph, it is clear that both profiles gradually taper off toward zero as the forecast horizon is extended. Hence, this provides further evidence that two stationary relations have been identified. Interestingly, both profiles overshoot in the sense that immediately following the shock both vectors initially rise, i.e. move away from equilibrium, and then fall. These dynamics are far from surprising in the housing market with asset like adjustment processes. However, in both cases, close to 70% of the correction has been completed after only three quarters. In the case of the first vector (the demand relationship), the profile shows a good deal of persistence. After about three quarters it actually rises again before declining steadily toward equilibrium (zero). The adjustment process for the second vector, which captures the level of house prices consistent with "normal profits", is more rapid. After 10 quarters over 90% of the disequilibrium has been corrected.

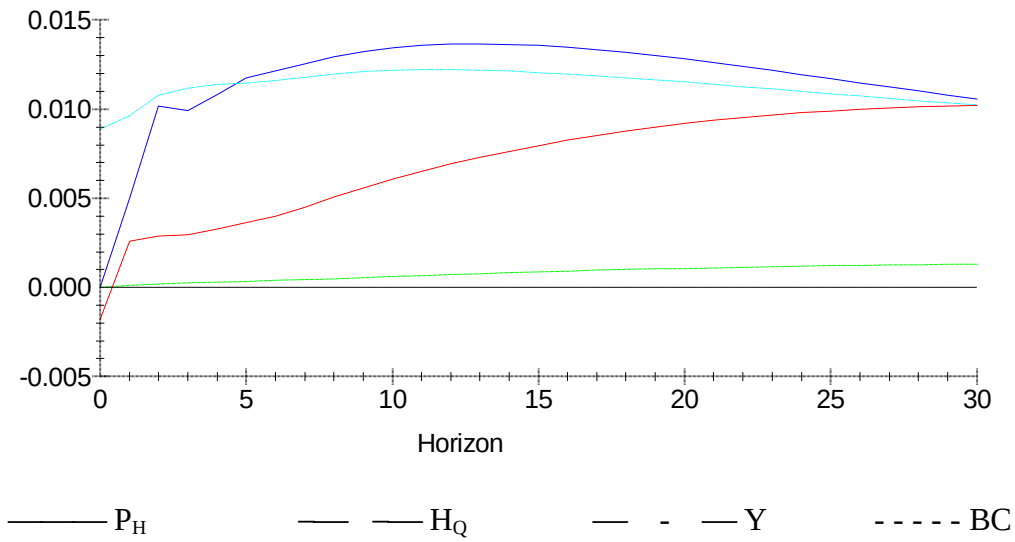
It is also possible to examine the impulse responses of the individual variables within the cointegrated VAR to a variable-specific shock. In light of the prominence given to income in this model, it is particularly interesting to examine the response of house

prices, construction costs and the housing stock following a shock to the level of real income. These responses are graphed in Chart 4.4.[70] From the Chart, it can be noted that, consistent with the non-stationarity of the variables in the model, shocks to individual variables do not die out but have permanent effects. While these shocks are in general not unique, and hence they cannot be given a strong causal interpretation, it is interesting to observe how closely the responses accord with economic intuition. In particular, the graph depicts a strong response of house prices following a positive shock to income. Only two quarters after the original shock real house prices have risen almost proportionately. In the presence of sluggish supply adjustment, this swift price adjustment represents an efficient response which has the effect of choking off any excess demand in the housing market. However, the shock to income also induces a rise in house prices relative to the cost base of the average construction firm. This opens up an enhanced scope for earning profits in the house building sector. Not surprisingly, therefore, the stock of housing adjusts upwards but only sluggishly (recall the adjustment coefficients in the equation for ΔH_Q in Table 4.5) in response to this enhanced scope for profitable activity.[71] Finally it can be seen from the graph that it takes approximately 30 quarters before the equilibrium ratio of house prices to costs is restored. Equilibrium house prices and construction costs have responded proportionately (approximately) to the long-term increase in income. The long-term response of the housing stock is of the order of 1/10th of the proportionate increase in the long-term level of income, again supporting the previous evidence of large scale constraints on the supply side of the market.

