ISSN 0265-8003

BOOMS AND BUSTS IN THE UK HOUSING MARKET

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Discussion Paper No. 1615
March 1997

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ABSTRACT

Booms and Busts in the UK Housing Market*

The often volatile behaviour of UK house prices between 1957 and 1994 is analysed in an annual econometric model. Theory suggests that financial liberalization of mortgage markets in the 1980s should have led to notable shifts in house price behaviour. The evidence supports the predictions of theory, suggesting shifts took place in wealth effects, as in the consumption function, and that real interest rates and income expectations became more important. The presence of transactions costs suggests important non-linearities in house price dynamics. The paper also contains an explicit econometric treatment of expectations, demography, supply spillovers from the rented sector and of composition biases in the official house price index.

JEL Classification: G14, R21
Keywords: econometrics of house prices, financial liberalization, asset market inefficiency, asset price volatility

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*This paper is produced as part of a CEPR research programme on *Finance in Europe: Markets, Instruments and Institutions*, supported by a grant from the Commission of the European Communities under its Human Capital and Mobility Programme (no. ERBCHRXCT940653). The authors are grateful for comments on earlier versions to the referees and to Janine Aron, Andy Chesher, Nick Coote, Mike Dicks, Steve Martin, Geoff Meen, Penelope Rowlatt, Neil Shephard and seminar participants at Bristol, Dublin, NERA and Oxford. David Hendry is due special thanks for unfailing help over the years this research has been in gestation. Responsibility for errors, however, lies with the authors. Gavin Cameron and Rebecca Emerson provided skilled research support. This research was financed in part by ESRC programme grants R000 23 1184 and R000 23 4954.

Submitted 13 January 1997

NON-TECHNICAL SUMMARY

In the last 40 years there have been two major booms in the UK owner-occupied housing market: in the early-1970s and in the late-1980s. There were also smaller booms in the 1960s and, more briefly, in the late-1970s, while the 1990s has seen bust on an unprecedented scale, at least for the United Kingdom. In this paper we examine the causes of these booms and busts with a new econometric model for the prices of second-hand UK houses in the period 1957–94.

It is now recognized that the increases in housing wealth which took place in the 1980s contributed significantly to the consumer boom of that decade. Indeed, that none of the major econometric models of the United Kingdom incorporated housing wealth in their consumption functions at that time was a major reason for the failure to forecast consumer expenditure, which led to costly errors in macroeconomic policy. The major econometric models of the UK economy do now incorporate housing wealth alongside financial wealth in their consumption functions. This makes it all the more important to have an econometric model which increases understanding of the determinants of house prices and of the effects of various policies on house prices – fiscal, monetary or supply-side.

This paper derives an equation for real house prices as an inverted housing-demand function. The theory of housing demand is examined in an intertemporal context which takes into account expectations, credit constraints, lumpy transaction costs and uncertainty. The theory predicts several shifts in parameters as a result of the financial liberalization of the 1980s. One of these concerns shifts in wealth effects which we have already analysed in work on UK consumer spending at a national and regional level. The empirical evidence supports similar shifts in the housing demand function. Furthermore, the theory predicts an increased role for income-growth expectations and real interest rates in the 1980s. This is strongly borne out by the empirical evidence.

The presence of lumpy transaction costs is shown to result in important non-linearities or threshold effects in the aggregate demand for housing. This arises from the extensive margin of housing demand: the greater the appreciation of house prices (actual and prospective), the more households are pulled over the transaction cost hurdle to engage in trade. At these times of heightened activity or 'frenzy', sharply increased demand feeds back into higher prices and, as in 1971–3, 1978–9 and 1986–9, substantial increases in

house prices then occur. These spikes in the data can be successfully modelled with a non-linearity in the predicted rate of return. Indeed Hendry's (1984) specification of a cubic (though applied by him to last-quarter's capital appreciation) is shown to provide an excellent empirical approximation to the non-linearity. Without such a non-linearity or dummies for the spikes in the data, the equation standard error more than doubles. We also find evidence that sharp falls in the rate of return make households more cautious about entering the housing market.

Our treatment of expectations in the paper takes care to make reasonable assumptions about the information which agents are likely to have, and permits both forward-looking and extrapolative elements in behaviour. The strong evidence that both house prices and relative rates of return in housing are forecastable is consistent with the hypothesis that housing markets are far from efficient. Indeed, our evidence is for an important extrapolative element, as well as a rational element, in the formation of rate-of-return expectations. Similarly, for income expectations, the results support findings in the consumption context, that forward-looking expectations are important, but that many households appear to feel constrained by current income.

Relative to previous work, there are a number of other innovations in the paper including the treatment of composition biases in the house price index and the incorporation of an index of demographic change. This rises with an increase in the shares of the population in the key house buying age groups. Another significant improvement is to allow the supply, both of owner-occupied and of rented property, to play a role.

According to our model, many factors conspired to produce the house price boom of the late-1980s. Initial debt levels were low as were real house prices, giving scope for rises in both. Income growth after the early 1980s recession was strong, as were income-growth expectations and these became more important as a result of financial liberalization, though partly offset by bigger real interest rate effects. Wealth to income ratios grew and the spendability of illiquid assets was enhanced by financial liberalization. Financial liberalization also permitted higher gearing levels. Demographic trends were favourable with stronger population growth in the key house buying age group. The supply of houses grew more slowly, with construction of social housing falling to a small fraction of its level in the 1970s. Finally, in 1987–8 interest rates fell and the proposed abolition of property taxes in favour of the poll tax gave a further impetus to valuations.

The bust in the 1990s was the result of the reversal of most of these factors. Interest rates rose from 1988–90. Income growth and growth expectations weakened. Demographic trends reversed. The revolt against the poll tax resulted in a new property tax, the council tax, being reintroduced. Debt levels and real house prices had reached very high levels, while wealth to income ratios then fell and recently experienced rates of return became negative and made households more cautious. Mortgage lenders tightened up their lending criteria, in a *partial* reversal of financial liberalization. Under these conditions, and while real interest rates remained high, not even the major falls in nominal interest rates that took place in the 1990s were sufficient to revive UK house prices. Our results suggest an important lagged endogenous and indeed non-linear element in behaviour which implies a potential for volatility. Evidence for such volatility can be found in the years 1989 to 1995, when house price to income ratios (as seen in Chart 1) had gone from the second highest peak in the post-war period to the lowest level since, probably, before the war.

While our model suggests that fundamentally the potential for volatility remains, it also implies that three major dampening forces will contain the next upturn: unfavourable demographic trends, high levels of debt and high real after-tax interest rates. To this one can add the greater awareness by mortgage lenders of default risk and, by the authorities, of the UK housing market as a potential factor in macroeconomic instability. This suggests that policy responses would not be lacking if any signs of overheating were again to develop.

1 Introduction

In the past 40 years, there have been two major booms in the UK's owner-occupied housing market: in the early 1970s and in the late 1980s. There were also smaller booms in the 1960s and, more briefly, in the late 1970s, while the 1990's have seen a bust on an unprecedented scale, at least for the UK. In this paper, we examine the causes of these booms and busts with a new econometric model for the prices of second-hand UK houses. The use of annual data allows us to analyse the period 1957-1994.

It is now recognized that the increases in housing wealth which took place in the 1980s contributed significantly to the consumer boom of the 1980s. Indeed, that none of the major econometric models of the UK incorporated housing wealth in their consumption functions at that time, was a major reason for the failure to forecast consumer expenditure which led to costly errors in macroeconomic policy. The major models of the UK economy do now incorporate housing wealth alongside financial wealth in their consumption functions. This makes it all the more important to have an econometric model which increases our understanding of the determinants of house prices and of the effects on house prices of various policies, fiscal, monetary or supply side.

In the remainder of this Introduction we examine different ways of measuring booms and busts. Section 2 reviews recent work on UK house prices. Section 3 summarizes the theoretical background. Within the framework of intertemporal optimization, this section discusses the implications of mortgage rationing, transactions costs and uncertainty for housing demand and hence for house prices. The specification of our model is described in Section 4 and the empirical results in Section 5. The demand for housing and for other forms of consumer expenditure should be set in the same theoretical framework. Our model shares the same explicit treatment of income expectations and wealth effects used in our work on consumption, Muellbauer and Murphy (1995) and Muellbauer and Lattimore (1995). Here different assets have different spendability weights and these weights shift with financial liberalization. Furthermore, the theory summarized in Section 3 predicts some additional testable parameter shifts in a house price equation resulting from reductions in mortgage rationing. The model contains an explicit treatment of house price expectations, and includes housing market 'frenzy' effects implied by lumpy transactions costs. The model also incorporates the effects of shifts in the age structure of the population, spill-overs from the supply of rented accommodation and an explicit treatment of measurement errors in the Department of the Environment's house price indices associated with shifts in the structure of the mortgage market. Our model thus differs in some major ways from recent work on UK house prices.

There are essentially two ways of characterising booms (and busts) in the housing market. One way is to look at a measure of affordability, of which the simplest is the house price to income ratio. This measure is much referred to by all informed commentators on the housing market. The other, is to look at a measure of the investment returns from housing.

Our measure of the second-hand house price to income ratio, shown in Chart 1, makes some adjustments to the officially recorded house price index, and takes personal disposable non-property income as the income concept. As explained in detail in the Appendix, it incorporates two adjustments to the recorded index. The first is to adjust for an assumed quality improvement of 0.3% per annum.[1] The second is to address sample selection bias: the index is based on data from a sample of Building Society transactions. However, the segment of the market catered to by building societies has altered substantially over the years and we adjust for this. Chart 1 shows both the adjusted and the unadjusted indices relative to income. However, the story Chart 1 tells is broadly similar to that from alternative ways of measuring house prices and income. It is immediately apparent that the 1989 and 1973 peaks were of a similar order of magnitude.

The other key indicator of the state of the housing market is a measure of the rate of return. As Section 3 explains, this is closely related to the 'user cost' concept much discussed in the literature on housing and other durable goods. A dwelling is not only a roof over one's head, but by general reputation, has often been by far the best investment for UK households. In general, the rate of return on net equity equals

$$(\text{capital appreciation} + \text{net imputed rent - interest cost})/\text{net equity}$$

Net imputed rent is the rent saved by being an owner-occupier rather than a tenant, after subtracting the costs of maintaining the fabric of the dwelling and paying property taxes. It is not easy to estimate, given the restricted opportunities for private renting and the rationing of local authority and housing association housing. The interest cost consists of after tax mortgage payments. For someone owning outright, net equity is simply the value of the dwelling. For a borrower, it is the value of the dwelling minus the outstanding loan.

