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## Contents

**Abstract**

It is widely perceived that credit supply conditions faced by UK consumers, particularly in the mortgage market, have been liberalised since the late 1970s, with implications for the housing market and consumer spending. This paper examines quarterly microdata from the Survey of Mortgage Lenders to learn about changes in credit conditions from loan to value ratios (LVRs) and loan to income ratios (LIRs) of first-time buyers (classified by region and age). It combines data on the proportions of high LVR and high LIR loans with aggregate information on UK consumer credit and mortgage debt to give ten quarterly series for 1975-2001. These are modelled in a ten-equation system. A comprehensive set of economic and demographic influences on the demand and supply of credit, applying relevant sign restrictions, are controlled for. A single time-varying index of credit conditions captures the common variation in the ten credit indicators which cannot be explained by the economic and demographic controls. The broad coverage of credit market indicators and thorough investigation of economic forces driving the credit market should make the resulting credit conditions index more robust than previous estimates. The index increases in the 1980s, peaking towards the end of the decade. It retraces part of this rise in the early 1990s, before increasing again to levels, for one of the two measures, exceeding the previous peak. The index is useful in modelling consumption and the housing market, and in interpreting current monetary conditions. An important by-product of the paper is the model for consumer credit and mortgage debt developed here.

JEL classification: C32, E44, E51, G21.

**Summary**

It is widely perceived that credit supply conditions for UK consumers have been liberalised since the late 1970s, with implications for the housing market and consumer spending. Consumption and the housing market (with changes in credit availability likely to have contributed) were important factors in the economic boom of the late 1980s and the subsequent recession of the early 1990s.

The need for a credit conditions index (CCI), which measures credit availability other than through the level of interest rates, has been recognised in previous work on consumption. Proxies such as unsecured credit to income ratios and interest rate spreads have been used in empirical work. However, such proxies are unsatisfactory because they depend on the economic environment. This paper constructs a CCI, that, as far as possible, is free of this criticism because it controls for the effects of the economic environment. The paper constructs a CCI for households between 1976 and 2001. The index is constructed by assuming that there is an unobserved common influence (credit conditions) in each of ten credit indicators. Because this is assumed to be the same in each indicator, it is possible to back out an estimate. The history of institutional changes in the credit markets is used to guide the estimation of the CCI. Two of the ten credit indicators are aggregate unsecured debt and mortgages (secured debt). The remaining eight consist of the fractions of high loan to income and high loan to value mortgages for UK first-time house buyers split by age and regions. We argue that mortgage defaults largely arise from the coincidence of having a poor debt/equity position and experiencing cash-flow problems. So mortgage lenders limit initial loan to value and loan to income ratios to control the risk of default. We use these arguments to model the fractions of first-time buyers with high loan to value ratios and high loan to income ratios. We build on previous literature to derive specifications for aggregate unsecured and mortgage debt, although the attention to expectations and risk distinguish these models from previous work.

To ensure that, as far as possible, the CCI is not affected by the economic environment, we test and include a large set of economic controls. We start from a very general specification, so we carefully consider what theory tells us the effects of the controls should be. As far as possible, the CCI should measure credit availability, ie the supply of credit available to a typical household, once economic and demographic influences have been removed. The econometric results produce two credit condition indices. In one case, the CCI has only a direct impact on the level of credit. In the other, it works in combination with other variables, so that, for example, the influence of the real interest rate and housing wealth on debt shifts with CCI. Both indices increase in the 1980s, peaking towards the end of the decade. They fall partway back in the early 1990s, before increasing again towards the end of the sample. All equations include a common risk factor that depends upon a measure of inflation volatility, the change in the unemployment rate and a measure that is designed to capture the possibility of housing returns declining, all in the previous two years, and the mortgage possessions rate in the previous three years. At the same time, we also estimate new models for unsecured debt and mortgage debt.

## 1. Introduction

It is widely perceived that credit conditions facing UK consumers, particularly in the mortgage market, have been liberalised since the 1970s. The implications for the housing market and consumer spending have been important: the evidence is that consumption and the housing market were the principal agencies in the economic boom of the late 1980s and the subsequent recession of the early 1990s. Changes in credit availability during that period are likely to have contributed to the boom and subsequent retrenchment in consumption.

The UK experience of financial liberalisation must be seen in the wider international context. It is noteworthy that measures of globalisation in financial markets, such as the ratio of gross capital flows between OECD economies, divided by OECD GDP, expanded rapidly in the 1980s and 1990s. Many countries abandoned controls on international capital movements in the 1980s and eliminated interest ceilings and other deposit and credit market restrictions. Allen and Santamero (1998) argue that the deepening of financial architecture illustrated by the development of markets for financial futures, options, swaps, securitised loans, and synthetic securities have altered the roles of financial intermediaries. In particular, they have allowed far more sophisticated risk management, including by financial intermediaries directly or indirectly lending to households. Transactions costs and asymmetric information declined with costs of IT and telephony, and data management and quality have improved. In the United States, the automation of many of the steps in the lending process resulted in the cost of originating a mortgage declining from 2.5% to 1.5% (Bennett *et al* (1998)). Risks have been reduced by improved initial credit scoring and case management, and transferred to other market participants. Calem *et al* (2005) argue that lower consumer switching costs in the credit card market have increased the degree of competition in these markets. A similar case is made for other household debt markets in the United States (Lyons (2003)). International financial liberalisation and its sometimes unpleasant macroeconomic aftermath are discussed further by Caprio *et al* (2001) and Goodhart *et al* (2004).

The need for a credit conditions index (CCI), which measures credit availability, ie the position of the supply function for credit faced by a typical household, other than via the level of interest rates, has been widely recognised in the consumption literature. Indeed, proxies such as unsecured credit to income ratios and interest rate spreads have been used in empirical work (see Bayoumi (1993a,b) and Sarno and Taylor (1998) as examples of the former; and Scott (1996), for the latter). However, such proxies are unsatisfactory because they are too dependent on interest rates, asset prices, incomes, expectations, risk perceptions and other aspects of the economic environment. The key aim of the present paper is to construct a CCI, which, as far as possible, is free of this endogeneity criticism because it controls for the effects of the economic environment.