[70] The shocks are orthogonalised using a standard Choleski decomposition of the covariance matrix of errors. For the purpose of this decomposition, the order of the variables in the VAR was P_H, H_Q, Y, R, BC. The response of the variables in Chart 4.4. were found to be insensitive to changes in this ordering (suggesting that the covariance matrix of errors is a diagonal matrix).

[71] Consistent with this sluggish stock adjustment, real house prices are observed to overshoot their long-run equilibrium level.

Chart 4.4: Impulse Responses Following a Shock to Income



4.6 An Analysis with Consumption

As has already been discussed, an increasingly popular view in both theoretical and empirical discussions of the housing market is that there is an inherent link between real consumption and variation in housing wealth. Since a large component of variation in aggregate housing wealth is due to variation in real house prices, this thesis can be investigated using the framework developed in the previous section by simply including real personal consumption as an additional variable in the above system. Hence, as an extension to the previous analysis it is interesting to consider the six variable system below:

$$Z = \{P_H, H_Q, Y, C, R, BC\}$$

where C is real personal consumption (logged) and all other variables are as defined above. Using this vector of variables, it is possible to test for feedback from any disequilibrium in the housing market onto aggregate consumption. Importantly however, since all variables in the Johansen procedure are (at least initially) treated as endogenous, the estimation of this system also allows for the possibility that real

income may have been a common source of increase in both house prices and consumption.

Table 4.6 below reports the maximum eigenvalue and Trace test statistics for the six variable system which includes consumption.[72] As is well known, the inclusion of an additional I(1) variable opens up the possibility of a third cointegrating relationship among the variables. Economic arguments would also suggest three long-run relationships: the two cointegrating vectors analysed above together with a third relationship between consumption and income and (possibly) interest rates. As can be seen from the Table, the rank tests provide strong support for the hypothesis of cointegration although there is some ambiguity concerning the number of cointegrating relationships depending on which test and which critical values are used. At the 90% level, the Trace test indicates a rank of three. In contrast the maximum eigenvalue test marginally favours a rank of four. Since a rank of three is consistent with both the economic and statistical arguments presented above, the analysis below proceeds under the assumption that there are three stationary relationships among the six variables being considered in the VAR.

Table 4.6: *l* max and Trace Tests

H_o: r	Eigenvalue	*l* max	Critical Value		Trace	Critical Value	
			90%	95%		90%	95%
0	0.4897	57.85*	24.63	39.4	144.16*	89.37	94.2
1	0.3430	36.13*	20.90	33.5	86.31*	64.74	68.5
2	0.2427	23.91*	17.15	27.1	50.18 *	43.84	47.2
3	0.1884	17.95*	13.39	21.0	26.27	26.70	29.7
4	0.0785	7.04	10.60	14.1	8.32	13.31	15.4
5	0.0149	1.29	2.71	3.8	1.29	2.71	3.8

* H_o rejected at the 10% level

The next step in the analysis is to attempt to identify unique long-run relationships consistent with economic theory. As in the previous analysis, this is performed by testing over-identifying restrictions against an exactly identified model which imposes one arbitrary normalisation plus two other restrictions on each of the long-run

[72] A lag length of three was consistent with no autocorrelation in the residuals.

relationships. The estimated long-run parameters on the exactly identified model are reported in the top row of Table 4.7. The first hypothesis (H_1) tests whether the first two vectors are consistent with those previously identified in section 4.3 above. As can be seen from the Table this hypothesis is easily accepted by the data with a very high probability value and the estimated long-run coefficients are very similar to those estimated previously.

Table 4.7: Long-run Hypothesis Tests: Z = {P_H, H_Q, Y, C, R, BC}

Test		**Restricted** b							
		P_H	**H_Q**	**Y**	**C**	**R**	**BC**	**LR Statistic**	**P-Value**
EIM	β_1	-0.836	1	0.247	0	0.078	0		
	β_2	1	-2.335	0	0	-0.091	0.233	n.a.	n.a.
	β_3	-0.110	0	-0.889	1	-0.017	0		
H_1	β_1	1	1	-1	0	0.064	0		
	β_2	1	0	0	0	-0.296	-1	$\chi2(4)=4.70$	0.32
	β_3	0.105	0	-0.984	1	-0.009	0		
H_2	β_1	1	1	-1	0	0.063	0		
	β_2	1	0	0	0	-0.295	-1	$\chi2(5)=4.71$	0.45
	β_3	0	0	-0.917	1	-0.009	0		
H_3	β_1	1	1	-1	0	0.068	0		
	β_2	1	0	0	0	-0.292	-1	$\chi2(6)=5.58$	0.47
	β_3	0	0	-0.884	1	0	0		
H_4	β_1	1	1	-1	0	0.201	0		
	β_2	1	0	0	0	-0.454	-1	$\chi2(7)=16.24$	0.02
	β_3	0	0	-1	1	0	0		

