

# House Prices, Inflation and the Mortgage Market

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*Abstract:* This paper presents an analysis of house prices using quarterly Irish data over the period 1971-1980. Evidence is provided to support the hypotheses that real house prices are significantly influenced by the cost and availability of mortgage credit, the design of the mortgage instrument and the tax advantage of owner-occupation. Special attention is given to the role played by inflation which, when acting in concert with the tax and mortgage systems, affects the demand for housing services and real house prices.

## I INTRODUCTION

This paper presents an analysis of real house prices in Ireland with special reference to the role played by inflation, the tax system and the type of mortgage instrument used to finance house purchase. Evidence from other countries, principally the US and UK, suggests that the traditional homogeneity assumption normally imputed to consumer demand functions may not be valid in the case of housing. (See, for example, Buckley and Ermish (1982), Follain (1982) and Kearl (1979).) This assumption implies that anticipated inflation is neutral with respect to consumption so that an inflation which leaves relative prices and real incomes unchanged has no effect on consumption decisions.

\*This paper was supported by a grant from the Committee for Social Science Research in Ireland for which the author expresses his gratitude. Thanks are also due to Mark Wynne and Lore Hayes for assistance with data collection and to two anonymous referees for comments on earlier drafts. The usual disclaimer applies.

In the case of housing at least three arguments have been advanced to show that when nominal interest rates rise with inflation, institutional aspects of the tax system and the mortgage market may combine to invalidate the neutrality postulate. First, under the present tax system mortgage interest payments are deductible against tax but the capital gains and imputed income from owner-occupation are tax free. If interest rates respond to inflation then granting tax relief on interest payments together with exemption for capital gains may alter the real after-tax cost of housing capital and, consequently, the demand for housing services, even if inflation is anticipated and relative prices are constant.

Second, inflation may also affect housing demand via its impact on the type of mortgage instrument used in house purchase. The majority of mortgages are of the variable interest-rate type which, at a given interest rate, fixes the nominal value of gross repayments over the life of the mortgage. When the interest rate rises, monthly repayments also rise but in a disproportionate manner. For example, consider a 25 year mortgage of £10,000. With zero inflation and a nominal interest rate of 3 per cent annual repayments would equal £574. At a 2 per cent inflation rate and a 5 per cent nominal interest rate annual repayments would increase by 24 per cent to £709. Hence, even if inflation is correctly anticipated and nominal incomes are adjusted accordingly, the real cost of a mortgage as perceived by the owner-occupier may rise significantly.

Third, even though inflation may increase the real value of initial repayments, a rise in anticipated inflation also implies a faster decline in the real value of future repayments with the consequence that the real burden of the mortgage falls more rapidly. This effect arises because the conventional mortgage fixes repayments in nominal terms and the rate of decline in their real value is greater the higher the rate of inflation.

The analysis also attempts to account for the influence of mortgage availability on house prices. Institutional lenders, principally building societies, tend to change their interest rates relatively infrequently with the consequence that the differential between capital and mortgage market rates may vary especially when the former are rising. Failure to offer "competitive" rates to depositors may lead to a decline in mortgage supply and the use of non-price rationing by lenders, with the consequence that house buyers may be constrained with respect to mortgage availability.<sup>1</sup>

Section II of the paper details the manner in which inflation, the tax system and the mortgage instrument may affect housing demand. Section III develops a model to explain the rate of change of real house prices and

1. A competitive market is taken to be one in which the mortgage rate adjusts to equate aggregate mortgage demand and supply.

presents estimates using quarterly Irish data over the period 1971(3) to 1980(4). The paper concludes that inflation when acting in concert with the tax system and the standard mortgage has significant implications for housing demand and for real house prices.

## II INFLATION AND HOUSING DEMAND

Recent research on the housing market has suggested that inflation may have three distinct effects on the demand for housing services. First, given that mortgage interest is tax deductible while capital gains are not, inflation reduces the after-tax user cost of housing capital and therefore stimulates housing demand. Second, via its impact on the real value of initial repayments, inflation may increase the real cost of capital as perceived by owner-occupiers and consequently reduces desired consumption of housing services. Third, as the nominal interest rate rises with inflation the real value of the stream of repayments necessary to amortise a mortgage declines more rapidly and increases housing demand.