[1] The small size of this adjustment is explained by the fact that the Department of the Environment house price index is mix-adjusted and so captures major features of quality change.

This rate of return should be measured relative to the return from other kinds of investments. The most obvious interest rate here is that on a building society share account, this being the most popular form of liquid saving.

Net equity is the value of the dwelling multiplied by (1- lvr + tc), where lvr is the loan to value ratio and tc is the transactions cost of purchasing a dwelling as a fraction of its value. In recent years tc has been of the order of $2\frac{1}{2}$% to $3\frac{1}{2}$% of the value of an average UK house, according to surveys by the Woolwich Building Society, and $3\frac{1}{2}$-5% for a sale. For a borrower, the rate of return on net equity relative to liquid assets is

$$(\% \text{ capital gain} + \% \text{ net imputed rent} - \text{lvr} \times \text{abmr})/(1-\text{lvr}+\text{tc}) - \text{bsr} \qquad (1)$$

where abmr is the after-tax building society mortgage rate of interest, and bsr is the (after-tax) building society share rate of interest. An allowance for transactions costs of selling is deducted from the capital gain. This formula is easy to understand when one recalls that the mortgage = lvr x value, and net equity = (1 - lvr + tc) x value. For first-time buyers with mortgages, the average loan to value ratios for building societies peaked at around 85% in 1988.[2] Even if one makes an allowance for transactions costs of, say 3%, (1-lvr+tc) = 0.18. Its inverse, a measure of how much returns are geared up by borrowing is 5.56. Roughly speaking, new borrowers were able to achieve a rate of return in housing relative to saving in a building society account, five and one half times as large as owner-occupiers without a mortgage, albeit with the uncertainty over future house prices amplified by gearing.

Chart 2 shows three measures of the relative rate of return which assume imputed rent equal to 2% of capital value, net of maintenance costs, taxes and transactions costs of selling (averaged to a per annum basis). The first is for those owning outright, the second is for average buyers with a mortgage and the last is for average first-time buyers, these last assuming a 3% transactions cost of buying. These measures suggest a somewhat different perspective on housing market developments in the last 40 years from that given in Chart 1. For example, in terms of rates of return, the late 1970s boom in the housing market is rather more impressive than in terms of the house price/income ratio in Chart 1. The reason is that interest rates were low relative to house price increases (and relative to general inflation). The same feature explains a remarkable phenomenon. In real terms, average house prices fell around 40% between 1973 and 1977. This was accomplished without the rate of return in housing becoming significantly negative! Finally, Chart 2

[2] This figure excludes 'Right to Buy' purchasers of social housing at heavy discounts.

shows the remarkable outperformance relative to liquid assets, particularly from 1959-1989, of housing financed by borrowing.

Recently, the situation has been very different. With real interest rates high, and the unwinding of the house price overshoot of the late 1980s, the years 1990 to 1995 have seen unprecedentedly high negative rates of return. For the highly geared, ie. those who bought fairly recently, this is a new and most unpleasant experience. It is reflected in the record number of 345,000 households, perhaps 1 million people, who had their homes repossessed between 1990 and 1995, and in the high numbers of households with mortgage arrears exceeding 10% of their debt: around 150,000 households, or 1.5% of those with mortgages at the peak in 1992-3. Chart 2, incidentally, shows that without gearing, rates of return in the 1980s never got close to the 1972 peak. However, with financial liberalization[3] in the 1980s significantly increasing gearing, the geared first-time buyers' rate of return in 1988 exceeded 80%. This was despite the fact that real after-tax interest rates measured relative to the general rate of inflation were much higher in 1988 than in 1972. The decline in rates of income tax and the effect of the £30,000 ceiling on mortgages eligible for tax relief had reduced the proportionate benefit of mortgage interest tax relief since 1983 and thus contributed to this increase in real after-tax interest rates. Moreover, in 1988 tax relief was restricted to one per property instead of one per borrower. In 1989 it was restricted to the standard rate of income tax. The rate of relief was further cut to 20% in 1994 and to 15% in 1995.

As we shall see, our model reveals that recently experienced rates of return play an important part in driving demand in the housing market. This helps to explain the volatility of house prices revealed in Charts 1 and 2.

[3]There was widespread mortgage rationing before 1981, particularly during a long period of negative real interest rates, after which credit availability was dramatically liberalized in stages. To summarize the key stages, the abolition of the 'corset' on bank lending brought the banks into the mortgage market beginning in 1981. From 1983, the building societies were allowed increasingly to borrow from the money markets to finance home loans, having been previously restricted to lend on only their customers' deposits. In 1985, began the entry into the mortgage market by the centralized mortgage lenders, a new and aggressive type of lender, often backed by foreign banks. In 1986, the Building Societies Act was passed and 'administrative guidance' of building societies by the Bank of England was removed. This further liberalized the activities of building societies. Now building societies are permitted to finance up to 40% of their lending from money market borrowing as opposed to retail deposits.

Thus, in the 1980s, financial liberalization went much further than in the temporary episode in 1971-73, under the 'Competition and Credit Control' policy. When the economy overheated at the height of the 'Barber boom' in 1973, that experiment was abandoned. Lawson (1992) gives a good overview of financial liberalization in the 1980s.

2. A Brief Review of Recent UK House Price Equations

Most estimated house price equations are best viewed as inverted demand equations. A simplified version of the underlying model of house prices that most researchers use is as follows. The demand for housing services, which is assumed proportional to the housing stock, is specified as:

$$H/POP = f(y,\mu,D) \tag{2}$$

where H is the demand for housing, POP is the population of individuals or households, y is average real income, μ is the real user cost of housing services and D represents other factors which shift the demand curve.

The user cost is commonly defined as:

$$\mu=p^h[r+\delta - \dot{p}^{he} /p^h] \tag{3}$$

where p^h is the real price of houses, r is the tax-adjusted interest rate, δ is the depreciation rate or the rate of maintenance costs including property taxation, and $\dot{p}^{he} /p^h$ is the expected rate of appreciation of house prices. Note that, abstracting from gearing, the rate of return in (1) is essentially the rate of imputed rent minus the user cost component, $\nu =[r+\delta - \dot{p}^{he} /p^h]$. With constant gearing, the two concepts would be hard to distinguish in empirical work.

Using $\mu=p^h\nu$, we can invert the demand function (2) to obtain an equation for p^h,

$$p^h=g\ (H/POP, y, \nu, D) \tag{4}$$

Estimated versions of equation (4) condition on the housing stock H, proxy $\dot{p}^{he} /p^h$ by lags in house price appreciation, and often include a proxy for credit/mortgage rationing, say M. Rationing increases the user cost component ν since it now includes the shadow price of the rationing constraint. Thus, empirical models of house prices frequently use the following specification:

$$p^h=g(H/POP,y,r, \dot{p}^{he} /p^h, M,...) \tag{5}$$

The functional forms and lags actually used tend to be largely data determined.

Equation (2) may be derived from an explicit multi-period utility maximization problem where there are two goods - housing services and a composite consumption good, (see Dougherty and Van Order (1982), for example). y is then a measure of permanent income or some combination of physical and financial wealth and current and future real income.

The demand for housing and the consumption function then share similar features, a fact we shall exploit below.

The model of house prices can be completed by adding an equation for the supply of housing services:

$$\dot{H} = F(p^h, POP, S) - \delta H \tag{6}$$

where S represents other factors which shift the supply curve. Buckley and Ermisch (1982), Poterba (1984), Mankiw and Weil (1989) and others use this sort of model. Many researchers assume that agents have rational expectations although Case and Shiller (1989), Poterba (1991), Cutler et al (1991), and Shiller (1993) argue that many individuals in the housing market have extrapolative expectations. The house price equations in the HM Treasury and London Business School models of the early 1990s, may be viewed as reduced form equations derived from (4) and (6) though making little serious attempt to incorporate supply side features (see Milne (1991) for the LBS house price model).

Meen (1993) surveys a number of earlier estimated house price equations for the UK, including Hendry (1984), as well as early 1990s versions of the Bank of England, Treasury, National Institute, and LBS and his own Oxford Economic Forecasting equation. Hendry estimates an inverted housing demand equation. He conditions on the mortgage stock which he includes as a proxy for mortgage rationing which was pervasive over his sample period 1959 to 1981. He uses nominal interest rates and includes a lagged cubic in the rate of change of house prices to capture speculative frenzy. Meen (1985) derives a direct measure of excess demand for mortgages, the difference between the percentage increase in mortgage demand and supply, which he calls MRAT. MRAT is estimated using quarterly data up to 1984 and is zero post 1981 even though there was considerable financial liberalization after 1981.

Meen (1990, 1993, 1996) finds that mortgage rationing in the past, as measured by MRAT, had large effects on house prices. Meen includes financial wealth as an explanatory variable in his model and measures the housing stock relative to the number of households. Following Buckley and Ermisch (1982), the number of households, which is endogenous, is replaced by an exogenous proxy by taking headship rates disaggregated by age and sex in a base year and multiplying these by population in each age/sex band.

Dicks (1990), like Meen, eschews use of Hendry's cubic 'frenzy' measure. Most models have difficulties otherwise in capturing the 1972 spike in the data at the peak of the 1972-3 housing boom, except via dummies.[4] The Bank of England model of the early 1990s

[4] Dicks suggests the cube of income growth as an alternative and investigates a range of alternative

omits cube effects and represents demography by the proportion of the population aged 25-29.

In further work at the Bank, Breedon and Joyce (1992) estimate a three equation model of house prices, mortgage arrears and repossessions for the period 1970 to 1990. The cointegrating vector shows house prices depending upon real income, real gross financial wealth, the owner-occupied house stock and the proportion of the population aged 25 to 29, a prime housing buying group. Additional terms in real user costs, real net liquid financial assets, the loan to value ratio for first time buyers and the change in repossessions are included in their dynamic price equation. However, Pain and Westaway (1996) find that Breedon and Joyce's model is unstable out of sample.