The next step in the analysis is to attempt to identify the economic content of the third cointegrating vector. This is undertaken in the series of hypotheses denoted H_2 to H_4. Under H_2, the additional restriction that house prices are excluded from the third cointegrating vector is strongly accepted by the data. The estimated relationship, normalised on consumption, has the interpretation of a long-run consumption function increasing in income. Surprisingly, the long-run coefficient on the level of the interest

rate is negative (implying a positive semi-elasticity) but it is very close to zero. The hypothesis that the interest rate coefficient is zero is tested and accepted under H_3. The final hypothesis (H_4) tests the restriction that the long-run income elasticity of consumption is unity.[73] This hypothesis is, however, rejected by the data at the 5% level. It would seem, therefore, that the analysis should proceed on the basis of the long-run structure identified under H_3. The third restricted vector under H_3 is graphed in Chart 4.5 below.[74] The vector appears reasonably stationary over the sample period. It suggest that there have been two main periods, the mid to late 1970s and the mid to late 1980s, during which consumption has been high relative to equilibrium income. Interestingly, both of these periods correspond to movements in house prices above their equilibrium with costs (recall Chart 4.1). Over the more recent period,

Chart 4.5 : The Third Restricted Cointegrating Vector

$b_3\mathbf{Z_t}$ **= C - 0.884*Y**

[73] The hypothesis of a unit long-run elasticity of consumption with respect to income was employed in the previous study of Irish consumption by Frain, Howlett and Maguire (1995). This assumption is consistent with the concept of "balanced growth" and also with the permanent income theory of consumption (see Surrey, 1989).

[74] The graphs of the first and second restricted vectors are very similar to those given previously in Charts 4.1 and 4.2.

consumption would appear to be somewhat below its equilibrium level. This constitutes *prima facie* evidence against the contention that the current housing boom is associated with a boom in consumption.

To examine this issue more closely, however, it is necessary to consider the adjustment coefficients in the parsimonious VAR. These are given in Table 4.8 below.[75] From the table, it can be seen that the adjustment coefficients in the equations for ΔP_H, ΔH_Q and ΔBC are almost the same as those in the previous analysis of the five variable system given above. Commentary will therefore be confined to the equations for aggregate income and consumption.

Table 4.8: Adjustment Coefficients in the Parsimonious VAR (PVAR) Representation

	Adjustment Coefficients			
	$\beta_1 Z_t$ (t-statistic in brackets)	$\beta_2 Z_t$ (t-statistic in brackets)	$\beta_3 Z_t$ (t-statistic in brackets)	Long-run cointegrating vectors
ΔP_H	-0.073	-	-	
	(-3.64)			$\beta_1 Z_t = H_Q + P_H - Y + 0.068R$
ΔH_Q	0.008	0.003	-0.014	
	(5.43)	(6.09)	(-3.35)	
ΔY	-0.023	-	0.041	$\beta_2 Z_t = P_H - BC - 0.292R$
	(-4.08)		(1.19)	
ΔC	-	0.015	-0.282	
		(3.92)	(-4.79)	$\beta_3 Z_t = C - 0.884Y$
ΔBC	-	0.008	-	
		(2.10)		