### (i) *The User Cost of Housing*

In a world of anticipated inflation the user cost per unit of housing capital may, for purposes of exposition, be represented by

$$UC = (1 - x)(r + ai) - hp, \quad (1)$$

where UC is the cost of a unit of the owner occupied housing stock,  $x$  is the household's marginal tax rate,  $r$  is the real rate of interest,  $ai$  is anticipated inflation and  $hp$  is the anticipated rate of change of house prices. If inflation is correctly anticipated and relative prices are constant ( $ai = hp$ ) then, given a constant real rate of interest, the effect of a rise in  $ai$  on UC is  $dUC/dai = -x < 0$ . That is, a rise in anticipated inflation reduces the user cost by the extent of the household's marginal tax rate. If the real rate of interest is not independent of anticipated inflation the effect of a change in  $ai$  on user cost (assuming  $ai = hp$ ) is  $dUC/dai = (1 - x)dr/dai - x$ , where  $dr/dai$  approximates the extent to which the real rate declines (nominal rate does not rise) with an increase in anticipated inflation.<sup>2</sup>

### (ii) *The Mortgage Instrument*

A relationship such as (1) may not fully describe the cost of capital as perceived by owner-occupiers. This possibility arises because of the type of mortgage instrument typically used to finance house purchase. Under the

2. Define the nominal rate as  $i = r + ai$  so that  $UC = (1 - x)i - hp$ . Then  $dUC/dai = (1 - x)di/dai - 1$ . If, for example,  $di/dai = 0$  then  $dUC/dai = -1$ .

standard mortgage instrument the annual repayment of capital and interest per pound borrowed ( $Q$ ) is given by

$$Q = MR/[1 - (1 + MR)^{-N}], \quad (2)$$

where  $MR$  is the nominal mortgage rate and  $N$  is the amortisation period of the initial principal. To illustrate, consider a household with a base year income (year 0) of £10,000 which wishes to contract a mortgage equal to twice its expected year 1 income. If we assume that all nominal variables rise in line with inflation and that the real rate of interest is 3 per cent then a 5 per cent inflation rate would imply a year 1 income of £10,500, a mortgage of £21,000 and a mortgage rate of 8 per cent. In this case annual gross repayments would be £1,967 or 18.73 per cent of year 1 income. Alternatively, an inflation rate of 10 per cent would give repayments of £3,001 or 27.28 per cent of year 1 income. The real value of initial repayments would, therefore, rise by 46 per cent from £1,873 at 5 per cent inflation to £2,728 at 10 per cent inflation even though the real rate of interest is constant.

The third effect mentioned above arises because inflation, while not affecting the real cost of the mortgage when computed over the amortisation period, alters the profile of the real repayment stream. That is, for any given mortgage the present value of the real repayment stream necessary for full amortisation is the same when discounted at a constant real rate of interest irrespective of the nominal rate applied. Rather, the effect of inflation is to "tilt" the stream of real repayments so that their value declines more rapidly the greater is anticipated inflation at any given real rate of interest. The reason for this tilt is that the mortgage instrument requires the borrower to compensate the lender today for inflation which is expected to occur in the future or, as Kearl suggests, "... the expectation of inflation does not cause the household's real financial position to deteriorate, yet it has increased the burden of debt service since it is only in the *future* that inflation may deliver higher nominal incomes with which to make the *current* (and future) inflation-induced higher payments" (1979, pp. 1,115-1,116).