A first attempt in this direction for the United Kingdom was made by Muellbauer and Murphy (1993), in their ‘flib’ index, based on the analysis of average loan to value ratios (LVRs) in the

United Kingdom for first-time buyers from the 5% Sample of Building Society Mortgages.[1] For many of these buyers, the LVRs are at ceilings set by mortgage lenders. Effectively the method involved regressing the log average LVR on the log of the mortgage interest rate, the log house price to income ratio and the real mortgage interest rate, for 1969-80 data, and using the post-1980 residuals as a measure of the easing of credit conditions due to financial liberalisation. Caporale and Williams (2001) and Fernandez-Corugedo and Price (2002) have extended the method to more recent data and have applied it to modelling consumption. However, the method is somewhat fragile since it relies on a single indicator, and plausible changes in the specification of the relationship can cause notable changes in the implied 'flib' estimates. Muellbauer (1997) used annual regional data for first-time buyers on average LVRs and on the proportion of LVRs over 0.9 to bring additional information to bear, using dummies to trace out the post-1980 easing of mortgage credit. As he acknowledges, see also Muellbauer (2002), there is a sample selection problem in relying on a sample, which, before 1992, contained only building societies. Thus, when the banks aggressively entered the mortgage market, loan terms offered by building societies became much less representative of the market as a whole.

From 1975 to 2001, there are over a million observations on mortgages for first-time buyers in the Survey of Mortgage Lenders (SML), and in its predecessor before 1992, the 5% Sample of Building Society Mortgages. We extract quarterly data on loan and household characteristics from this source, excluding sitting tenants and others buying at a price discount. The present paper uses quarterly data on distributions of LVRs and also loan to income ratios (LIRs), with a regional and age split, and combines these with aggregate data on mortgage and non-mortgage household debt to generate time-series data for 1975 Q1 to 2001 Q4 on ten credit indicators. These are modelled in a ten-equation system with extensive economic controls, and a common factor, the credit conditions index, is extracted. The common factor restriction is also used to model the effects of uncertainty for the debt market environment, using a wide range of uncertainty proxies combined into a single index. Since the aggregate data are not subject to sample selection problems, we can use them to identify sample selection factors for the microdata.

The broad coverage of credit market indicators and the thorough and comprehensive investigation of economic forces driving the credit market should make the resulting index more robust than previous estimates. The economic variables we control or check for include factors likely to influence perceived risk: unemployment rates, measures of inflation and interest rate volatility, asymmetric rate of return measures for the housing market, and the recent history of mortgage possessions rates. They also include yield gaps to reflect interest rate expectations, one year ahead income growth to reflect income expectations, as well as survey-based consumer confidence measures, and more conventional demography, interest rate, wealth and income effects. Our index is intended as a scalar measure of credit availability, ie of the position of the supply function for credit faced by a typical household, once all these economic and demographic influences have been removed.

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[1] LVRs have been used in studies of mortgage default as an indicator of lending quality (Breedon and Joyce (1992), Brookes, Dicks and Pradhan (1994)). Lending quality and 'ease of credit' tend to be negatively related, though better screening of individuals' credit histories and other characteristics could improve quality *and* access to credit.

In the United States there is no survey comparable to the SML. However, the Survey of Consumer Finances since 1983 has asked households directly about credit constraints. Cox and Japelli (1993) have used this to estimate the proportions of credit constrained households in 1983. Lyons (2003) has extended the method to comparisons with later surveys in order to estimate by how much actual household debt was below desired debt, and hence to obtain some indication of increased credit availability over time. Comparable data are not available in the United Kingdom so that the SML is the best source on mortgage credit conditions.[2]

We use the term 'credit conditions index' rather than 'financial liberalisation index' because of the latter's connotations of process, rather than outcome.[3] Nevertheless, the process of financial deregulation and other changes in financial architecture, described in Section 2, have had an important bearing on the credit availability outcome. We return in the conclusions to the question of whether our index solves the 'endogeneity' problem. As well as its use in econometric modelling of consumption, debt and the housing market, our estimated index has applicability in interpreting the current state of credit markets. New models for unsecured and mortgage debt are an important by-product of our research.

We should make clear at the outset, that when the marginal impact of our index on debt levels and the other debt indicators is measured, these are not the general equilibrium effects of a shock to credit supply on these indicators. Our models are all conditional on interest rates, asset prices, income and other variables, which themselves will be influenced directly or indirectly by such a shock. General equilibrium calculations of this type can only be carried out inside a much larger model that endogenises variables which depend on the credit conditions index.

The layout of the paper is as follows. Section 2 examines the various aspects of liberalisation and other changes in UK credit markets since the 1970s. Section 3 discusses the information content of the Survey of Mortgage Lenders and its predecessor. It discusses reasons why lenders use credit ceilings, such as limits on loan to income and loan to value ratios. The information we extract consists of the proportions, by age and region, of first-time buyers with loan to income ratios of 2.5 or more and the corresponding proportions with loan to value ratios of 0.9 or more. The remainder of Section 3 explains the empirical methodology and various economic influences on the proportions of high loan to income and high loan to value ratios. Section 4 discusses the economic influences on unsecured and mortgage debt, in the context of the previous literature. Section 5 presents empirical estimates of the ten-equation system assuming there are no interaction effects between the credit conditions index and the other economic variables. Section 6 discusses possible interaction effects of this type and presents estimates of the generalised model including interaction effects. Both versions of the credit conditions index can be seen in Chart 13. Section 7 concludes and discusses possible applications of the credit conditions index. A data appendix provides details of data construction and sources.

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(2) Though the British Household Panel Survey from 1991, and a survey carried out by the Bank of England in 2003, provide micro evidence on debt and household balance sheets, see May *et al* (2004).

(3) Our index of credit supply conditions refers to shifts in the supply of credit function. We also refer to this index as measuring the non-price aspect of credit availability to remind the reader that the index is capturing shifts in the supply of credit rather than movements along the supply curve.

## 2. Credit market liberalisation in the United Kingdom

In the 1970s, a period of negative after-tax real interest rates, the UK authorities attempted to control credit with stringent liquidity ratios on banks, special deposits (the 'corset'), regulations on minimum deposits and maximum repayment periods on hire purchase credit, and directives and persuasion aimed at building societies to limit lending and/or to keep nominal interest rates low. There were several key events in the evolution of financial liberalisation under the Thatcher Government, which came to power in 1979. Exchange controls were removed in 1979, opening the banking sector to greater foreign competition and giving domestic institutions access to the developing Eurodollar markets. This was an important step in integrating the United Kingdom into rapidly expanding international capital markets, discussed earlier. The logical step after removing exchange controls was to abolish the minimum deposit requirement on banks, or 'corset' on bank lending. Banks could enter the mortgage market from 1980.