Pain and Westaway's (1996) model differs from previous work since they condition on consumption rather than on income. They derive their house price equation from the marginal rate of substitution condition relating the consumption of goods and housing services in an intertemporal optimising model. They argue that conditioning on consumption has a number of advantages. Firstly, the same permanent income or sum of human and physical capital measure which determines consumption is used in determining housing demand. Secondly, the impact of changes in mortgage rationing/financial liberalization on the marginal rate of substitution is considerably smaller than the impact on the overall level of either consumer expenditure or housing demand. In other words, part of the effect of financial liberalization is already reflected in the consumption data. They model house prices using quarterly data from 1970 to 1993. In their cointegrating vector real house prices depend upon consumption and the owner-occupied housing stock (with common coefficients) and the real user cost of housing. They find weak evidence that mortgage rationing mattered in the 1970s. Their house price equation encompasses an updated version of Breedon and Joyce's (1992) equation, which includes many more explanatory variables including the proportion of the population aged 25 to 29.

Hall et al. (1996) estimate a stochastically switching regime model of real house prices using quarterly data from 1967 to 1994. Their results suggest that the observed booms in real house prices are associated with an unstable regime and that the probability that the system remains in an unstable regime decreases as deviations from the equilibrium increase. However, the model is somewhat thin in economic content.

Our paper tries to combine the spirit of the best in these approaches, by drawing on a theoretical framework set out in Muellbauer (1996a) and summarized in Section 3, with

specifications for demography, mortgage rationing and the effect of variations in income inequality.

important new features. These concern particularly the role of credit restrictions, lumpy transactions costs and uncertainty. Like Meen, we believe that shifts in the credit regime caused important behavioural shifts and demonstrate what shifts are predicted by theory. Like Pain and Westaway (1996), we address seriously the fact that housing and consumer demand more generally derive from a common framework. Like Hendry (1984) and Hall et al (1996) we recognize that periods of housing market 'instability' or 'frenzy' occur. The combination of transactions costs and speculative behaviour gives important theoretical clues for how best to model these episodes. Throughout, we are careful to explicitly model house price or rate of return expectations and income expectations. Finally, our treatment of demography and supply spillovers from the rented sector encompasses and goes beyond previous work.

3. Housing Demand, Credit Rationing, Transactions Costs and Uncertainty

The demand for housing is subject to uncertainty and transactions costs, and under asymmetric information, lenders impose limits on credit which constrain some households at least some of the time. Moreover, in the UK, the credit market has been subject to a major regime change. Financial deregulation in the 1980s made mortgage credit more easily available than in the 1960s and 1970s, when it was often rationed for reasons that had little to do with the lenders' view of default risk by borrowers.

The conventional analysis of the effects of credit rationing on consumption demand, see Flemming (1973), suggests that, when rationing binds, consumers are at a corner solution. Here current consumption is constrained by current income and rationed current borrowing. Thus, neither expected future incomes nor real interest rates are relevant. The implication for aggregate consumption is that income expectations and real interest rates should have weaker aggregate effects in periods when higher proportions of households are subject to credit rationing.

The most important consequence of introducing housing into the choice set when consumers are bound by credit constraints is that housing offers another way of trading off consumption now for consumption in the future. When prospective returns in housing are high and consumers are credit constrained, a reduction in current consumption enables more housing to be bought, which allows greater future consumption to take place, as consumers exercize the choice to switch into cheaper housing or rented housing or gain access to borrowing via high collateral values.

It is shown in Muellbauer (1996a) that the consumption function then typically has the form

$$c_1 = c(\phi_1, W) \tag{7}$$

where ϕ is a measure of the slope of the intertemporal consumption trade-off via housing investment, and W is a measure of life cycle wealth, incorporating initial assets, current income and discounted expected income. The demand for housing under credit rationing can then be directly derived from the period-to-period budget constraint which links housing expenditure with current consumption, initial assets, current income and borrowing. Expected income growth enters this only through current consumption. But since the less is spent on current consumption, the more can be spent on housing, an increase in expected income growth increases current consumption and REDUCES housing demand. This holds whether the credit constraint in the form of a limit on the loan-to-value or the loan-to-income ratio.

For example, in the latter case, suppose the debt ceiling is θy_1 where θ=3 or $3\frac{1}{2}$ say, and y_1 is real annual income. Then

$$p_1^h H_1 = A_0(1+r_0) + (1+\theta)\, y_1 - c(\phi_1, W) - p_1^r H_0 \tag{8}$$

where p_1^h, H_1 are respectively the real price and quantity of housing, A_0 is initial financial assets so that $A_0(1+r_0)$ is the spending power of these assets and $p_1^r H_0$ is the rent paid by a first-time buyer becoming an owner occupier at the end of period 1.

This contrasts with the conventional demand for housing in the absence of credit constraints of the generic form

$$H_1 = H_1(\mu, \frac{1}{1+r}, W) \tag{9}$$

where μ is a user cost measure of housing, r is a real interest rate and W is life-cycle wealth.

In the 1980's and 1990's, fewer households' housing demands will have been governed by (8) and an increased proportion by (9). Thus, in our house price equation, we should expect income growth expectations and the real interest rate to be more important in the 1980s and 1990s than in the earlier periods and we test for such parameter shifts below.

Let us turn now to transactions costs. Though UK transactions costs are among the lowest in the world, they have an important fixed cost element, as well as a sliding scale. Muellbauer (1996a) considers the implications of lumpy transactions costs both for the choice, where it exists, between renting and owning, and for trading up by existing owner-occupiers. Let $H_1(\mu, \frac{1}{1+r}, W)$ as in (9) represent housing demand by a previous owner-occupier with housing of H_0 who has crossed the transactions cost hurdle and is not constrained by credit. This is the 'intensive' margin of demand. Note that W includes the wealth effect from existing housing $p_1^h H_0$, but nets off transactions costs.

The 'extensive' margin of demand is analysed by examining the choice condition under which the transactions cost hurdle is crossed. Approximately, this takes the form

$$[H_1(\mu, \frac{1}{1+r_1}, W) - H_0] \, [\pi + \frac{p_2^h}{1+r_1} - p_1^h] > tc \tag{10}$$

where π is the ratio of the marginal utilities of housing and wealth and tc is lump-sum transactions cost. Note capital gains expectations in p_2^h enter non-linearly since they also enter μ. Given a distribution of unobserved characteristics, house price expectations and wealth, in the aggregate the number of households for whom the inequality (10) holds, traces out the number of owner-occupiers trading up. This will be a highly non-linear function of capital gains expectations but also of current capital gains. Three reasons for the latter are as follows. First, note the correlation between capital gains and $H_1(\ ) - H_0$ in (10). Secondly, as Stein (1995) has noted, high real house prices boost the spendable wealth of existing owner-occupiers, releasing some from credit constraints. Recent capital gains have a similar effect. Finally, with an extrapolative element in expectations, expected gains depend on current ones. This helps explain the correlation between current capital appreciation and transactions volume in the housing market.[5]

The aggregate version of condition (10) suggests an important role for a non-linear 'frenzy' effect in a house price equation reflecting the presence of larger numbers of speculative traders, which we test below. It should depend upon expected and current capital appreciation in housing. This is a theoretical rationale for Hendry's (1984) cubic in last quarter's house price appreciation.[6]

Finally, consider the effects of uncertainty, particularly concerning the rate of return in housing. In theory, a risk adjusted rate of return can be defined. In general, this will involve second and higher moments of the probability distributions of house prices, income and interest rates. However, with bankruptcy or mortgage repossession a potential

[5] Note, however, that Stein (1995) does not remark on this correlation but only on that between real house prices and transactions volume.

[6] One could also make a somewhat weaker case for Dicks' (1991) cubic in income growth, since (10) suggests a non-linear response to W, of which income is a part.

risk likely to have a high penalty in most households' utility functions, measures of risk which are particularly sensitive to the downside are likely to be most relevant. We test for such effects in our empirical work.

4. Specification of a House Price Equation

As noted in the Introduction, slight adjustments have been made to the DOE mix-adjusted index of second-hand UK house prices which was spliced to the Nationwide index before 1968. This is deflated by the UK consumer expenditure deflator[7], pc, to define our dependent variable ln(hp/pc). We shall now discuss the key specification issues under various subheadings.

(a) The Treatment of House Price and Rate of Return Expectations

As noted in Section 2, the notion of rational expectations in the housing market has been widely disputed. In our model the expected rate of return or its obverse, the user cost plays an important role. We permit a mix of forward looking and crudely extrapolative expectations to enter the model and allow the data to determine the weights on each. For this purpose, however, we need a house price forecasting model that the more rational households might be expected to use. It is improbable that such households possess or have a full understanding of and data on the supply side[8] and how changes in age structure, and in the structure of the mortgage market might affect house prices. In other words, the Muth (1961) concept of rational expectations is inappropriate here. Thus we specify a semi-rational forecasting rule based on the information which consumers are likely to have: income, interest rates, recent house price levels and changes, inflation and recent changes in mortgage lending. Empirically, it turns out that, at least since the late 1960s, house price changes in the South East predict future UK house price changes better than do UK house price changes themselves. Changes in mortgage lending are proxied by the rate of acceleration of the log mortgage stock, $\Delta^2 \ln m$. Testing down from a general specification which satisfies homogeneity gives the following parsimonious specification. This satisfies a parameter stability test estimating for 1956-1981 and 1956-1994.

[7] Details of data construction and sources are given in the Appendix.

[8] Note that this is missing even in the Treasury and LBS models of the early 1990s. Mankiw and Weil (1989) make a smilar argument regarding consumer ignorance of changes in demographic structure or of their relevance for predicting house prices.

$$\Delta\ln(hp/pc)_t = \underset{(2.1)}{1.05} + \underset{(6.5)}{1.65}\ \Delta\ln ryn_t - \underset{(2.2)}{0.85}\ \Delta_2 abmr_t$$
$$+ \underset{(6.5)}{0.49}\ (\Delta\ln hpse_{t-1} - \Delta\ln pc_t)$$
$$+ \underset{(4.0)}{0.90}\ \Delta^2\ln m_{t-1} - \underset{(2.1)}{0.12}\ \ln(hp/yn)_{t-1} \qquad (11)$$

Sample period 1956-1994 s.e. = 0.0316, $\bar{R}^2 = 0.871$, DW = 2.13, LM test for 2nd order auto-correlation chi-square 0.76.

$$\Delta\ln(hp/pc)_t = \underset{(1.9)}{1.38} + \underset{(5.0)}{1.65}\ \Delta\ln ryn_t - \underset{(0.4)}{0.36}\ \Delta_2 abmr_t$$
$$+ \underset{(4.4)}{0.46}\ (\Delta\ln hpse_{t-1} - \Delta\ln pc_t)$$
$$+ \underset{(2.8)}{0.95}\ \Delta^2\ln m_{t-1} - \underset{(1.9)}{0.16}\ \ln(hp/yn)_{t-1}$$

Sample period 1956-1981 s.e. = 0.0347, $\bar{R}^2 = 0.853$, DW = 1.95, LM test for 2nd order auto-correlation chi-square 0.02.