Kearl approximates this tilting effect by the elasticity of the present value of a given stream of payments with respect to the discount rate  $d = 1/(1 + MR)$ . The present value (PV) of the repayments stream is

$$PV_t = \sum_1^N REP_t \cdot d^t, \quad (3)$$

where  $REP$  is the annual gross repayment and  $t$  is time. The elasticity of  $PV$  with respect to  $d$  is

$$T = \frac{\sum_1^N t \cdot d^t}{\sum_1^N d^t}. \quad (4)$$

To explain the relevance of  $T$ , it is useful to view an individual's mortgage demand as a decision to allocate part of his gross income to mortgage repayments. The present value of "desired" repayments must then equal "desired" mortgage size, when discounted at the current mortgage rate, and the higher the interest rate the lower the affordable mortgage given a prior decision on  $REP$ .  $T$  is therefore equivalent to the elasticity of mortgage demand with respect to the discount rate. A relatively large value for  $T$  implies that a rise in the mortgage rate will induce a relatively large decline in mortgage size to offset the impact of a high interest rate on  $REP$ . Hence, given a positive relationship between housing demand and mortgage size we would, *ceteris paribus*, expect a negative relationship between  $T$  and the demand for housing services.

However, whereas  $Q$  is positively related to the mortgage rate,  $T$  declines as  $MR$  rises. It follows that a rise in  $MR$  produces conflicting effects on the "perceived" cost of housing. First, by increasing initial repayments ( $Q$ ) housing demand is depressed. Second, a rise in  $MR$  reduces  $T$  and consequently stimulates housing demand. In other words, at a given real rate of interest, a rise in anticipated inflation which is reflected in nominal interest rates intensifies the real burden of current repayments but leads to a more rapid decline in future repayments relative to income.

### III A MODEL OF HOUSE PRICES

The model developed in this section assumes that the rate of change of real house prices is positively related to the excess demand for housing services, i.e.,

$$\frac{(PH/P)_t}{(PH/P)_{t-1}} = (Hsd_t/Hs_{t-1})^R \quad k > 0, \quad (5)$$

where  $PH$  is the price of houses,  $P$  is a generalised price index,  $Hs$  is the flow of housing services and  $Hsd$  is the demand for housing services. Kearl (1979) and Buckley (1982), along with others, assume that  $Hs$  is proportional to the physical stock of owner-occupied housing and, given that net additions are small relative to the stock, the service flow can be taken as fixed at each point in time. Although this idea is maintained in the present paper, it is modified to account for the further assumption that owner-occupiers are concerned with the market valuation of the quantity of services yielded by the physical stock. If  $q$  is the physical quantity of services derived from a given stock, then  $q \cdot PH/P$  is assumed to be a measure of the real value of, or real expenditure on, the given flow so that  $Hs$  is related to the real value of the housing stock  $RHK = HK \cdot PH/P$ , where  $HK$  is the physical stock. Assuming that the physical demand is unit elastic with respect to  $PH/P$ , then  $Hsd$  can be inter-

puted as desired real expenditure on housing services.<sup>3</sup> If the demand for housing services is determined by some vector of exogenous variables  $Z$ , then (5) gives the following equilibrium relationship for real house prices:

$$\text{Ln}(\text{PH}/\text{P})_t = \text{Ln}[D(Z)] - \text{LnHK}_t. \quad (6)$$

The demand for housing services is modelled as

$$\text{Hsd} = D(\text{UC}, \text{RQ}, \text{T}, \text{A}, \text{Y}, \text{DF}), \quad (7)$$

where UC and T are defined as above, RQ (= Q/P) is the real value of gross repayments per unit of principal borrowed, A is a measure of mortgage availability, Y is real income and DF represents demographic factors. The user cost per unit of housing capital is approximated by

$$\text{UC} = \text{MR}(1 - x)(1 - V) + \text{AR}(1 - x)V - \text{SUB} - \text{DPH}, \quad (8)$$

where V is equity in housing, AR is the representative interest rate on non-housing assets, SUB represents subsidies to owner-occupiers and DPH is the rate of change of PH. The variables V and SUB are measured as a proportion of house value. The first term in (8) measures the after-tax cost of mortgage finance while the second approximates the opportunity cost of holding wealth in housing equity. The methods used to approximate x, SUB and the other variables are described in the appendix.<sup>4</sup> If, for simplicity, MR and AR are assumed to be equal, then UC is independent of V, and hence

$$\text{UC} = \text{MR}(1 - x) - \text{SUB} - \text{DPH}. \quad (9)$$

Mortgage availability is included in (7) on the hypothesis that lending institutions frequently allow their interest rate structure to get out of line with capital market rates with the consequence that funds available for lending may fall below the level which would be offered in a more "competitive" market structure.<sup>5</sup> When faced with an excess demand for mortgages, institutions resort to non-price rationing as a means of allocating available supply. This type of behaviour may mean that borrowers can obtain relatively cheap finance but they may not get all they desire so that their housing

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3. Partial support for this assumption may be found in Kenneally and McCarthy (1982). Unfortunately the comparison is not completely valid as these authors use HK as the dependent variable in their demand function.