Increased competition in the mortgage market led to the relaxation of rules on building societies (eg their access to wholesale financial markets) and the break-up in 1983 of the interest rate fixing agreements. The Building Societies Act (1986) formalised the relaxation of rules. One consequence is likely to have been charging higher interest rates for more risky loans.(4) A second phase of new entry into the mortgage market from 1985 was heralded by the influx of centralised mortgage lenders without high street branches.(5)

The Basel I Accords on capital adequacy ratios for banks, agreed in 1988, gave mortgage loans a preferred status, with a 50% risk weighting relative to other loans. This may have caused a further easing to the mortgage-lending regime in the United Kingdom.

The first major demutualisation of a building society occurred in 1989 (Abbey National), demonstrating the new fluidity of the mortgage market. This was followed by a spate of others over the next decade. Initially banks and building societies served somewhat different markets, but by 1990, differences in the average loan or the average income of borrowers between bank and building society customers had become relatively insignificant.

After 1990, following the start of the mortgage repossessions crisis, credit market liberalisation was partly reversed. The Building Society Commission increased prudential advice in 1991. Mortgage indemnity insurers moved the terms of insurance policies sharply against mortgage lenders, not just in pricing, but also in risk sharing. One symptom of the tougher conditions of the early 1990s was the loss of market share of centralised mortgage lenders (with higher default rates than building societies).

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(4) We have microeconomic evidence from the Survey of Mortgage Lenders and its predecessor of a significant positive correlation in cross-sections of loan to value ratios for first-time buyers from 1983 with the mortgage rate charged. This correlation is absent before 1983. However, these correlations are relatively weak or entirely absent for loan to income ratios. We control for borrower income in these analyses.

(5) These included Allied Irish Bank, Credit Lyonnais and other foreign banks.

Improvements in the mortgage lenders' credit scoring methods, data and arrears management and probably in pricing for risk occurred after the early 1990s, as in the United States (see Introduction). The late 1990s saw another type of new entry - the internet mortgage lenders - and significant innovation in new products, such as fixed-rate mortgages over longer terms and 'flexible mortgages'. The latter permit borrowers to repay loans more quickly, take payment holidays or extend loans flexibly, as long as loan to value ratios remain within pre-set bounds, see Munro *et al* (2001). The spate of special offers to new customers tended to improve mortgage terms for those willing to undergo the inconvenience of remortgaging, one symptom of the strength of competitive pressures, see Samuels (2001).

In 1998, a significant change in pricing behaviour by mortgage lenders occurred. Following the lead of the largest lender, the Halifax, lenders gave borrowers exemption from mortgage indemnity insurance (which insures lenders against mortgage default) if loan to value ratios were below 0.9. This gave borrowers a considerable incentive to reduce mortgages to below this level.

Chart 1 illustrates two aspects of this brief history. It shows the value share of banks in mortgages outstanding (Abbey National continues to be treated as a building society after 1988). The rapid rise from 1980 is notable, but after 1990, this share has little more meaning as a sign of competitive pressure since the lending profiles of banks and building societies had become very similar. Chart 1 also shows the value share of centralised mortgage lenders, demonstrating the post-1985 rise (see the left axis for the scale), and renewed growth in recent years.

Chart 2 shows consumption to income and house price to income ratios rising strongly in the 1980s. Part of the co-movement is due to credit market liberalisation rather than the causal effect of house prices on consumption as demonstrated by Aron and Muellbauer (2006). Chart 3 shows mortgage and unsecured debt to income ratios more than doubling between 1980 and 1990 and rising to new heights recently.

As mentioned in the introduction, another type of evidence is available from surveys of mortgage lenders, carried out since the end of 1968. We turn next to the use of data from this source.

## 3. Extracting information on credit conditions from the Survey of Mortgage Lenders

### *3.1 Distributions of loan to income and loan to value ratios and limits set by lenders*

The key reason for mortgage lenders applying limits to loan to income ratios (LIRs) and loan to value ratios (LVRs) is to avoid the risk of default, both in payment arrears, and, more seriously, mortgage possession. Mortgage possession, where the lender seizes the housing collateral of mortgages in default, can be seen as the intersection of two events: the 'debt/equity ratio rising above some threshold' and 'a trigger function (of debt service ratio, income shocks) exceeding another threshold'. The first of these events makes it difficult or impossible for the borrower to trade down to cheaper housing or out into the rental sector, given the difficulty of obtaining substantial unsecured debt. Borrowers and lenders have a common interest in avoiding default, even with a bad debt/equity ratio, since mortgage possession in the United Kingdom is unpleasant for borrowers. The latter are liable for the lenders' transactions costs, and subject to pursuit in the courts for years and denial of access to future credit. However, if unexpected cash-flow problems arise - the trigger function exceeding some threshold - there will often be no alternative to default.

The probability of default, ie the intersection of the two bad events, equals the probability of a bad debt/equity ratio multiplied by the probability of a bad trigger, given a bad debt/equity ratio.[(6)] By limiting the initial LVR, lenders can reduce the probability of later bad debt/equity ratios, arising through a fall in house prices, and/or through accumulated payment arrears.

Limiting initial LIRs, reduces the probability of a later bad 'trigger'. For example, with a LIR of 2.5, the initial debt service ratio is $2.5*r$, where $r$ is the tax-adjusted mortgage interest rate plus pro-rated loan repayments, initially a small fraction of monthly mortgage payments, plus pro-rated insurance costs. For example, with $r$ at 10%, 25% of income is committed to debt service. However, with $r$ at 15%, 37.5% of income would be committed to debt service, a percentage many households would find hard to tolerate, particularly if they had not planned for it. Thus, in an environment of high nominal interest rates, lenders are likely to apply tighter LIR criteria, while in a low interest rate environment the opposite will be the case. As Kearl (1979) notes, constant repayment mortgages, which may be a feature of regulation or convention, together with restrictions on or costs of refinancing impose welfare-reducing front-end loading on real mortgage payments by households. With credit market liberalisation, the influence of nominal mortgage rates on LIR ceilings should decline.