Diagnostics

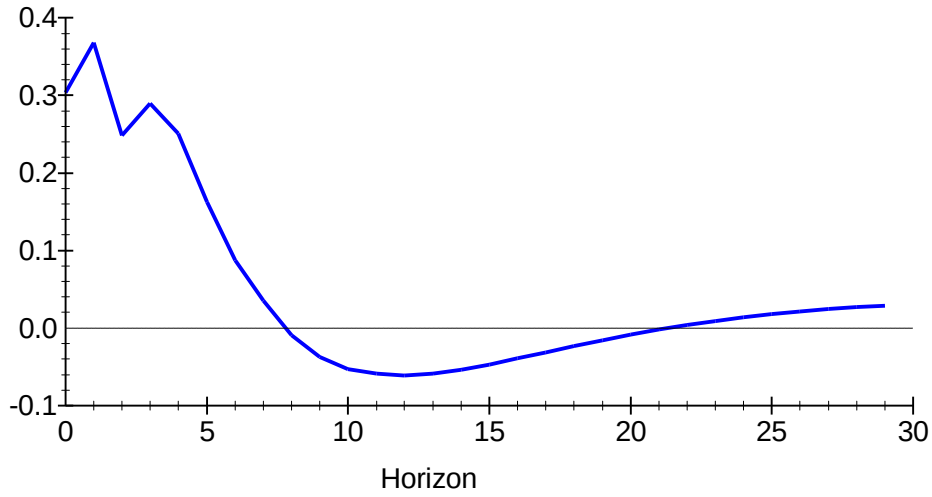
Vector AR 1: F(25,231) = 0.756[0.79] Vector Normality: $\chi^2(10)$ = 53.24[0.00]

Vector AR 1 - 4 : F(100,233) = 0.924 [0.66]

[75] The system has again been estimated conditional on exogenous interest rates. In the system with consumption, the hypothesis that income was exogenous was rejected by the data and therefore an equation for the change in income is included in the system.

In the equation for aggregate consumption, the third cointegrating vector enters with a negative sign indicating that whenever consumption is high (low) relative to the level of income it adjusts down (up). At 0.229, the coefficient suggest that consumption adjusts rapidly to correct any disequilibrium following a change in income levels.[76] In the equation for aggregate income it can also be seen that income adjusts in the expected direction in order to restore the equilibrium ratio of consumption to income. The estimated adjustment coefficient is, however, not significant at the 10% level. This supports the macroeconomic view that income is reasonably exogenous with respect to consumption. Finally, it can also be seen that the second cointegrating vector enters the consumption equation with a positive sign. This suggest that disequilibrium in the housing market, as proxied by the ratio of house prices to construction costs, can feed through positively into the growth rate of real consumption. The first cointegrating vector, which also measures the extent of the disequilibrium in the housing market, does not, however, have any appreciable effect on the rate of growth of real consumption.

Chart 4.6: Response of Third Cointegrating Vector (House Price Shock)