4. The cost of capital proxy is deficient in at least two respects. First, no account is taken of property taxes (rates). However, it should be noted that rates remission was available on new houses for most of the sample period and rates were abolished in 1977. Second, the expected rate of change of PH is proxied by the actual rate. This assumption is made for computational simplicity. However, in the regression results reported below, UC is measured as a four quarter moving average. See equation (11).

5. Assuming that mortgage supply is a positive function of MR. For evidence of this see Hewitt and Thom (1979) and O'Loughlin (1980).

decisions may be constrained by mortgage availability. The measure of mortgage availability (A) is proxied by  $DSK_t / .25 \sum_1^4 DSK_{t-i}$ , where DSK is the growth rate of the real stock (deflated by PH) of building society share and deposit liabilities. DSK is used on the assumption that mortgage lending is closely related to the flow of savings through institutions. The specification therefore assumes that mortgage rationing will be intensified (relaxed) if the current growth of shares and deposits falls (rises) relative to the growth rate over the previous four quarters. Alternative proxies such as the average loan to value ratio and total mortgage approvals were also tested but the specifications proved "inferior" on the usual statistical criterion.<sup>6</sup> As Irish data do not include an official series on real disposable income, the index of industrial production in transportable goods industries was used as a proxy. This variable gave better results than other proxies such as an earnings index. DF was proxied by the ratio of marriages to private sector completions. Once again the paucity of official data necessitated such a proxy. Finally, the real price of housing was measured by the ratio of the average price of new houses, for which mortgages were approved by the main lending institutions, to the consumer price index. In order to control for quality changes, the nominal price of houses was deflated by the average floor area (in square metres) of houses for which planning permission has been granted. As there is an obvious delay between granting planning permission and completion, the deflator was lagged by six quarters.<sup>7</sup> Assuming a log-linear specification for (7) and substituting into (5) gives

$$\begin{aligned} \Delta \text{Ln}(\text{PH}/\text{P})_t = & ka_0 + ka_1 \text{UC}_t + ka_2 \text{LnRQ}_t + ka_3 \text{LnT}_t + ka_4 \text{LnA}_t + \\ & ka_5 \text{LnY}_t + ka_6 \text{LnDF}_t - k \text{LnRHK}_{t-1} + u_t, \end{aligned} \quad (10)$$

where  $\Delta$  is the first difference operator and  $u$  is a random disturbance term with constant variance and  $E(u) = 0$ . The expected signs of the coefficients in (10) are,  $a_1, a_2, a_3 < 0$  and  $a_4, a_5, a_6, k > 0$ .

As user cost is measured as a percentage rate the specification of (10) permits a variable elasticity of housing demand with respect to UC. To allow for the possibility that the impact on housing demand of changes in the determining variables may be spread over several periods a four quarter

6. The growth of deposits at thrift institutions has been used as an availability proxy in several housing sector studies. See Jaffee and Rosen (1979).

7. It would be more satisfactory to use a house price series which reflected existing, as well as new, house prices. A sufficiently long quarterly series on second-hand house prices is, unfortunately, not available.