It would seem logical for lenders to offer borrowers a trade-off between LVR and LIR limits, since it should be possible to raise the LIR when LVR is lowered, keeping overall risk constant. We are not aware of formal, *ex-ante* offer schedules of this type being published by any of the major mortgage lenders. However, lenders do operate some trade-offs in practice, in making mortgage offers in specific circumstances, having evaluated all the information provided by a mortgage applicant. For example, some lenders offer self-certification mortgages where, for LVRs below 70% or 80%, the lender does not carry out income checks but relies on the information given by the borrower. In any case, even if any given mortgage lender offered only a specific LVR, LIR pair, in the market as a whole, borrowers will find variations in these offers. Borrowers therefore face a schedule of LVR, LIR possibilities, the envelope of best offers.[(7)]

For given interest rates, house prices etc, financial liberalisation as occurred in the 1980s, is likely to have raised both types of limits on loans as reflected in this schedule of best offers. Note that,

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[(6)] The United Kingdom differs in important ways from many US states where borrowers' liabilities end as soon as they return the keys to the mortgaged property to the lender. Thus, in the United States, the debt/equity ratio should have a more dominant role in defaults, largely decided on by borrowers. In the United States, the 'rational default model' (Vandell (1995)), which applies option pricing theory to find the bad debt/equity threshold, beyond which the household defaults, in absence of transactions costs and credit restrictions, is widely applied. It is unlikely to apply in the United Kingdom, where most defaults were instigated by lenders, not borrowers. Unpublished research on arrears and possessions for a large mortgage lender in the United Kingdom (Cameron, Hendry and Muellbauer) provides evidence consistent with these points.

[(7)] A best offer is a pair of LVR, LIR offers where no alternative offer is higher in both LVR and LIR at the same interest rate. In practice, there can also be variations, such as first-time buyer discounts, in interest rates and other mortgage charges such as conditions associated with fixed-rate offers.

while borrowers and lenders have significant common interests in wanting to avoid loan defaults or coming under severe financial pressure from debt service costs, there seems no reason why financial liberalisation should cause unconstrained *borrowers* to want to raise these LVRs and LIRs.[8] The rise in LIR and LVR, which occurred, and which cannot be explained by conventional demand-side variables, is therefore likely to have been a shift on the credit supply side.

Muellbauer (1997) has discussed the structure of decision-making behind the observable LIRs and LVRs. A credit-unconstrained household chooses a mortgage loan $M^d$ and a house of value $V^d$ by maximising utility subject to its budget constraint and the housing quality-house price trade-off generating $LVR^d = M^d/V^d$ and $LIR^d = M^d/Y$ ($Y$ is the household's current income). The household is faced with the schedule of best LVR, LIR offers described above. There are two possibilities illustrated in Charts 4a and 4b.

Chart 4a illustrates the case of a household whose voluntary LVR, LIR choice is below the best offer schedule available in the market. The fact that there are such households means that the market share of mortgage lenders offering lower LVR, LIR limits than available from other lenders is not zero. The household indifference curves illustrated are the contours of a utility hill whose peak is at *H*. This coincides with the chosen equilibrium point *E*.

Households are making temporal and intertemporal consumption, housing and risk trade-offs. Note that the value of the house purchased is $V=(LIR/LVR)Y$. For a given income $Y$, $V$ can increase if $LIR$ increases for a given $LVR$, or if $LVR$ falls for a given $LIR$. Thus, in Chart 4, a move to the right and/or down represents more housing. Such a move, however, implies less non-housing consumption, at least in the current period and near future, though if the user cost of housing is expected to be negative, future consumption can be expected to be higher. In particular, with a given $LIR$, the sacrifice in current consumption to increase the down-payment inherent in increasing $V$ and reducing $LVR$, soon becomes untenable − unless there is access to unsecured credit. Such credit is generally more expensive.[9]

Chart 4b illustrates the case of the household constrained in the mortgage market. Point *H* is not attainable and the household chooses the point *E* on the *LVR*, *LIR* offer envelope where it can reach its highest indifference curve. As illustrated, the shape of the utility contours is independent of the position of the *LVR*, *LIR* offer envelope. This would be the case if mortgage borrowers also held some more expensive non-mortgage debt with different liquidity and risk

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(8) While we make the point that financial liberalisation should not lead to an increase in the ceilings chosen by borrowers, habit formation may suggest the contrary. With credit market liberalisation, the consumption of housing goods increased in the economy as agents were able to borrow to purchase a house. As the consumption of housing goods increased, individuals falling behind would have come under reference group pressure to 'keep up with the Joneses' and so increase their housing consumption and debt levels. However, note that the story begins with credit market liberalisation. It certainly seems plausible that the diffusion process by which it affected behaviour could have been via consumer habits as well as their and the lenders' information sets. These channels cannot be empirically distinguished in our estimates of the long-run impact of the credit conditions index on behaviour.

(9) The different risk characteristics to the borrower in the event of payment difficulties and lumpy transactions costs, can make holding both kinds of debt rational, even if the household were able to borrow sufficiently in the mortgage market, see Brito and Hartley (1995).

characteristics, see footnote 8. Kinks in the indifference curves and corresponding behavioural switches could otherwise arise and could also result from limits on non-mortgage credit.

*3.2 The empirical methodology*

We use 26 years of quarterly data on mortgage credit conditions from the Survey of Mortgage Lenders (SML) and its predecessor.[10] Specifically, we examine distributions of LVR and LIR for first-time buyers (FTBs), concentrating particularly on vulnerable tails for LVR $\geq$ 0.9 and LIR $\geq$ 2.5. We examine data by age (under 27 and 27 plus) and by region (North/South) giving eight series on the proportion of FTBs in these respective vulnerable tails. By including also aggregate data on mortgage debt and unsecured consumer credit (see Chart 3) we have ten series. We then use economic and demographic variables to control for variations in credit demand. We combine relevant economic risk indicators into a single RISK index, which enters all the equations. The common unobserved supply shift component, our credit conditions index (CCI), also enters all equations. CCI is constructed with a spline function driven by year dummies. The set-up of the ten-equation system is detailed in Section 5.

The CCI index can subsequently be used to model consumption (Aron and Muellbauer (2006)), house prices (Cameron *et al* (2006)), housing equity withdrawal, housing turnover and subsequent loan defaults in separate equations. Alternatively, such equations could be added to the system.