Here ryn is per capita real personal disposable non-property income and yn is the nominal equivalent; $\Delta_2$abmr is the 2 year change in the tax adjusted Building Society mortgage rate, abmr; hpse is the house price index for the South East including London; and m is the nominal mortgage stock. Absolute t-ratios are shown in parentheses. Note the feedback from the lagged house price/income ratio is too weak to be consistent with cointegration of house prices and income, while the impact elasticity of house prices to income is around 1.7. It seems that the lagged acceleration of the mortgage stock handles the mortgage market regime changes of the 1980s quite well.

Though this equation forecasts next period's house prices given this period's[9], it cannot be used directly as an ingredient of the one year ahead expected rate of return in an equation that models the current level of house prices. Let us define the ungeared current rate of return, as $ror_t = 0.02 + \Delta\ln hp_t - \frac{1}{2}(ar_t + ar_{t-1})$ where ar_t is an average of tax adjusted borrowing and lending rates using λ_t and $1-\lambda_t$ weights,[10] where λ is the loan to value ratio. The time averaging of ar_t and ar_{t-1} is to capture the point that since house price data refer to the annual average, the relevant interest rate connecting years

[9] Notice that if the income and interest rate change and the rate of inflation were replaced by forecast values, this would be a genuine 1 year ahead forecasting equation. If this is done, the adjusted R^2 is still over 80%, violating any form of the efficient markets hypothesis.

[10] To be precise, the weight $(1-\lambda_t + tc)$, as implied by (1) above, applies to the lending rate.

t and t-1 is an average of rates prevailing in the two years. The 0.02 represents the net benefit of owner-occupation after maintenance, taxes and averaged selling costs, but this only becomes relevant for non-linear or time varying transformations of ror_t. The fitted value of the rate of return $\mathrm{r}\hat{o}_t$ replaces $\Delta\mathrm{lnhp}_t$ and λ_t by their fitted values using current exogenous and lagged information.

For forward looking households, the future rate of return is relevant. To forecast ror_{t+1} using information on exogenous variables dated t and on endogenous and exogenous variables dated t-1, a parsimonious equation was found explaining ror_{t+1} using $\mathrm{r}\hat{o}\mathrm{r}_t$, the real mortgage rate at t, the one year ahead forecasts of income growth and the change in the mortgage interest rate, and the current change in the mortgage interest rate, see the Appendix for details. This gives $\mathrm{r}\hat{\hat{o}}\mathrm{r}_{t+1}$.

This equation is remarkably stable. It suggests that, in the information set available to better informed households, the current fitted rate of return and forecast income growth between them pick up much of the variation in next period's rate of return. This explains one of our later findings: the pairs of variables ($\mathrm{r}\hat{o}_t$, $\mathrm{r}\hat{\hat{o}}\mathrm{r}_{t+1}$) and ($\mathrm{r}\hat{o}\mathrm{r}_t$, $\Delta\ln\mathrm{r}\hat{y}\mathrm{n}_{t+1}$) have similar explanatory power in explaining the variation in real house prices. Thus, it is hard to distinguish a specification conditional on income growth expectations from one conditional on future rate of return expectations.

(b) Frenzy and Uncertainty

We follow Hendry (1984) in using a cubic functional form to approximate the non-linear or threshold effect predicted by the theoretical model. However, we apply it to $\mathrm{r}\hat{o}\mathrm{r}_t$ and tested for cubic effects in $\mathrm{r}\hat{o}\mathrm{r}_{t+1}$ and ror_{t-1} also, though these turned out to be absent. The issue of whether linear rate of return effects enter in geared or ungeared form turns out to be relatively unimportant for goodness of fit. The data marginally prefer the linear terms not to be geared. However, the data clearly prefer the cubic terms to be geared. Given the important speculative component in behaviour during periods of hyperactivity, this makes good economic sense.

To represent the downside risk of negative returns we define an indicator to pick out negative rates of return: let $\mathrm{rorm}_t = 0$, if $\mathrm{ror}_t \geq 0$, and $\mathrm{rorm}_t = \mathrm{ror}_t$ if $\mathrm{ror}_t < 0$. We experimented with $\mathrm{r}\hat{o}\mathrm{rm}_t$ and lags in rorm_t. Lags at 2 and 3 years proved to be significant and with coefficients of similar size. Thus, it takes 4 years after the event for the fear of big capital losses to vanish.[11]

The possibility of negative frenzy is part of the theory: some houseowners sell out or trade down to avoid expected capital losses which are greater than transactions costs. However, the effect is unlikely to be symmetric. The functional form (10) implies asymmetry: a somewhat weaker downside reaction because of the π term which reflects the fact that trading down involves the loss of housing services which contribute to utility. Such an asymmetry can be tested by including a cubic in the geared version of $rorm_t$. This is insignificant (t=0.8) though consistent with the hypothesis that the downside reaction is a little weaker.[12]

(c) Wealth Effects

Since housing demand and consumer demand in general stem from a common theory, the treatment of asset affects here is consistent with the theory set out in Muellbauer and Lattimore (1995) and applied to UK regional consumption data in Muellbauer and Murphy (1995). The basic idea is that illiquid assets (ie., assets that are capital uncertain and may be subject to transactions costs or restrictions) are less spendable than liquid assets but that their relative spendability weight increased with the financial liberalization of the 1980s. Conversely, in the 1980s debt became more and more like negative liquid assets, whereas in earlier times of credit constraints, its negative spendability weight relative to liquid assets was less than unity, reflecting the benefits of having debt when debt was rationed. In Muellbauer and Murphy (1995), composite personal sector wealth was modelled as

$$compass_t = [LA_t - cred_t\ DB_t + (\alpha_0 + (1\text{-}\alpha_0)\ cred_t)\ \alpha_1 ILA_t] \qquad (12)$$

where LA is personal liquid assets, DB is debt and ILA is illiquid assets which includes illiquid financial assets (gilts, stocks and life insurance funds) and physical assets (including owner occupied housing). cred is a variable normalized between 0 and 1 which reflects ease of credit or financial liberality, see the Appendix. α_1 is the spendability weight

[11] One might have expected more recent effects as well. But it may be that the cubic frenzy effect, when it goes negative, already mops up the contribution of more recent information to downside risk. Interestingly, if we interpret the percentage of mortgages repossessed as a downside risk indicator, it enters as the rate of change 3 years earlier, a longer lag than in the specification by Breedon and Joyce (1992).

[12] The cubic is not the only plausible functional form. The sign preserving quadratic defined by the function $f(x) = x^2$ for $x \geq 0$, and $f(x) = -x^2$ for $x < 0$, fits virtually as well and has a similar mirrored 'S' shape with zero slope at x=0.

of illiquid assets when cred equals unity and $\alpha_0\alpha_1$ is the spendability weight when cred equals zero. For consumption data, α_1 was estimated at around 0.4, similar results having been obtained for aggregate UK and US data in earlier work, though α_0 was more poorly determined. In this implementation we fixed α_1 at 0.4 and allowed α_0 to be freely estimated, the point estimate of 0.3 being consistent with the consumption function evidence. The wealth effect enters as the ratio of lagged composite wealth to current non-property income.

(d) Income Expectations and Parameter Shifts

Income expectations are introduced via the one year ahead forecast of income growth $E_t\Delta\ln ryn_{t+1}$. This is derived from a UK version of the model explained and estimated for the US in Muellbauer (1996b).

As predicted by the theory summarized in Section 3, income expectations and the real interest rate should be more important in the 1980s as a result of the relaxation of credit constraints. One way of introducing such parameter shifts is to interact the fitted value of $E_t\Delta\ln ryn_{t+1}$ and the real interest rate with the financial liberality indicator $cred_{t-1}$. This works about as well as the simple method of interacting with a dummy which is 0 up to 1981 and 1 thereafter. The results reported are for the simpler interaction effect.

(e) The Housing Stock, Population and Demography

Ideally, in an aggregate model, the housing stock ought to be an index of housing volume using some fixed price weights to combine dwellings of different sizes or else measuring housing volume in some common space units. Similarly, population ought to be an index weighting different demographic groups by some weights reflecting their different space requirement; though these inevitably depend also on budgets and prices. The housing stock data at our disposal is the number of housing units irrespective of size. With such data, one might have thought that the number of households would be the appropriate indicator of population, but this is highly endogenous, see Dicks (1988). Buckley and Ermisch (1982) suggest a population index using as weights for the different demographic groups the percentage in some reference year of households headed by someone in their respective demographic group. Meen (1990, 1993, 1996) uses 1981 census weights. Data for 1963-94 provided by Meen, were extended back to 1957. Between 1970 and 1994, the ratio grew by almost 10%, probably reflecting the longer survival rates and higher population shares of elderly widows and widowers.

In our work we apply both the Meen measure, also used to scale income, and conventional population as in the Bank of England model. However, in contrast to previous work, we also introduce a shorter term measure of demand pressure on housing coming from changes in age structure. The 5% DOE sample of building society mortgages gives the percentage of mortgages granted to each age group in the population. These percentages dated t-1 are used to weight the log change, at time t, of the proportion of the population in the respective age groups. The resulting variable is strongly persistent and passes tests for I(1), ie., appears to be integrated of order 1, like real house prices. It was high in the early 1970s and in the 1980s and is falling in the 1990s, since baby boomers have passed through the main house buying age ranges. We find it to be an important contributor to the determination of house prices, whether we use the Meen approach or conventional population data.

One other difference between our specification and previous work is that we do not impose the restriction that the owner-occupied housing stock is the relevant stock measure. As Buckley and Ermisch (1982) suggest, an increase in the non-owner occupied housing stock, where there is rationing of demand for this stock, is likely to have some negative spillover effects onto the prices of owner-occupied housing, though these should be smaller than the effects from a similar increase in the stock of housing for owner-occupation. We allow for this effect by not restricting the coefficient on the log proportion of owner-occupied housing to be the same as that on the total log housing stock.