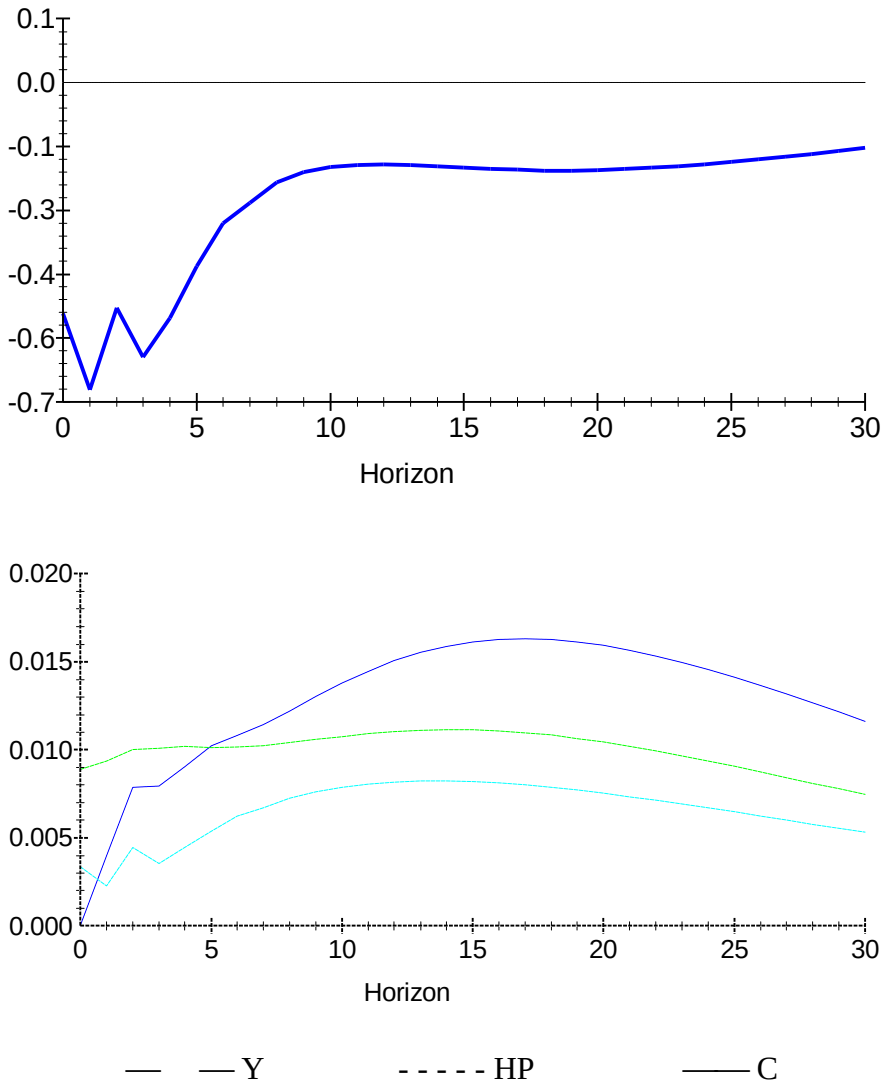


[76] This is confirmed by an examination of the persistence profile for the third (restricted) cointegrating vector which shows that close to 90% of any deviation from equilibrium is corrected after about three quarters.

The above finding that the second cointegrating vector enters the equation for real consumption with a positive sign is somewhat supportive of the hypothesis that disequilibria in the housing market can give rise to movements in consumption above its equilibrium level relative to income. An alternative approach to assessing this proposition is to examine the impulse response of the third cointegrating vector following a positive shock in house prices. This is graphed in Chart 4.6. From the graph, it can be seen that the shock to the equation for house prices results in a rise in consumption relative to equilibrium, i.e. an immediate positive response in the third cointegrating vector. This positive effect persists for close to seven quarters and the vector actually overshoots its long-run equilibrium level before settling down close to zero. This finding is once again supportive of the hypothesis of feedback from real house prices onto real consumption.

It is, however, important to point out that it is sharp increases in real income coupled with sluggish housing stock adjustment that can explain movements in house prices relative to equilibrium (recall Chart 4.4). Perhaps a more interesting hypothesis is to examine the effects of an income shock on the third cointegrating vector. This response is depicted in the upper panel of Chart 4.7. The immediate effect of the positive income shock is to give rise to a fall in consumption relative to equilibrium, i.e. the cointegrating relation drops below its pre-shock level of zero. Gradually over time consumption responds positively to the increased level of income and the cointegrating relation tends back toward zero. At no time, however, does consumption actually overshoot its new equilibrium given the higher level of income. This is confirmed in the lower panel of the chart which plots the response of income, house prices and consumption following the same shock to income. While both consumption and house prices rise as a result of the shock, at no time does the level of consumption actually overshoot given the new higher level of income.

Chart 4.7: Response of Third Cointegrating Vector (Income Shock)



In conclusion, the above analysis of the differing effects of various shocks on the third cointegrating vector suggests that the response of consumption depends on the *type* of shock hitting the housing market.[77] In the case of a purely random increase in house prices (a house price shock), there is some evidence in support of the thesis that this gives rise to a positive deviation in consumption above its equilibrium given the level of income. However, in the case of an income shock, while the model gives rise to a positive response in *both* consumption and real house prices, there would appear to be no evidence that consumption rises above or overshoots its new equilibrium level.

[77] This is reminiscent of the results of Miles (1994) who distinguished between the effects of shocks to the level of variables and shocks to their growth rate.

5. Concluding Remarks

In recent years, there have been large-scale movements in the price of housing relative to the price of other goods and services in the Irish economy. This has occurred during a period of almost unprecedented macroeconomic growth. There has, however, been little or no recent empirical analysis of either the macroeconomic effects of house price movements or, conversely, the macroeconomic factors which may lie behind changes in house prices in Ireland. From the perspective of a monetary authority, this is unfortunate because a central bank has a particular interest in the housing market given its mandate to maintain price stability and also its additional responsibilities as supervisor of the financial sector. Therefore, this paper has sought to empirically assess the important linkages which may exist between the housing sector and the macroeconomy. Following a brief introduction, Section 2 examined the relevance of the housing market from a central banking perspective. As a precursor to the empirical work, Section 3 discussed the nature of the housing market from a microeconomic perspective. The empirical analysis, which was undertaken in Section 4, focused on (i) the effects of rising real incomes on house prices, (ii) the impact of monetary policy, i.e. interest rates, on developments in the housing market, (iii) the nature and speed of price adjustment in the housing market, (iv) the nature and speed of supply adjustment in the housing market and (v) potential impacts of rising real house prices on real consumption. Below, the main results and policy implications are reviewed in brief.