Koyck lag structure was imposed on the RHS variables of (7)<sup>8</sup>. This lag is given by

$$\sum_0^3 b_i \text{Ln}X_{t-i} \quad (11)$$

where  $b_0 = .2$ ,  $b_1 = .3$ ,  $b_2 = .3$ ,  $b_3 = .2$  and X represents each of the right hand variables in (7). Estimating (10) by OLS over 1971(3) to 1980(4) gave the following result:

$$\begin{aligned} \Delta \text{Ln}(\text{PH}/\text{P})_t = & 2.676 - 2.37\text{UC}_t - .841\text{LnRQ}_t - 1.09\text{LnT}_t + .662\text{LnA}_t \\ & (2.99) \quad (6.30) \quad (7.66) \quad (5.75) \quad (2.00) \\ & + 1.604\text{LnY}_t + .262\text{LnDF}_t - .953\text{LnRHK}_{t-1} + \text{SEASONALS} \\ & (5.99) \quad (2.37) \quad (8.16) \end{aligned} \quad (12)$$

$R = .768$   $\text{DW} = 2.049$   $\text{SEE} = .037$  (t-statistics are in parentheses),

which yields the following equilibrium relationship for real house prices

$$\begin{aligned} \text{Ln}(\text{PH}/\text{P})_t = & 2.807 - 2.486\text{UC}_t - .882\text{LnRQ}_t - 1.143\text{LnT}_t + \\ & .694\text{LnA}_t + 1.683\text{LnY}_t + .274\text{LnDF}_t - \text{LnRHK}_t. \end{aligned} \quad (13)$$

Of the seven estimated coefficients in (12) five are significant at the 1 per cent level and the other two (on LnA and LnDF) are significant at the 5 per cent level. The value of the Durbin-Watson statistic together with a critical level<sup>9</sup> of .834 for the Box-Pierce Q-statistic suggests that serial correlation is not a problem, while the estimated coefficient of determination is reasonable given that the dependent variable is first differenced.

The results confirm that both user cost and the distortions due to initial payments (RQ) and tilting (T) are, along with mortgage availability, significant determinants of real house prices and housing demand. The estimate for  $k = .953$  implies that the real value of the service flow adjusts rapidly to demand pressure. For example, a 1 per cent rise in Y means that the equilibrium level of the real price must increase by 1.683 per cent for the given stock to be willingly held, i.e., the real value of the service flow must increase by this amount to restore equality between Hsd and Hs. Allowing for the imposed Koyck lag PH/P rises by .3208 per cent in the current quarter and the full adjustment is completed within two years.

The positive sign of the income elasticity indicates that housing is a normal

8. Alternatively the moving average terms may be regarded as proxing the expected values of the RHS variables in (7). The model then combines the partial adjustment mechanism (5) and adaptive expectations (11) with the distributed lags imposed rather than being subjected to a Koyck transformation.

9. The critical level is the significance level at which the null hypothesis of no serial correlation is just rejected.



Table 1: *Interest rate elasticities*

<i>MR</i>	<i>Q</i>	<i>T</i>	$E_Q$	$E_T$	$E_{PH/P}$	% <i>Ch.</i>
(1)	(2)	(3)	(4)	(5)	(6)	(7)
.04	.0640	10.9930	.44	-.17	-.246	-6.150
.06	.0782	10.0720	.59	-.25	-.316	-5.267
.08	.0936	9.2250	.70	-.33	-.352	-4.400
.10	.1101	8.4580	.79	-.41	-.371	-3.710
.12	.1275	7.7708	.84	-.47	-.379	-3.158
.14	.1454	7.1610	.89	-.52	-.397	-2.835
.16	.1640	6.6230	.92	-.57	-.399	-2.493

good. Its statistical significance is in contrast with the result reported by Kenneally and McCarthy (1982) who also use a different proxy.

Assuming a constant real rate of interest the impact of inflation on house prices can be approximated by the elasticity of PH/P with respect to the mortgage rate. From (13)

$$E_{PH/P} = a_1 MR(1 - x) + a_2 E_Q + a_3 E_T, \quad (14)$$

where  $E_{PH/P}$ ,  $E_Q$ ,  $E_T$  are the elasticities of PH/P, Q and T with respect to MR. Table 1 presents estimates of these elasticities for different values of MR assuming a marginal tax rate of 35 per cent. Columns (2) and (3) give estimates of Q and T while Columns (4) and (5) give the corresponding elasticities. Column (6) gives  $E_{PH/P}$  and Column (7) shows the percentage change in real price associated with a 1 per cent change in MR, i.e., from .04 to .05. Although the absolute value of  $E_{PH/P}$  increases with MR it does so at a diminishing rate. Hence, the impact of a 1 per cent rise in the mortgage rate, Column (7), diminishes as MR rises. This phenomenon is caused by the influence of the tilting effect as proxied by T. As MR rises the effect on Q along with increased user cost reduces both housing demand and real price. However, as the current level of repayments rise with Q, the real value of the future stream declines more rapidly as indicated by the increasing absolute value of the interest elasticity of T. The impact of higher current nominal, and real, repayments is therefore moderated by the stimulus to demand through an expected decline in the real value of the fixed repayment.