5. Empirical Results

We now turn to our empirical findings. Table 1, columns 1-3 shows results for a parsimonious specification for different samples when income and the total housing stock are on a simple per capita basis. Columns 4-6 show results for the corresponding specification when the Meen measure of weighted population is used to scale both income and the total housing stock. This fits marginally better but has very similar parameter estimates, diagnostics and parameter stability properties.

Table 1: UK Second-hand House Price Models with Two Alternative Treatments of Population

	Scaling stock and income by population			Scaling stock and income by weighted population		
	(1)	(2)	(3)	(4)	(5)	(6)
ln(hp/pc)	1957-94	1957-87	1957-81	1957-94	1957-87	1957-81
intercept	2.37 (3.8)	2.67 (3.2)	2.42 (2.1)	2.19 (5.2)	2.16 (3.0)	2.10 (2.1)
$\ln(hp/pc)_{-1}$	0.34 (9.1)	0.35 (7.0)	0.33 (6.2)	0.32 (8.5)	0.32 (6.4)	0.32 (5.8)
$\ln hs_{-1}$-ln pop	-1.46 (4.3)	-1.24 (2.9)	-1.47 (2.5)	-1.32 (3.7)	-1.17 (2.8)	-1.43 (2.5)
$\ln poo_{-1}$	-0.44 (4.1)	-0.44 (2.6)	-0.45 (2.0)	-0.48 (4.3)	-0.52 (2.9)	-0.50 (2.1)
dldem	5.9 (6.3)	6.2 (5.6)	6.4 (5.1)	5.8 (6.4)	6.1 (5.8)	6.3 (5.1)
avln ryn	1.71 (8.5)	1.60 (4.6)	1.70 (3.7)	1.73 (9.5)	1.71 (5.1)	1.76 (4.1)
$\Delta\ln \hat{ryn}_{+1}$	0.56 (2.7)	0.54 (2.1)	0.59 (1.6)	0.47 (2.2)	0.47 (1.9)	0.56 (1.5)
$Dum\Delta\ln \hat{ryyn}_{+1}$	0.77 (2.6)	0.76 (1.0)	-	0.78 (2.9)	0.69 (1.0)	-
$compass_{-1}$	0.14 (3.7)	0.15 (2.1)	0.13 (1.6)	0.15 (4.4)	0.17 (2.5)	0.14 (1.8)
Dumwr	-3.0 (2.7)	-2.8 (1.2)	-	-3.0 (2.9)	-3.1 (1.4)	-
$\hat{ror}$	0.20* (6.4)	0.22* (4.0)	0.25* (3.8)	0.20* (6.9)	0.21* (4.0)	0.24* (3.6)
ror_{-1}	0.20* (6.4)	0.22* (4.0)	0.25* (3.8)	0.20* (6.9)	0.21* (4.0)	0.24* (3.6)
$(gr\hat{or})^3$	0.37 (11.6)	0.36 (9.2)	0.34 (7.6)	0.35 (11.4)	0.34 (9.5)	0.33 (7.7)
$avrorm_{-2}$	0.30 (5.2)	0.48 (1.9)	0.13 (0.2)	0.28 (5.2)	0.44 (1.9)	0.24 (0.4)
D88	0.068 (3.7)	-	-	0.071 (4.1)	-	-
D89	0.081 (4.5)	-	-	0.084 (4.8)	-	-
α_0	0.31 (2.4)	0.35 (1.7)	0.58 (1.4)	0.30 (2.6)	0.29 (1.6)	0.48 (1.3)
s.e.	0.0126	0.0135	0.0145	0.0120	0.0129	0.0140
R^2	0.9984	0.9972	0.9962	0.9986	0.9975	0.9965
DW	2.32	2.33	2.64	2.37	2.31	2.59
AR2 F-test	1.22			1.26		

where hp = UK house price index, pc = consumer expenditure deflator, hs = total housing stock, pop = population, pop* = weighted population used by Meen, poo = proportion of housing stock which is owner-occupied, adjusted for 'Right to Buy' sales, ryn = real disposable non-property income/pop, ryn* = ditto/pop*, and av indicates the two year moving average. $\Delta\ln \hat{ryn}_{t+1}$ is forecast income growth, $Dum\Delta\ln \hat{ryn}_{t+1}$, interacts this with the post 1981 dummy. $compass_{t-1}$ = composite assets = $[LA_{t-1}\text{-}cred_{t-1}DB_{t-1}+(\alpha_0+(1\text{-}\alpha_0)cred_{t-1})\ 0.4ILA_{t-1}]$, see (12) above, Dumwr = post 1981 dummy x debt/income weighted real mortage interest rate, $\hat{ror}_t$ = fitted value of current relative rate of return in housing, ror = actual value of the same, $gr\hat{or}_t$ = fitted value of the geared relative rate of return, rorm = ror if ror < 0, rorm = 0 otherwise. D88, D89 are dummies respectively 1 in 1988 and 1989 and zero otherwise. Absolute values of t-ratios are shown in parentheses. Pairwise parameter restrictions are indicated by an asterisk on the parameter estimate. Means and standard deviations for all the variables in Tables 1 and 2 are shown in Table 3.

Let us examine the implications of column 4, using the Meen population data. Given the coefficient of 0.32 on the lagged real price, this implies that a one percent increase in the housing stock, both owner-occupied and rented, lowers the real price of housing by about 1.9 percent. Conversely the price elasticity of demand for housing is -0.52. With a rate of owner-occupation of 67%, a one percent increase in the owner-occupied stock, holding the rental stock fixed, lowers the real price of housing by 1.5% while a one percent increase in the rental stock lowers it by 0.4%.

The short run demographic change indicator dldem is highly significant (t=6.4). Income enters with a similar coefficient on lagged as current income and this coefficient restriction was imposed. We interpret the lagged income effect in terms of lags in mortgage approval, usually conditional on income evidence, and in housing transactions. The implied long run income elasticity of demand for housing is 1.32, while the elasticity of real house prices to real income is 2.5, given the housing stock.[13]

The inclusion of a time trend in the column 4 specification gives an insignificant result (t=-0.6), but leaves the coefficient on the housing stock, a trend like variable, less well determined (t=1.7). Similarly, the implied income and price elasticities of housing demand, are then less precisely estimated.

Income growth expectations are significant and, as predicted by the theory, became significantly more important in the 1980s with financial deregulation. Relative to the effect of income, these come through more strongly than in our parallel work on consumption. As noted in subsection (a) above, this is probably because rate of return expectations, in which income growth expectations are an important factor, are not explicitly included in this specification. Wealth effects are significant and the coefficient relative to the income effect is in line with our consumption estimates. The parameter α_0 which measures the impact of financial liberality on the spendability of illiquid assets is estimated at 0.30. This suggests that, at the peak of financial repression, illiquid assets had a spendability weight of 0.12 compared with liquid assets, but that this rose to 0.4 at the peak of financial liberality.

Another prediction of the theory is borne out in the significant real interest rate effect after 1981 compared with an insignificant effect earlier. Interest rates, of course, also enter the relative rate of return. The lagged and current relative rates of return have similar coefficients and the equality restriction was imposed. The cubic enters only as a current

[13] This is conditional on the fitted rate of return $\bar{ror}$ and the composite wealth to income ratio, which respectively depend negatively and positively on the lagged house price/income ratio. These two effects roughly cancel out.

effect and the data prefer the geared form of the relative rate of return here. The effect of downside risk is captured, via the lagged rorm term, which equals the rate of return ror if this is negative, but is otherwise zero. At various stages of the process of reducing a general specification to a parsimonious one, a nominal interest rate was included but found to be insignificant. Meen (1990, 1993) has argued that the effect of house price uncertainty for cautious households is to discount expected house price appreciation relative to the interest rate element in rate of return measures. The inclusion of the level of a nominal interest rate tests for this.

Dummies for 1988 and 1989 turn out to be significant. A common element driving up house prices in those years was the announcement effect[14] of the replacement of the local property tax (Domestic Rates) by the Poll Tax which was implemented in Scotland in 1989 and in England and Wales, by then to great protest, in 1990. A further factor in 1988 was the March Budget announcement that mortgage interest tax relief would be restricted to one per property from August. This led to many younger home buyers trying to buy in the months before multiple tax relief was abolished, driving up prices in the process. The reversal of this demand advancement effect and growing doubts about the survival of the Poll Tax, see Lawson (1992), ch. 46, whose replacement by a new property based tax was announced in April 1991, explain the disappearance of such price boosts in the 1990s. We can check the robustness of our specification by including dummies for 1990, 1991 and 1992 in the context of Table 1, col. 4. The respective coefficients are -0.021 (0.57), -0.013 (0.34) and 0.007 (0.28) with absolute t-ratios shown in parentheses. An F-test confirms their joint insignificance. The coefficients on the cubic, $(\text{gr}\dot{o}\text{r})^3$, and the asymmetric risk proxy, avrorm_{-2}, are almost unchanged and both are still highly significant.

Finally, various other hypotheses were investigated, without very significant results. These included the ratio of non-manual to manual earnings which has a positive but insignificant effect. A dummy 0 up to 1968 and 1 thereafter captures the abolition of Schedule A, a tax on imputed rent. This has a coefficient of around 3% but with t=1.8 is not significant at the 5% level. A measure of the change in the incidence of long duration strikes found relevant to reflect short term income uncertainty in the consumption function is just insignificant here, t=1.9. Levels demographic effects, eg., the proportion of population aged 20 to 29 or 25 to 34, always proved insignificant. Parameter stability is satisfactory for both population definitions as columns 2 and 3 and 5 and 6 confirm

[14]Hughes (1989) and Spencer (1989) estimated a full effect of the elimination of Rates on house prices of the order of 15-20%. A short run effect of 8% in 1989 would be consistent with uncertainty about the return of property taxes in future.

and was checked over a number of other subsamples.

One possible objection to the Table 1 estimates is that they rely on parameter estimates of the fitted house price equation (11), meant to reflect the limited information set of households. It is possible to estimate the parameters of (11) jointly[15] with the remaining parameters of the model, apart from the intercept in (11) which is hard to identify. Imposing the same intercept as in (11) gives the estimates shown in Table 2, col (1) which are comparable and very similar to those in Table 1, col (4), except for the cubic term.[16] Note that the equation standard error has fallen even though five more parameters are being estimated.