A key empirical result in the paper was the identification of two long-run relationships which capture the fundamental economic behaviour on both the demand and supply sides of the housing market. The analysis suggests that in the long-run the demand side of the market can be modelled using a stable relationship between house prices, the housing stock, aggregate income and mortgage interest rates. Normalised on the housing stock, this relationship can be interpreted as a long-run housing demand schedule which gives the desired housing stock consistent with the prevailing level of house prices, real income and interest rates. Using this framework it is possible to test

various hypotheses concerning the long-run impact of changes in income, house prices and interest rates on the demand for housing. It was discovered that an increase in income gives rise to a proportional rise in the demand for housing. In addition, the long-run demand for housing responds negatively and proportionately to increases in the price of housing. Mortgage interest rates were also shown to exert a significant negative effect on the long-run demand for housing.

To model the supply side of the market, the empirical section of the paper tested the data for the existence of a stable ratio of house prices to construction costs (including land costs) which is consistent with "normal profits" in the house building sector. The estimated coefficients suggest that, over the long-run, firms in the construction sector pass on any increase in their cost base to home purchasers in order to maintain profit margins. The analysis also shows a strong positive effect of mortgage interest rates on house prices over the long-run. This is consistent with the view that higher interest rates have a contractionary effect on the supply of dwellings. However, this response may also be explained by the belief that high inflation, or the high inflation uncertainty associated with high interest rates, is "good" for the housing market because economic agents perceive home buying to offer a reasonable hedge against future inflation.

The paper also examined in detail the manner in which house prices, the housing stock and housing costs adjust in order to correct any deviation from the long-run relationships described above. In particular, it was shown that house prices adjust positively in response to any excess demand for housing. The housing stock also adjusted positively in order to ensure the stability of the profit ratio described above. This adjustment, however, was particularly sluggish. This was confirmed by an analysis of the response of the variables in the model following a shock to income. In particular it was found that, over a very long horizon, the stock of housing increased by only 1/10*th* of the proportional increase in the demand for housing following a sudden increase in income. This suggests that there are severe constraints which are

operating on the supply side of the housing market due to, for example, a shortage of available land or problems with the housing services infrastructure (water supply etc.).

Using the two long-run relationships described above, it is possible to assess the extent to which recent changes in house prices have been consistent with housing market equilibrium. On the demand side, it is clear that recent large increases in income, coupled with historically low levels of mortgage interest rates, have given rise to a substantial increase in the desired stock of housing. Because supply adjusts only slowly, this explains the large increase in house prices that has taken place in recent times. However, from a graphical examination of the demand relationship, it would appear that - as of the first quarter of 1997 - the increase in house prices had not been sufficient to "choke-off" this excess demand. For the housing market to return to equilibrium, either house prices had to rise even further or the constraints on the supply side of the market would have to have been relaxed substantially. Since the first quarter of 1997 (the last observation to which the empirical study relates), there has of course been a further significant rise in house prices. Together with the significant pick-up in new house completions, this would have the effect of diminishing the excess demand which the model implies existed at that time.

Based on the above characterisation of housing demand, it would seem possible to explain much of the recent rise in house prices as an efficient relative price change in the presence of very sluggish supply adjustment. In addition, the model suggests that, given the short-run fixity of supply, it is reasonable to expect that house prices will overshoot their equilibrium level and then subsequently decline somewhat. Some degree of price volatility is, therefore, a natural feature of the housing market. However, while such sharp relative price changes may be efficient from a market-clearing perspective, they may not be desirable because they still pose a potential threat to macroeconomic stability. There are, in addition, distributional implications of sharp changes in relative prices. One obvious strategy to counteract the recent sharp increases in the price of housing would be to direct housing market policy in a manner

which actively relaxes the constraints on the supply side of the market. However, it is important to note that there are risks attaching to any policy which gives rise to a large-scale increases in the supply of dwellings in an attempt to hold prices down. In particular, since the study has illustrated the extreme sensitivity of housing demand to developments in the macroeconomy, any significant macroeconomic downturn would be immediately reflected in terms of reduced housing demand. Were this to occur just as large numbers of new housing completions were arriving on the market, the possibility of a significant decline in house prices could not be ruled out.