Usable electronic records for the LIR and LVR distributions begin in 1975 but average LIRs and LVRs for first-time buyers (excluding discounted 'right to buy' sales to social housing tenants) are available back to 1969 and are illustrated in Chart 5. The LIR graph shows an early peak in 1972 during the first of the post-war house price booms, a strong rise between 1980 and 1990, and a weaker upward drift in more recent years. Despite some definitional issues, to be discussed, the data suggest a considerable positive correlation between average house price/income ratios and LIRs.[11] The graph of the average LVR ratio suggests the opposite correlation with average house price/income ratios, and a strong rise between 1980 and 1984, with levels thereafter remaining higher than before, but otherwise no immediately obvious pattern emerging.

Charts 6 and 7 show PLIR, the percentage of FTBs with LIRs of 2.5 or more by age and region, rising from under 10% in 1980 to over 60% in 1989 in the case of the South and to over 35% in the North. The correlation with average house price to income ratios is apparent as in Chart 5: both the 1989-90 peak and the early 1990s decline in the South are consistent with the pronounced Southern boom/bust in house prices in this period. The systematic tendency of PLIR

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[10] The survey and its predecessor consisted of a 5% sample until 2002. The survey includes information on income, size of loan, value of house being purchased, previous tenure, the age of the main borrower, whether the price was discounted, type and duration of mortgage, and the interest rate charged. From 1983, single borrowers and multiple borrowers, such as couples, are distinguished, but not so in earlier years.

[11] They also contain at least a hint that the temporary early 1970s 'Competition and Credit Control' policy shift was associated with some easing of credit market conditions.

to be higher in the South than the North is consistent with higher house price/income ratios in the South. Differences by age are less pronounced than by region: in both regions, older FTBs tend to have slightly lower percentages of high LIR mortgages.[12]

Charts 8 and 9 show PLVR, the percentage of FTBs with LVRs of 0.9 or more. The graphs show a very clear difference between borrowers aged under 27 and those aged over 27: in both regions, systematically higher percentages of younger borrowers have LVRs of 0.9 or more. One should expect such differences since younger borrowers tend to have lower cash resources and so are less able to provide substantial deposits. For these younger borrowers, PLVR rose from averages of 25%-30% in 1975-80, to 60%-80% and 50%-70% for North and South, respectively, for 1984-2000. The decline since 1998 is notable.

### *3.3 Economic factors impinging on PLIR*

The structure of decision-making underlying the observed LIR and LVR distributions was discussed in Section 3.1. In many respects mortgage lenders and households have a common interest in avoiding default, as discussed above. The direction of effects of interest rate and risk factors on the proportion of high LIR loans will therefore be the same. The directions of most of the economic forces operating on the proportion of high LIR loans are easy to understand, see Muellbauer (1997) for more microeconomic detail. The key economic variables and the signs of their expected effects on PLIR, are now listed:[13]

*Nominal interest rate*: a high rate raises the debt service ratio, see Section 3.1. **(-)**

*Real interest rate*: a high real rate raises the probability of mortgage arrears and lower house prices and so default risk. **(-)**

*Interest rate expectations*: the nominal yield gap between gilts at durations of one or more years minus short rates, should reflect the market view of the direction of movement of short rates. **(-)**

*Interest spread between unsecured and mortgage debt*: a higher spread increases the price advantage of mortgage debt and so raises PLIR. **(+)**

*House price/income ratio*: a high ratio puts pressure on borrowers to get the highest possible loan (and so helps explain higher PLIR in South). **(+)**

*Consumer confidence*: greater confidence in economic prospects should increase the willingness of lenders to lend and borrowers to borrow. **(+)**

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[12] We have also examined plots of the PLIR type using thresholds of 3 and 3.5. These have broadly similar shapes but clearly respond somewhat differently to house prices and risk factors. Given that we control for these, we expect the estimated CCI to be fairly insensitive to the precise choice of threshold. The choice of 2.5 was influenced by the fact that, in the important 1980-85 period, the proportions above the higher thresholds are substantially lower, which is likely to increase sampling variability.

[13] Note that the signs in brackets and in bold indicate the impact of the chosen variable on the dependent variable.

*Perceived risk*: we examine five indicators, which enter a risk factor common to all ten equations. The first two are inflation and interest rate volatility. Greater historical volatility is likely to be interpreted, by lenders and borrowers, as a sign of greater riskiness and should discourage borrowing on high multiples. The third risk indicator is the four-quarter change in the rate of unemployment. The fourth risk indicator is an asymmetric indicator[(14)] of returns on housing and the fifth is the rate of mortgage possessions (these are two or three-year moving averages). **(-)**

*Deviation of real income from trend*: one aspect of favourable economic conditions. **(+)**

*Expected income growth*: using actual income growth over the next four quarters as a proxy. **(+)**

*Dummy for cut in ISMI* (income support for mortgage interest): in 1995 such income support was sharply reduced, increasing the risk of cash-flow problems in the event of unemployment. **(-)**

*Dummy for mortgage indemnity premium pricing*: in 1998, market leader Halifax removed mortgage indemnity premia for LVR < 0.9 and the market followed. This gave borrowers an incentive to bring LVRs below 0.9, eg by increasing unsecured borrowing to raise cash deposits. The effect on PLIR is less clear: a negative effect operates via those mortgages, which would previously have been in the group where LVR is greater than 0.9; but a positive effect on PLIR also operates since mortgages with LVR below 0.9 became cheaper. Moreover, with PLVR lower, risk is reduced in the house price risk dimension, giving scope for relaxation in the income risk dimension, so raising PLIR. **(?)**

*Share of couples*: since lenders apply lower LIR ceilings to joint incomes, a rise in the share of couples among first-time buyers, would lower the proportion of high LIR loans. **(-)**

*Sample selection due to the increasing market share of banks*: before 1992, when the mortgage lenders' survey refers to building societies only, an increase in the share of banks (and later, in centralised mortgage lenders) makes the building society sample less representative of the whole market. In other words, while our dependent variable should be the log-odds-ratio of PLIR for *all* mortgage lenders, before 1992 it was based only on building societies (including Abbey National). We therefore need to add a correction factor to the equation. If the proportion of high LIR loans for banks was above/below that for building societies, the correction factor would be negative/positive, and it also needs to be weighted by the share of banks. From 1983, data are available on average loans advanced by banks and building societies. The data show average bank loans per borrower to be around 30% higher than building society loans in 1983-85, but declining to be close to the level of building societies by 1990. For 1980-82, we assume bank advances to be 40% higher. We define our sample selection bias correction factor to be a coefficient to be estimated times (average bank advance/average building society advance –1)* (annual change in the share of banks in total mortgages outstanding), and zero after 1990, when banks and building societies have very similar lending profiles. The change in the share of banks is a proxy for the share in the volume of new advances to FTBs by banks, which is not available.