A forward looking rate of return can be given a role in the model, though as noted above, it is hard to distinguish from the effects of income growth expectations and the current rate of return. Table 2, col. (2), shows a specification which incorporates the forward looking rate of return $\hat{\overline{ror}}_{t+1}$ imposing the acceptable restriction that it has the same coefficient as the current rate of return $\hat{ror}_t$.The fit is the same as in Table 1, col. (4) with which it is comparable.

Table 2, cols (3) and (4) also shows results when the cubic 'frenzy' term, and the measure of downside risk are omitted. Income growth (or rate of return) expectations, the shift therein and the 1980s real interest rate effect are then quite insignificant, while the current rate of return $\hat{ror}_t$ dominates. Testing for further interest rate effects, real or nominal, produced no significant effects. The equation standard error more than doubles, with a pronounced outlier in 1972. The effect of housing stock relative to population is very poorly determined and the effect of income is much weaker than in Table 1. Similarly poor results are obtained using the alternative simple treatment of population. These results suggest that the omission of a non-linear 'frenzy' effect is a major specification error. The omission worsens the fit and fails to support the predictions of economic theory regarding

[15]Joint estimation here means replacing the fitted value of $\Delta\ln(hp/pc)_t$ which appears in $\hat{ror}_t$ and in $(gror_t)^3$ by an equation of the form $\beta_0 + \Sigma\beta_j x_{jt}$, where the xj's are the variables listed in (11). The βj's are then estimated together with the parameters shown in Table 2, col. (1).

[16]Note that the quantitative implications of the cubic are very similar, though the t-ratio of 2.3 suggests that the coefficient is not very precisely estimated. Setting it to zero, however, results in the equation standard error more than doubling. The jointly estimated equivalent of eq (11), using Hall, Cummins and Schnake's (1995) TSP package, now reads

$$\Delta\ln(hp/pc)_t = 1.05 + \underset{(4.7)}{0.90}\ \Delta\ln ryn_t - \underset{(3.4)}{0.83}\ \Delta_2 abmr_t + \underset{(6.5)}{0.28}\,(\Delta\ln hpse_{t-1} - \Delta\ln pc_t)$$

$$+ \underset{(3.0)}{0.61}\ \Delta^2\ln m_{t-1} - \underset{(93.3)}{0.12}\ \ln(hp/yn)_{t-1}$$

This suggests a (somewhat) weaker effect from income growth and from the lagged change in the South East house price than the OLS estimate of equation (16).

Table 2: UK Second-Hand House Price Models with (1) Joint Estimation of House Price Expectations Component, (2) Forward-looking Rate of Return, (3) and (4) Omitting Frenzy Effect

ln(hp/pc)	(1) 1957-94	(2) 1957-94	(3) 1957-94	(4) 1957-81
intercept	2.14 (4.6)	2.47 (5.7)	2.76 (3.0)	3.00 (2.6)
$\ln(hp/pc)_{-1}$	0.32 (8.0)	0.28 (7.1)	0.54 (6.4)	0.48 (4.2)
$\ln hs_{-1}$-ln pop	-1.17 (3.4)	-1.24 (3.3)	-0.26 (0.5)	-0.10 (0.2)
$\ln poo_{-1}$	-0.52 (4.2)	-0.51 (4.5)	-0.35 (1.2)	-0.34 (1.0
dldem	5.7 (7.0)	6.3 (6.5)	6.7 (3.8)	9.4 (4.3)
avln ryn	1.73 (8.0)	1.75 (9.4)	0.84 (3.7)	0.73 (4.3)
$\Delta\ln \hat{ryn}_{+1}$	0.41 (2.1)	0.08 (0.3)	-	-
$Dum\Delta\ln \hat{ryn}_{+1}$	0.63 (1.4)	0.81 (2.9)	-	-
$compass_{-1}/yn$	0.20 (4.8)	0.17 (4.7)	0.16 (4.7)	0.15 (1.2)
Dumwr	-3.0 (2.5)	-2.8 (2.7)	-	-
$\hat{\hat{ror}}_{+1}$	-	0.12* (2.6)	-	-
$\hat{ror}$	0.23* (5.4)	0.12* (2.6)	0.80 (7.5)	0.84 (6.6)
ror_{-1}	0.23* (5.4)	0.25 (5.7)	0.14 (1.4)	0.25 (1.8)
$(gr\hat{or})^3$	1.85 (2.3)	0.35 (8.4)	-	-
$avrorm_{-2}$	0.36 (4.4)	0.27* (4.6)	-	-
D88	0.067 (3.9)	0.077 (4.0)	0.079 (2.7)	-
D89	0.077 (3.8)	0.093 (5.1)	0.022 (0.7)	-
α_0	0.25 (2.9)	0.32 (3.10)	0.30 (imposed)	0.30 (imposed)
s.e.	0.0106	0.0120	0.0268	0.0261
R^2	0.9989	0.9986	0.9929	0.9879
DW	2.00	2.39	1.79	2.17
AR2 F-test	0.39	1.38	0.91	

Absolute values of t-ratios in parenthesis. $\hat{\hat{ror}}_{+1}$ is the one year ahead forecast of the rate of return using exogenous information at t and endogenous and exogenous information at t-1.

the consequences of financial liberalization, which are supported by a better specified model including a 'frenzy' effect.[17]

Unconventionally, we have left to last an analysis of the integration and cointegration properties of the data, see Granger (1986), Engle and Granger (1987) and Johansen (1988). These tests suggest that log real house prices, log real income, the short term demographic variable, the composite asset to income ratio, given α_0=0.3, the weighted real rate of mortgage interest and the relative rate of return are all I(1). However, log housing stock/population and the log proportion of owner-occupiers are I(2), though, of course, with low variance. A static regression of ln(hp/pc) on ln hs_{-1}-ln pop, ln poo_{-1}, dldem, ln ryn, $compass_{-1}/yn$ and ror is consistent with the existence of cointegration among these variables. Muellbauer (1996b) suggests the presence of a low variance I(2) component in log income, which simple Dickey-Fuller tests, see Dickey and Fuller (1981), fail to detect. The same may be true of the log real house price. Then the presence of low variance I(2) variables in the regression could be perfectly consistent with cointegration. There is little point in using the static regression to derive the long run parameters, when economic theory suggests that expectational effects, parameter shifts and non-linearities are all important and are indeed supported by the data. Taking these into account should give superior estimates of the long run parameters.

6. Conclusions

In this paper we have derived an equation for real house prices as an inverted housing demand function. The theory of housing demand was examined in an intertemporal context taking into account expectations, credit constraints, lumpy transactions costs and uncertainty. The theory predicts several shifts in parameters as a result of the financial liberalization of the 1980's. One of these concerns shifts in wealth effects which we have

[17] In a separate investigation available from the authors, a consistent annual data set is used to compare our specifications with annual equivalents of the Bank, Treasury and LBS models and models by Breedon and Joyce (1982), Meen (1993, 1996) and Pain and Westaway (1986). Despite starting with a general lag structure for each and testing down to parsimonious equations, we find that our model fits better in all comparisons. The single most important reason for this lies in the non-linear frenzy effect which is significant when added as an additional regressor in every one of these alternative specifications; and clearly dominates the cubic in income growth suggested by Dicks (1990). Given the high correlation (the AR1 coefficient is over 0.8) in quarterly data between adjacent quarter house price changes, it is clear that the previous quarter's house price change is doing a great deal of the work in these quarterly models. It can be argued that our use of annual data favours our more structural model in empirical model comparisons. For medium term forecasting, our model should give more reliable results. We plan to check this on quarterly data.

already analysed in work on UK consumer spending at a national and regional level. The empirical evidence supports similar shifts in the housing demand function. Furthermore, the theory predicts an increased role for income growth expectations and real interest rates in the 1980s. This is strongly borne out by the empirical evidence.

The presence of lumpy transactions costs is shown to result in important non-linearities or threshold effects in the aggregate demand for housing. This arises from the extensive margin of housing demand: the greater is appreciation of house prices, actual and prospective, the more households are pulled over the transactions cost hurdle to engage in trade. At these times of heightened activity or 'frenzy', sharply increased demand feeds back into higher prices and, as in 1971-3, 1978-9 and 1986-9, substantial increases in house prices then occur. These spikes in the data can be successfully modelled with a non-linearity in the predicted rate of return. Indeed Hendry's (1984) specification of a cubic (though applied by him to last quarter's capital appreciation) is shown to provide an excellent empirical approximation to the non-linearity. Without such a non-linearity or dummies for the spikes in the data, the equation standard error more than doubles.

Our treatment of expectations in the paper takes care to make reasonable assumptions about the information agents are likely to have and permits both forward looking and extrapolative elements in behaviour. The strong evidence that both house prices and relative rates of return in housing are forecastable is consistent with the hypothesis that housing markets are far from efficient. Indeed, our evidence is for an important extrapolative element, as well as a rational element, in the formation of rate of return expectations. Similarly, for income expectations, our results support our findings in the consumption context, that forward looking expectations are important but that many households appear to feel constrained by current income.

Relative to previous work, there are a number of other innovations in the paper including the treatment of composition biases in the house price index and the incorporation of an index of demographic change. This rises with an increase in the shares of the population in the key house buying age groups. Another innovation is to test for the effects of gearing in the rate of return or user cost of housing measure. This turns out to be of some importance in the cubic 'frenzy' effect.

We have also compared different treatments of population, simple vs. demographically weighted as recommended by Buckley and Ermisch (1982) and Meen (1990, 1993, 1996). The latter gives only a marginally better fit and very similar parameter estimates. A more significant improvement is to allow the supply, both of owner-occupied and of rented property, to play a role.[18]

According to our model, many factors conspired to produce the house price boom of the late 1980s. Initial debt levels were low as were real house prices, giving scope for rises in both. Income growth after the early 1980s recession was strong, as were income growth expectations and these became more important as a result of financial liberalization, though partly offset by bigger real interest rate effects. Wealth to income ratios grew and the spendability of illiquid assets was enhanced by financial liberalization. Financial liberalization also permitted higher gearing levels. Demographic trends were favourable with stronger population growth in the key house buying age group. The supply of houses grew more slowly, with construction of social housing falling to a small fraction of its level in the 1970s. Finally, in 1987-8 interest rates fell and the proposed abolition of property taxes in favour of the Poll Tax gave a further impetus to valuations.