The paper also sought to analyse possible interactions between disequilibrium in the housing market and consumer behaviour. In particular, the analysis attempted to assess the effects of increases in housing wealth on real personal consumption. While a complete examination of this issue would best be undertaken in a fully specified model of consumer behaviour, a preliminary assessment was made by including real consumption as an additional variable in the analysis. This resulted in the identification of a third equilibrium relationship which captures the long-term dependence of consumption on income levels. Using this relationship, it was shown that consumption reacts strongly in order to correct any deviation from equilibrium given the level of income. However, the analysis also suggested that deviations in house prices above their equilibrium tended to be associated with positive deviations in consumption relative to income. This was confirmed using impulse response analysis where it was shown that a shock to house prices gave rise to a significant expansion in consumption relative to income levels. Finally, however, when the source of the disequilibrium was a shock to income, this did not tend to be associated with a disproportionately high level of consumption.

In conclusion, it is important to point out the limitations of the above analysis and possible ways in which it could be usefully extended. One significant shortcoming relates to the neglect of the role of bank lending in the housing market. Financial institutions, as well as the authorities entrusted with their supervision, should be

particularly interested in whether or not lending policies, or financial liberalisation in general, have had any role in determining the behaviour of house prices over time. This could, however, be investigated within the same framework developed in this paper. Furthermore, while the study would appear to have achieved a large measure of success in modelling the long-run interaction between the housing market and the key macroeconomic variables of interest, some of the results pertaining to the short-run adjustment processes deserve a more complete analysis. In particular, it would be interesting to extend the above analysis using the framework suggested in Hendry (1984) by testing for possible non-linearities or asymmetries in the response of house prices to excess demand or supply. Lastly, while the study has provided insights into the self-equilibriating mechanisms which appear to exist in the housing market, it has not directly addressed or tested for the existence of a speculative bubble in Irish property prices. Since the economic consequences of purely speculative movements in house prices are likely to differ from those of warranted increases, this would also constitute a valuable area of enquiry.

Data Appendix

House Prices:

Computed as a weighted average of the country-wide average price of new and second-hand homes deflated by the consumer price index. The weights used in the calculation are based on loan approvals. The weight attaching to new house prices is calculated as the number of loan approvals on new houses divided by the total number of loans approved in a period. The weight attaching to second hand house prices is calculated as one minus the weight on new house prices. The weights are fixed over the four quarters of each year but are allowed to vary annually. Source: Housing Statistics Bulletin, Department of the Environment.

Consumption: Real personal consumption of goods and services. An annual series for personal consumption was taken from the National Accounts. This series was then interpolated to a quarterly series using retail sales as an indicator. In carrying out the interpolation, the procedure suggested in Chow and Lin (1971) was employed.

Income: Real Gross National Product (GNP) taken from the National Income and Expenditure accounts. The series was again interpolated using quarterly industrial production as an indicator in the Chow-Lin procedure.

Interest Rates:

A representative rate which applies to mortgage loans from building societies. Source: CSO

Housing Stock:

A measure of the housing stock was computed using data on housing completions published by the Department of the Environment. The measure was calculated using the perpetual inventory methodology assuming a constant annual rate of housing depletion of ¾% per annum. A base estimate of the number of households was taken from the Census of Population.

Composite Index of Costs:

Calculated by weighting together the House Building Cost Index (HBCI)published by the Department of the Environment and an index of the price of developmental land per housing unit. The price index for land was constructed by multiplying the annual estimates of the share of land costs (S_L) in house prices (produced by the Department of the environment) by the estimated house price series discussed above. In weighting the two indices, since the HBCI is estimated to account for no more than 65% of total costs, it received a weight of $W_1 = 0.65/(0.65+S_L)$. The land cost index received a weight of $(1-W_1)$.

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