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[(14)] This indicator is defined as the rate of return when this is negative and zero when the rate of return is positive.

Thus, when banks first entered the market, the average mortgage advance by banks was higher than that of building societies. The banks initially catered to the upper end of the market, particularly to existing bank customers with stable jobs, some liquidity, and known credit and income records and hence with relatively low credit risk. This drove the building societies down-market. One might have expected both PLIRs and PLVRs to be lower for higher income groups and so expect a positive coefficient for our sample selection correction factor. Indeed, our cross-section evidence is that throughout the sample, there is a negative correlation between the LIR and the borrower's income. However, as noted, for its own customers, a bank's information asymmetry will be lower than for a random customer and this would suggest high LIRs to be offered to such customers. This could result in a negative coefficient for our sample selection correction. Since we do not know which tendency dominates, we do not have a sign prior for this case. By the late 1980s, the average loans from banks and building societies had become fairly similar, and the sample selection effect fades away. **(?)**

*Sample selection due to increasing market share of centralised mortgage lenders*: these entered the market from 1985, obtaining access to customers through financial advisers, estate agents and others because they did not have an established presence on the United Kingdom's high streets. Their subsequent mortgage possessions rates were around three times as high as those of the building societies (Ford (1994)) suggesting a riskier lending profile, and thus a higher proportion of high LIR and high LVR loans. The annual change in the share of loans outstanding accounted for by centralised mortgage lenders is a proxy for their proportion of new advances and hence a sensible sample selection proxy. We expect negative effects on PLIR and PLVR.(15) **(-)**

### *3.4 Economic factors impinging on PLVR*

The economic factors affecting PLVR should work similarly to those affecting PLIR, with the following exceptions:

*House price to income ratio*: this should act on PLVR in the opposite direction to the effect on PLIR. There are two mechanisms: a high house price indicates a greater probability of a fall in house prices, other things being equal. Second, in areas with high house price/income ratios, households are more likely to be pushed to high LIR levels. To control overall levels of risk, lenders should be more cautious about offering very high LVRs to borrowers with high LIRs (see Section 3.1). **(-)**

*Rate of change of house prices*: valuations by surveyors for mortgage lenders are likely to be conservative, tending to lag behind the market when prices are rising strongly. Loan offers are based on these valuations but LVRs reported for completed transactions are based on prices actually paid, which will tend to exceed mortgage valuations in rising markets. The time lag in the mortgage approvals process can induce similar effect in rising markets, where the incidence

(15) Note that the information from aggregate mortgage debt data is the key for identifying such sample selection effects. For example, while the centralised mortgage lenders are gaining market share, this is reflected in rising aggregate mortgage debt/income ratios even though the building society data on PLIR and PLVR apparently suggests no rise or even a contraction of credit conditions.

of 'gazumping', the seller demanding a higher price than initially agreed, is higher. Note that this effect should be absent from the PLIR equation. **(-)**

*Dummy for mortgage indemnity premium pricing*: the relaxation from 1998 would have had a particularly strong effect for mortgages whose LVRs would otherwise have been only just above 0.9, where the cost saving would substantially exceed the higher marginal cost of unsecured borrowing; PVLRs should fall. **(-)**

*Average age*: though we divide borrowers into under 27, and 27 and over, age groups, variations do occur of average ages within these groups, especially in the open-ended 27 and over group, which drifted up in the 1990s, and especially since 1998. Since the accumulation of financial assets available for housing deposits increases with age, we expect a negative effect on PLVR.[(16)] Chart 15 shows the age deviations for borrowers over 27 years of age, that is the difference between their average age for each quarter and their mean age over 1975-2001. **(-)**

*Sample selection with respect to the rising share of banks*: the discussion of sample selection in Section 3.3 suggests a positive effect on PLVR for building society mortgages in the early 1980s from the rising market share of banks. It is likely that existing bank customers, particularly with above average incomes, would have had above average liquidity, so that the incidence of high LVRs would be lower, so pushing the observed PLVR for building societies above the market average. One could argue for an offsetting effect arising from lower information asymmetry for banks, as discussed in Section 3.3. However, the information banks have is likely to be about the security and prospects for the incomes of their customers and is more relevant for PLIR than for PLVR. This makes a positive sample selection effect more likely. **(+)**

*Sample selection due to increasing market share of centralised mortgage lenders*: a negative sample selection effect for centralised mortgage borrowers is expected for reasons discussed in Section 3.3. **(-)**

### *3.5 Functional forms for PLIR and PLVR equations*

Section 3.1 set out the decision structure behind the observed LIRs and LVRs. We do not have precise ideas about the functional forms for LIRs and LVRs corresponding to household choices not constrained by limits imposed by lenders, see Chart 4a, and how these differ from choices made subject at lenders' limits, see Chart 4b, and about the stochastic structure of disturbances at the level of individual households and mortgage lenders. Identification of these structural relationships is hopeless. Moreover, the observed distributions of LIRs and LVRs are for completed transactions of first-time buyers. Some potential FTBs may not have been able to obtain finance at all, or have been unsuccessful in housing search, or have encountered sellers unable to transact within the relevant period. Furthermore, the number of transactions by first-time buyers has fluctuated considerably over the past 26 years (Holmans (1996, 2001)) and it is possible that the shape of the LIR and LVR distributions may have been affected by the

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(16) One would expect a negative effect on PLIR also. However, given the stylised fact from Charts 4 and 5, of only a small age difference in PLIR between the under 27 and 27+ groups, it seems likely that this effect will be weak.

transactions volume. We cut through these potential complexities using a rich set of controls to model reduced-form equations for PLIR and PLVR.