The bust in the 1990s was the result of the reversal of most of these factors. Interest rates rose from 1988-90. Income growth and growth expectations weakened. Demographic trends reversed. The revolt against the Poll Tax resulted in a new property tax, the Council Tax, being reintroduced. Debt levels and real house prices had reached very high levels, while wealth to income ratios then fell and recently experienced rates of return became negative and made households more cautious. Mortgage lenders tightened up their lending criteria, in a partial reversal of financial liberalization. Under these conditions, not even the major falls in nominal interest rates that took place in the 1990s, while real interest rates remained high, were sufficient to revive UK house prices. Our results suggest an important lagged endogenous and indeed, non-linear, element in behaviour which implies a potential for volatility. Evidence for such volatility can be found in the years 1989 to 1995 when house price to income ratios as seen in Chart 1. have gone from the second highest peak in the post-war period to the lowest level, probably since before the War.

While our model suggests that, fundamentally, the potential for volatility remains, it also implies that three major dampening forces will contain the next upturn: unfavourable demographic trends, high levels of debt and high real after tax interest rates. To this one

[18] For most of the post-war period, because of rent controls and subsidized public sector rents, one can argue that there was excess demand for non-owner occupied housing, which was essentially rationed. Thus, buyers of owner occupied housing at the margin did not weigh rent levels relative to the costs of owner-occupation, justifying the omission of rents from demand functions for owner-occupied housing. Rent controls on the private rented sector were deregulated in a small way in the 1980 Housing Act and on all new lettings in the 1988 Housing Act. Furthermore, rents in the public sector have been raised closer to market levels. One could argue that private sector rents are now beginning to be relevant for the determination of prices of owner-occupied homes. This is an issue future modellers will need to address.

can add the greater awareness by mortgage lenders of default risk and, by the authorities, of the UK housing market as a potential factor in macroeconomic instability. This suggests that policy responses would not be lacking if any signs of overheating were again to develop.

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Chart 1

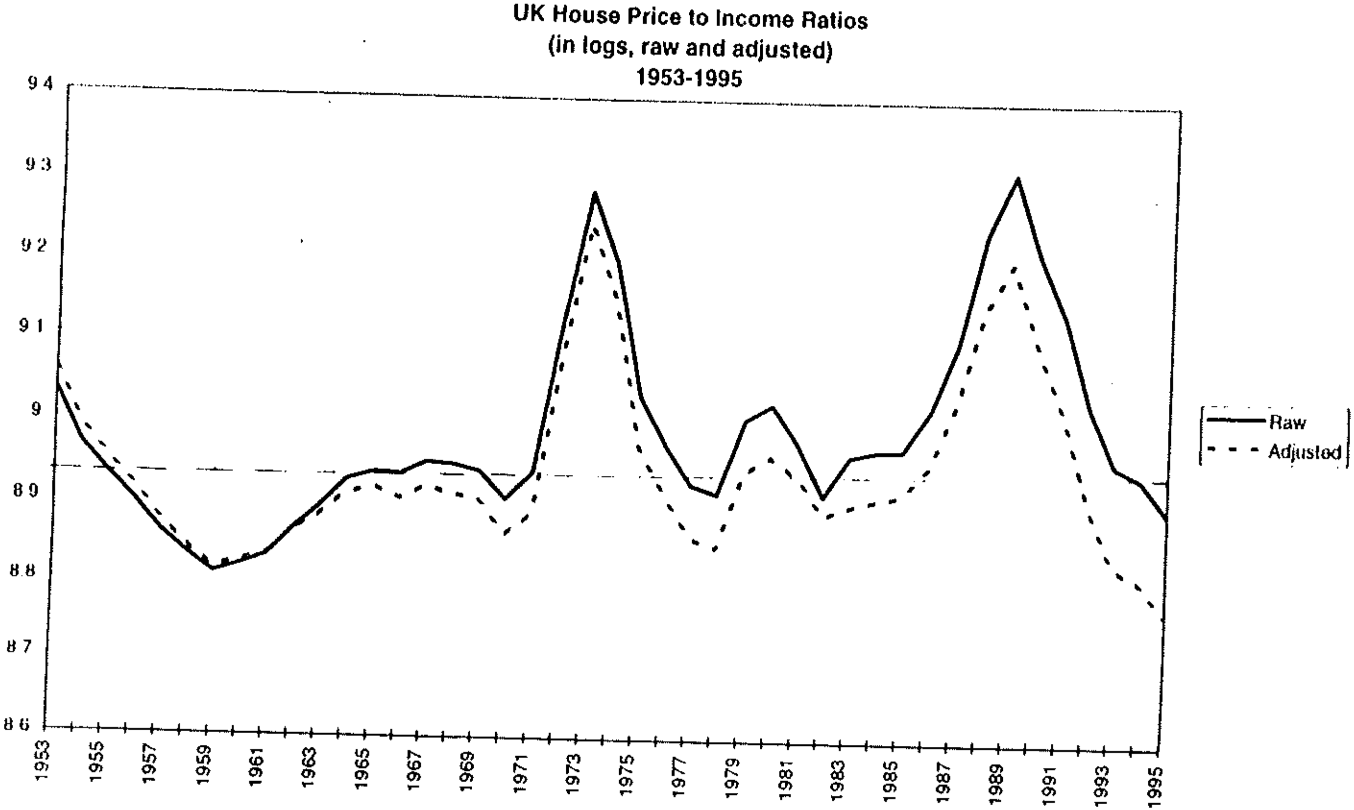
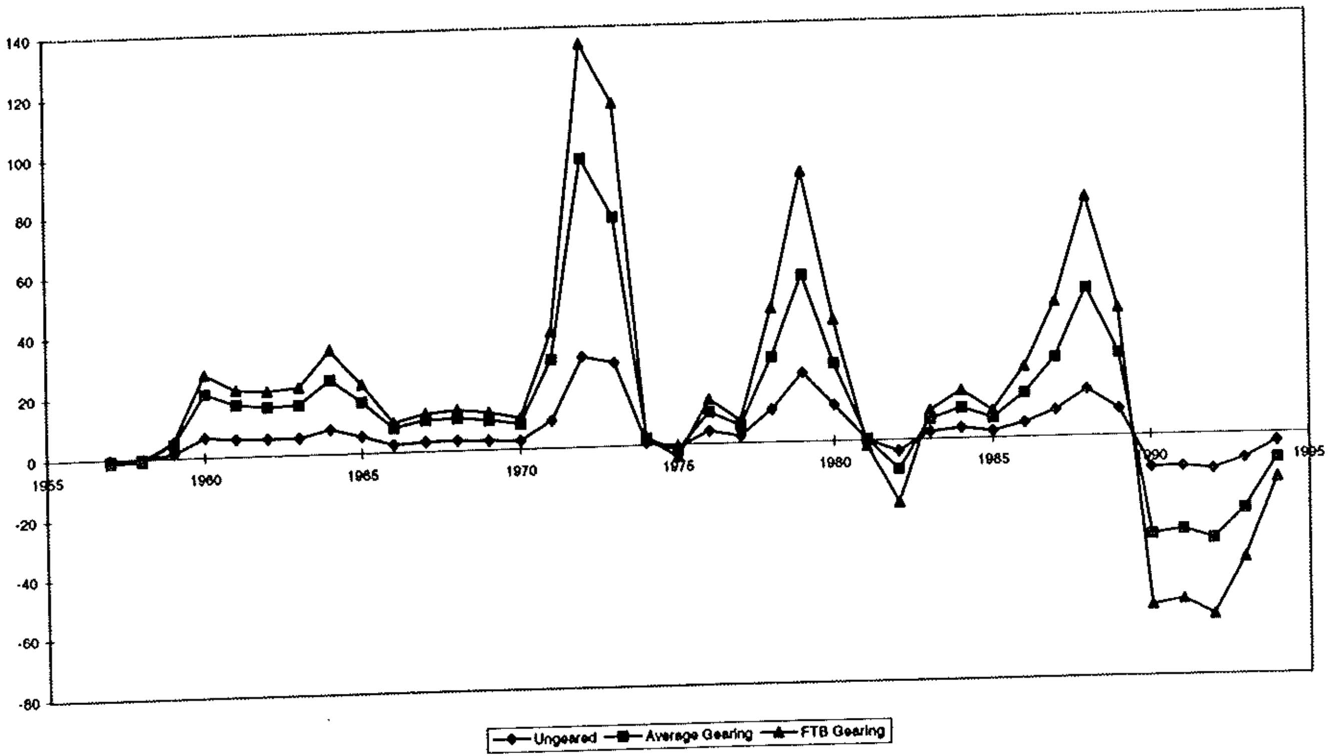

UK House Price to Income Ratios
(in logs, raw and adjusted)
1953-1995
9.4
9.3
9.2
9.1
9
8.9
8.8
8.7
8.6
1953
1955
1957
1959
1961
1963
1965
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
Raw
Adjusted

Chart 2: Relative Rates of Return in Housing: Ungeared, average gearing and average gearing for first time buyers



Appendix: Data Construction and Sources

(1) House Price Data

hp: adjusted UK house price index. From 1968Q2, the raw data came from the mix-adjusted index of second-hand house prices based on the DOE 5% sample of Building Society mortgages at the completion state, source: DOE Bulletins, Pre-1968Q2, this index are spliced to the Nationwide Building Society index of second-hand house prices. These prices are reported at the mortgage offer stage. A timing adjustment was made to the quarterly data to correct for this.

Although Building Societies have had the majority of the housing finance market, their data are unlikely to be fully representative, even after mix-adjustment. In principle, if good data on house prices were collected from all major providers of finance, a comprehensive house price index hp can be defined in logs as

$$\ln hp = w_{BS} \ln hp_{BS} + \sum_{i=2}^{n} w_i \ln hp_i$$

where BS refers to building societies and i to other lenders and w refers to the transaction shares. Then the bias from using $\ln hp_{BS}$ in place of $\ln hp$ is given by

$$\text{bias} = \ln hp_{BS} - \ln hp = \sum_{i=2}^{n} w_i \ln(hp_{BS}/hp_i)$$

since $w_{BS} = 1 - \sum_{i=2}^{n} w_i$. In the 1980s, banks made large inroads into the mortgage market while local authorities, once significant mortgage providers, have withdrawn. The share of insurance companies in the mortgage market has also varied over time. Traditionally, local authorities catered to the bottom end of the market while houses bought through insurance companies typically cost 30-40 more than houses bought with building society finance. Before the 1980s, banks were typically even more upmarket, tending to lend to established business customers. Since 1985, banks and insurance companies have been forced downmarket by the building societies (and perhaps 'centralised mortgage lenders') vying for market share. By 1989-90, average prices of bank and insurance company financed houses were below those financed by building societies. Thus a house price index based on building society transactions alone understated house prices in the mid 1980s but no longer did so in the 1990s.