## IV CONCLUSIONS

An important implication of the results reported in Section III is that the standard mortgage which fixes annual payments in nominal terms has a distorting effect on housing demand during inflationary periods. Even if the user cost of capital is unaffected by inflation the demand for housing may still be influenced by the manner in which inflation affects the household's perception of housing costs. From the owner-occupier's point of view the most important inflation-induced distortion is likely to be the effect on initial or current repayments. That is, a rise in nominal interest rates will increase the real value of repayments even if inflation is fully anticipated. This phenomenon is sometimes referred to as front-end loading, which means that when the mortgage rate rises, the nominal value of the repayment rises relative to income, even when inflation is fully anticipated and real incomes are constant. The results, therefore, lend support to the introduction of alternative mortgage instruments such as the real value mortgage, discussed by Whitley (1975), which fixes repayments in real rather than in nominal terms. Indexing nominal repayments not only eliminates the front-end loading problem but also the tilting effect of the fixed nominal payment system.

Further, given that mortgage supply is an increasing function of the mortgage interest rate, the significance of the availability proxy suggests that a more competitive market structure might benefit potential entrants such as newly-married couples. Increased competition might, of course, lead to higher mortgage interest rates but the consequent financing problems can be dealt with by offering alternative mortgage repayment systems. The real advantage is to be found in increased mortgage availability for those who are willing to pay the competitive price. Increased availability would not necessarily lead to permanently higher prices as the real price/availability relationship is a consequence of a non-competitive market structure.

As the model assumes that both the housing stock and net additions to it are given, the results must be treated with some caution. A more comprehensive model would attempt to explain starts, completions and the supply of mortgage finance in addition to real house prices. However, it is reassuring to note that the significance of inflation-induced distortions reflect the results reported by Kearl (1979) and Follain (1982) for the USA, and by Buckley and Ermish (1982) for the UK.

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## DATA APPENDIX

- A Mortgage availability proxied by  $DSK_t / .25 \sum_1^4 DSK_{t-i}$ .
- COMP Private sector completions. (QBHS)
- DF Ratio of marriages to COMP. (ISB)
- HK Owner-occupied housing stock. Computed by using the 1971 census figure and COMP assuming an annual depreciation rate of 2 per cent.
- MR Mortgage rate. (CB)
- P CPI, 1975 = 100. (ISB)
- PH Average price of new houses for which mortgage loans were approved by the main lending agencies deflated by  $FA_{t-6}$ ; where  $FA$  = average floor area of houses for which planning permission has been granted. (QBHS and ISB)
- SK Stock of building society share and deposit liabilities deflated by PH. (CB)
- SUB Subsidies to owner-occupiers. Total value of grants and mortgage subsidies divided by the number of grants and subsidies allocated. Department of the Environment *Annual Report*.
- Y Index of production in transportable goods industries, 1975 = 100. (ISB)

- x Marginal tax rate estimated as follows: the QBHS gives the income of borrowers classified by income class. The income of the "average" borrower was computed by  $y = w_1.M_1 + \dots + w_n.M_n$ , where  $w_i$  = the proportion of borrowers in income class  $i$  and  $M_i$  = the mid-point class  $i$ . As the top and bottom classes are open-ended the mid-points were assumed to be  $L_i \pm £500$ ,  $L_i \pm$  = the class limit. Given this estimate of  $y$ ,  $x$  was computed as the MTR applicable to a childless married couple using the tax bands and rates in successive Budgets.

CB *Central Bank Quarterly Bulletin*

ISB *Irish Statistical Bulletin*

QBHS *Quarterly Bulletin of Housing Statistics*