Suppose reduced forms(17) for observed LIRs and LVRs at the individual level are given by

$$\log \text{LIR}_{\text{it}} = f(x_t) + \varepsilon_{it} \quad \textbf{(1)}$$

$$\log \text{LVR}_{\text{it}} = g(x_t) + \eta_{it} \quad \textbf{(2)}$$

where $\varepsilon_i$ and $\eta_i$ are household specific error terms with zero means. Then

$$\text{PLIR}_{\text{t}} = P(f(x_t) + \varepsilon_{it} \geq \log 2.5) \quad \textbf{(3)}$$

$$\text{PLVR}_{\text{t}} = P(g(x_t) + \eta_{it} \geq \log 0.9) \quad \textbf{(4)}$$

If the distributions of $\varepsilon_{it}$ and $\eta_{it}$ could be approximated by logistics, so that, for example

$$P(\varepsilon_{it} > z_t) = 1/(1 + exp(\alpha z_t)) \quad \textbf{(5)}$$

Then $\exp(\alpha z_t) = (1 - P_t)/P_t$ and

$$\log(P_t / 1 - P_t) = -\alpha z_t \quad \textbf{(6)}$$

This suggests we should use these 'log-odds' ratios as the dependent variables. As we shall see, we allow for a possible misspecification of equation **(3)**, by introducing a cubic in $z_t$ as well.

## 4. Economic factors impinging on aggregate unsecured and mortgage debt to income ratios

One would expect the economic variables affecting debt to income ratios to work as follows:

*Demography*: proportions of working-age individuals in the key house-buying age groups, see Chart 10 for the ratio of 20-34 year olds to 20-69 year olds. **(+)**

*Income*: higher income should allow households to service debt more easily.(18) **(+)**

*Expected income growth*: if individuals are consumption smoothers and expect higher income growth in the future, they will increase their consumption of housing and non-housing goods for a given level of income and will therefore be more likely to get into debt. **(+)**

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(17) We call these 'reduced forms' because of the mix between decisions by lenders and by borrowers outlined in Section 3.1. In contrast, the aggregate debt equations are closer to structural demand equations, conditional on variations in the position of the credit supply function, measured through CCI.
(18) See Ludvigson (1999) for a theoretical model of unsecured debt as a function of consumers' income. In that model an increase in the debt to income ceiling enables consumers to get into more debt, a fact Ludvigson finds consistent with the data. Also see Japelli (1990) for the finding that a major reason households in the Survey of Consumer Finances are denied credit is because they had insufficient income.

*The change in the unemployment rate*: this may proxy income expectations and uncertainty.[19] **(-)**

*Liquid financial wealth*: at the individual level, greater liquid wealth reduces the need to borrow. At the level of the economy, a higher level of household liquid assets/income suggests a greater ability for the financial system to recycle assets into debt, though with financial deregulation, household deposits would no longer constrain lending to households. In other words, controlling for the credit conditions index, greater liquid wealth should reduce indebtedness. **(-)**

*Illiquid financial wealth*: eg tied up in pensions, provides long-term asset backing for debt, and so should have a positive effect on the demand for debt. **(+)**

*Housing wealth*: the greater gross housing wealth, the greater the available collateral for mortgage debt. However, for unsecured debt, the sign is ambiguous. Against the collateral argument is the argument that, given substitution between the two kinds of debt, having less collateral induces a switch towards unsecured borrowing. **(?/+)**

*Consumer confidence*: the consumer confidence measure used corresponds to the GfK survey and measures consumers' confidence about their finances and the state of the economy. An increase in confidence should be consonant with households taking on more debt. **(+)**

*Change in consumer credit controls*: consumer credit controls, which regulated down-payments and repayment periods for 'hire purchase' borrowing to buy durable goods, were an important policy instrument in the 1950s to 1970s. A tightening in controls should have a negative impact on unsecured debt in the 1970s, in addition to its role as a proxy for CCI at this time. **(-)**

*Stock of debt in the previous period/income*: the higher is debt, the more debt has to be repaid each period under typical debt contracts. Another aspect is equilibrium correction: the tendency of the steady-state level of debt not to be exceeded. For the rate of change of debt the lagged stock effect is therefore negative. **(-)**

*Nominal interest rate*: with a higher nominal interest rate the debt service ratio is likely to reduce the amount of debt that individuals are likely to undertake and to which lenders will agree. **(-)**

*Real interest rate*: higher real interest rates should lower debt through two channels. In the first, higher interest rates make debt less affordable. The second channel is through saving as higher real interest rates raise the relative price of current consumption. **(-)**

*Interest rate expectations*: the yield gap between gilts at durations of one or more years minus short rates, should reflect the market view of the direction of movement of short rates. **(-)**

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(19) Carroll and Dunn (1997) argue that unemployment expectations are a good predictor of consumption. In the United Kingdom, changes in the unemployment rate are persistent, so that they could have an expectational interpretation. The uncertainty role of changes in the unemployment rate is also allowed for through the common risk factor.

*Spreads between the credit card interest rate and mortgage rate*: a negative effect on unsecured debt; a positive effect on mortgage debt. **(-/+)**

*Perceived risk*: we use the five indicators discussed in Section 3.3, entering a risk factor common to all equations. **(-)**

*Dummy for cut in ISMI* (income support for mortgage interest): the increase in the risk of future cash-flow problems should reduce demand for mortgages at the margin, but increase demand for unsecured loans, by reducing their relative disadvantage. **(+/-)**

*Ratio of credit cards outstanding to adult population*: a positive effect on unsecured credit, see Chart 10. The more credit cards are available to consumers, the higher the probability that these will be used. **(+)**

*Dummy for mortgage indemnity premium pricing*: a positive effect on unsecured credit from 1998 as lenders abolished the premium for LVRs under 0.9 giving an incentive for those whose LVRs would have exceeded 0.9, particularly those who would have been only just over the 0.9 level, to use unsecured debt for marginal finance. Our prior is that this effect dominates an effect in the opposite direction from the overall lowering of mortgage costs relative to unsecured loans from the abolition of the premium for most mortgages. The effect on mortgage debt should also be positive: our prior is that the lowering of costs for most mortgages (including, of course, to previous owner-occupiers) outweighed the incentive to switch marginal funding to unsecured loans for those whose LVRs would have been over 0.9. **(+)**

## 5. Empirical results: the baseline model

Sections 3 and 4 have outlined the economic variables expected to impact on loan to income ratios (LIRs) and loan to value ratios (LVRs) for first-time buyers, as represented by the eight series on PLIR and PLVR, and on aggregate unsecured and mortgage debt, shown in Chart 3 as ratios to income. As explained in Section 3.2, the effect of the altered credit supply environment, linked to the institutional changes discussed in Section 2, is introduced in each equation through the credit conditions index (CCI) common to all ten equations. This is represented by a linear spline function, which apart from the year 1980, consists of connected straight-line segments, which can change slope at the beginning of each year.[20] The CCI also depends on the change in consumer credit controls, phased out in 1983. In addition, in the unsecured debt equation, we incorporate the ratio of the number of credit cards outstanding to the number of adults, to capture changes in credit supply not reflected in CCI, the latter being more tuned to the mortgage market. The data appendix details the data used.