Holmans (1990) gives some estimates of the part of this bias due to the banks' expansion in the mortgage market in the 1980s. He takes the ratio of the average value of houses mortgaged with banks av hp^b to those mortgaged with building societies av hp^{bs} as an estimate of hp^b/hp^{bs}. This overstates the bias since these average values are not mix-corrected and mix-correction would undoubtedly reduce this ratio. Furthermore, he neglects the role of local authorities and insurance companies. From data going back to 1960 in Housing and Construction Statistics, we computed a comprehensive measure $\sum_{i=2}^{n} w_i \ln(avhp_{BS}/avhp_i)$ using average values. The bias should be some fraction of this measure., Given the additive nature of the bias, we can estimate the appropriate fraction using the least squares criterion and a grid method. This estimate is close to 0.5 and this is what we assume. Our estimate of the bias suggests that the DOE index overstates house price inflation by 6.5% between 1982 and 1990 and 4.5% between 1985 and 1990. However, relative to 1980, the 1990 bias is only 2%. In other words, it is the years 1981 to 1987 which are most distorted relative to past measures. Before 1980, variations in the bias are relatively small.

Data for second-hand house prices for the South East region (including London) came from the same sources and were given the same bias adjustment.

Finally, an assumed adjustment for quality improvements of 0.3% per annum in the stock of second-hand owner-occupied housing was subtracted from UK and SE house price indices.

(2) Other Housing Data

hs: housing stock in number of dwelling units, measured at year end.

poo: proportion of owner-occupiers - CRTB/hs, where CRTB is a stock measure of right-to-buy (RTB) sales of (largely) council houses at large discounts. Resale of such houses was restricted for the first five years in 1980-86 and for the first three years from 1987. CRTB is defined as the cumulative sum of the number of RTB sales over the restricted period, but applies a decay rate of 12% p.a. once the restricted period is over. By 1994, this adjustment reduces the rate of owner-occupation from 67% to 62%. The adjustment is necessary since this part of the housing stock is arguably not generally available to purchasers of owner-occupied housing. Source: Housing and Construction Statistics

pop: mid-year estimates of UK population. Source: OPCS.

pop*: weighted population constructed by Meen using 1981 Census headship rates applied to number of individuals in each age and gender group.

dldem: demographic change index of main house buying age groups.

$= \sum_i wm_{it-1} \Delta \ln wpop_{it}$ where wm_i = share of total number of mortgages granted to age group i, and $wpop_i$ = population share of age group i. Sources: Housing and Construction Statistics, and OPCS.

$\bar{ror}_t$: rate of return in housing using fitted value of house price appreciation, $\Delta \ln \bar{hp}$, and fitted value of loan-to-value ratio, $\bar{lvr}$:

$\bar{ror}_t = 0.02 + \Delta \ln \bar{hp}_t - \bar{wthr}_t$ where average interest rate $wthr_t$ =
$0.5\ [\bar{lvr}_t\ abmr + (1.03 - \bar{lvr}_t) absr_t] + 0.5\ [lvr_{t-1}\ abmr_{t-1} +$
$(1.03 - lvr_{t-1})\ absr_{t-1}]$

and where abmr and absr are the tax-adjusted Building Society mortgage interest and share rates, respectively.

ror$_t$: the actual rate of return in housing is identical to $\dot{ror}_t$ except in using actual $\Delta \ln hp_t$ and actual lvr_t.

gror$_t$: geared rate of return in housing: $\dot{ror}_t/(1.03 - 0.5\ (\dot{lvr}_t + lvr_{t-1}))$.

abmr$_t$: tax adjusted Building Society mortgage rate $=(1-s_t tr_t)$ (gross B.S. mortgage interest rate) where tr_t is the standard rate at which tax relief applies and s_t is an estimate of the fraction of mortgages under the tax relief ceiling. s_t was derived from data on the size distribution of Building Society mortgages in Housing and Construction Statistics.

absr$_t$: tax adjusted Building Society share rate $= (1-tr_t)$ (gross B.S. share rate). Mortgage interest rate data come from Housing Finance.

$\ddot{ror}_{t+1}$: forecast value of rate of return in housing using exogenous information at t and endogenous information at t-1. This is based on the following equation, estimated over 1956-1993:

$$ror_{t+1} = -\underset{(3.8)}{0.055} + \underset{(5.8)}{0.84}\, r\hat{o}r_t - \underset{(2.3)}{3.32}\,\Delta\, \widehat{abmr}_{t+1} - \underset{(2.5)}{2.03}\ \Delta abmr_t - \underset{(4.4)}{0.86}\ rabmr_t$$
$$+ \underset{(7.0)}{3.33}\ \Delta \ln \widehat{ryn}_{t+1} \qquad (13)$$

Sample period 1956-1993 s.e. $= 0.0448$, $\bar{R}^2 = 0.745$, DW $= 2.12$,
Test for 2nd order autocorrelation chi-square 1.74

Equation stability was checked by running over the subsample 1956-1979:

$$ror_{t+1} = -\underset{(2.4)}{0.055} + \underset{(4.1)}{0.85}\ \hat{ror}_t - \underset{(1.0)}{3.58}\ \Delta \widehat{abmr}_{t+1} - \underset{(1.1)}{2.16}\ \Delta abmr_t - \underset{(2.6)}{0.74}\ rabmr_t$$
$$+ \underset{(5.4)}{3.58}\ \Delta \ln \widehat{ryn}_{t+1}$$

Sample period 1956-1979 s.e. $= 0.0471$, $\bar{R}^2 = 0.689$, DW $= 2.02$,
Test for 2nd order autocorrelation chi-square 3.70.

Here $\Delta \widehat{abmr}_{t+1}$ is a forecast of the change in the tax adjusted mortgage rate abmr and $\Delta \ln \widehat{ryn}_{t+1}$ is a forecast of real non-property income growth, both using exogenous information dated t, below.

The forecast of the mortgage rate came from an error correction model linking the mortgage rate with Bank base rate and a forecasting model for the latter, using lagged information on the base rate, inflation, US 3 month Treasury Bill rates, the trade balance to GDP ratio, income growth and forecast income growth.

dumwr: post 1981 dummy x debt weighted real mortgage interest rate, the latter defined as

$$(\text{mortgage debt/pdni})_{t-1}\ (\text{abmr}_t - \Delta \ln \text{pc}_t)$$

(3) Other Macrodata

pdni: personal disposable non-property income = personal disposable income (pdi) - estimated property income, where estimated property income = (personal sector rent, dividends and interest - imputed rent) (1 - standard tax rate) + imputed rent. Personal disposable income was adjusted by adding Poll Tax and Council Tax to avoid discontinuities in the national accounts series. Source: Blue Book and ONS Macrodata Bank.

ryn: real personal disposable non-property income per head = pdni/(pc)(pop).

pc: consumer expenditure deflator = nominal pdi/real pdi, after Poll Tax and Council Tax adjustment. Source: Blue Book and ONS Macrodata Bank.

LA_t, DB_t and ILA_t: respectively gross liquid assets, debt and gross illiquid assets, financial plus physical. Moving average of end of previous and end of current year t data. Source: Blue Book and Financial Statistics.

cred: is a variable, normalized between 0 and 1, to reflect variations in mortgage credit availability over time. Loan-to-value ratios for first-time buyers are taken to be the best immediate indicator of such credit conditions. But they also depend on interest rates, house price/income and other market conditions. The loan-to-value ratios are regressed for 1969-81 on these variables and on a measure of consumer credit controls, to reflect shifts in official policy on credit. The fitted value of the consumer credit control effects and post-1981 residuals are then taken to reflect the underlying credit situation, abstracting from interest rates, house price/income ratios etc. cred lies between 0 and 0.2 before 1981, then rises strongly, peaking at 1 in 1989, then falling back a little.

$\Delta \ln \widehat{ryn}_{+1}$: the one year ahead forecast of growth in income, ryn, from a UK version of Muellbauer (1996b). The key explanatory variables are $\ln ryn_t$, a time trend, changes in Bank base rate, changes in unemployment, competitiveness and the trade deficit and government deficit to GDP ratios. Parameter shifts in the last two variables are introduced to represent the shift in macroeconomic feedback rules in the 1980s, reflecting a reduced balance of payments constraint on growth with international financial liberalization and increasing concern with the public sector borrowing requirement as an objective in itself.

Table 3: Means and Standard Deviations of Variables

		mean	st.dev.
Equation (11)			
	$\Delta\ln(hp/pc)$	0.020	0.088
	$\Delta\ln ryn$	0.021	0.024
	$\Delta_2 abmr$	0.002	0.017
	$\Delta\ln hpse_{-1} - \Delta\ln pc$	0.028	0.095
	$\Delta^2\ln m_{-1}$	-0.002	0.026
	$\ln(hp/yn)$	8.944	0.105
Table 1, col. (4)			
	$\ln(hp/pc)$	10.449	0.318
	$\ln hs_{-1}$-$\ln pop$	0.113	0.073
	$\ln poo_{-1}$	-0.678	0.157
	dldem	0.002	0.0060
	avln ryn	2.572	0.217
	$\Delta\ln \hat{ryn}_{+1}$	0.021	0.019
	$Dum\Delta\ln \hat{ryn}_{+1}$	0.009	0.016
	$compass_{-1}/yn$	1.717	0.267
	Dumwr	0.009	0.014
	$\hat{ror}$	0.044	0.083
	ror_{-1}	0.046	0.088
	$(gr\hat{or})^3$	0.030	0.105
	$avrorm_{-2}$	-0.026	0.077
Equation (13)			
	$\hat{\hat{ror}}_{+1}$	0.045	0.090
	$\hat{ror}$	0.046	0.083
	$\Delta a\hat{b}mr_{+1}$	0.001	0.009
	$\Delta abmr$	0.001	0.011
	rabmr	0.002	0.044