Even without interaction effects (see Section 6), estimating this ten-equation system was not trivial: we imposed our extensive prior expectations on sign patterns of coefficients outlined in Sections 3 and 4, as well as on the broad outline of the CCI index, given the institutional

[20] For the year 1980, we check the quarterly timing and find that CCI rises only in 1980 Q4.

evolution described in Section 2. The sign priors are imposed sequentially by setting to zero parameters which violate these priors, restricting first the parameter which most strongly violates the prior. Moreover, to the extent practicable, we allowed the lag structures (eg of responses to interest rates and house price changes) to be determined empirically. For example, in the general specifications, we include quarterly interest rates with lags up to 4, and check for 4-quarter changes or 4-quarter moving averages at lags of 4 and 8. We also check whether current year effects can be simplified into 4-quarter changes or moving averages. It is well known that the order followed by reductions from general to simpler models can affect the final model chosen. We therefore check for alternative reduction paths by varying the order in which terms are simplified and priors imposed, and go back and re-check the restrictions.(21) The priors were helpful in reducing flexible general specifications to a parsimonious one. The priors, together with restrictions, such as zero coefficients on the pre-1980 time dummies in CCI, and normalisations about to be discussed, are important for achieving identification.

We now explain our framework and some identification issues. Our equations are:

$$\Delta y_{it} = \alpha_i \, (\theta_i \, CCI_t + \mu_i \, RISK_t + \Sigma \beta_{ij} x_{jt} - y_{it\text{-}1}) + \varepsilon_{it} \quad \text{for i=1,10} \qquad \textbf{(7)}$$

$$CCI_t = \Sigma \, \delta_s \, Dum_{st} + \lambda_{\,1} \Delta_4 CC_t + \lambda_{\,2} \, liqr_{t\text{-}1} \qquad \textbf{(8)}$$

$$RISK_t = \Sigma \, v_j z_{jt} \qquad \textbf{(9)}$$

The *y* variables in **(7)** are the two log debt measures and the eight log-odds-ratios of LVRs and LIRs exceeding given threshold values, by region and age. We model each as an equilibrium correction model (ECM), with the dependent variable in quarterly change form, $\Delta y$. Here $\alpha_i$ is the speed of adjustment. For those $x_{jt,}$ which can be given a long-run interpretation, $\beta_j$ is the long-run coefficient. Note that the *x*'s include variables in $\Delta$ form, and so are not in the long-run solution. We also impose some homogeneity across equations, for example, setting slope coefficients to be the same across regions and age for the four PLVR and the four PLIR equations, respectively.

The definition of the CCI given in **(8)** incorporates split trends – the *Dums*, the four-quarter change in consumer credit controls, $\Delta_4 CC$ and *liqr*, defined as the liquidity ratio of building societies up to 1980 Q3 minus its 1980 Q4 value, and zero thereafter. Section 5.6 below gives more details on the construction and estimation of CCI. The definition of the *RISK* factor initially incorporated measures of inflation volatility, interest rate volatility, the four-quarter rate of change of unemployment, a measure of negative returns in housing, and the rate of mortgage possessions. The final specification of the risk indicator, **(9)**, is as follows:

$$RISK_t = (1/(1+\delta))(\, v_1(aainfma_t + \delta \, aainfma_{t\text{-}4}) + v_2(\Delta_4 \, ur_t + \delta \, \Delta_4 \, ur_{t\text{-}4}) + v_3(nrorma_t + \delta \, nrorma_{\,t\text{-}4}) + v_4(possesma_{\,t\text{-}2} + \delta_1 \, possesma_{\,t\text{-}6} + \delta_1^{\,2} \, possesma_{\,t\text{-}10})/(1 + \delta_1 + \delta_1^{\,2}\,) \qquad \textbf{(10)}$$

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(21) For example, in an early version of the unsecured debt equation, we found a positive effect from our not very well measured interest rate and on base rate. This could be interpreted as an aspect of increased credit availability, since this will tend to be correlated with higher interest rates and since we want the CCI to capture credit availability, we set this coefficient to zero. In our final specification, however, as other elements of the model reached a parsimonious, interpretable structure we were able to find a specification with a (small) negative base rate effect.

Here *ma* is the four-quarter moving average throughout. Inflation volatility is proxied by *aainf*, the absolute value of the difference between the current four-quarter inflation rate and its value one year previously. To be precise, $aainf_t = abs(\Delta_4 lcp_t - \Delta_4 lcp_{t-4})$ where *lpc* is the log of consumer expenditure deflator, and *abs( )* indicates the absolute value. $\Delta_4 ur$ is the four-quarter change in the unemployment rate. Downside risk in housing returns is proxied by *nror*, equal to *ror*, the rate of return in housing when this is negative and equal to zero when *ror* is positive. We define $ror_t = \Delta_4 lhp_{t-1} + 0.02 - abmr_t/100$, lagging the house price appreciation term to avoid a possible endogeneity bias. Another aspect of housing risk is *posses*, the possessions rate, see Chart 11. This is the quarterly interpolation of a series published every six months. We lag it by two quarters to reflect the typical information lag. This lag is also supported by the empirical evidence. Both it and the downside risk measure can be interpreted as uncertainty about collateral, which Bernanke and Gertler (1989) argue, can induce tighter credit standards. More general forms of the function were investigated, including an interest rate volatility measure, and checking for longer lags in the first three terms. However, these were found to be insignificant. To define interest rate volatility, we define $albr_t = abs(\Delta_4 lbr_t)$, where *lbr* is the log of the base rate, and then take the four-quarter moving average.

It is clear that the $\alpha_i$ and therefore the $\beta_{ij}$ are identified in **(7)**. However, a scalar multiple of the coefficients in **(8)** cannot be separated from a similar multiple of $\theta_i$, so that either one of the coefficients in **(8)** or one of the $\theta_i$ has to be normalised at some value. Exactly the same applies to $\mu_i$ and the coefficients of **(9)** or **(10)**. We choose to set $\theta_i$=10 and $\mu_i$=10, for the PLVR equations. Estimation is performed in Hall and Cummins (1997) TSP 4.5 using system maximum likelihood, estimating the 10x10 co-variance matrix of equation disturbances.

*5.1 The equation for unsecured debt*

Previous research on unsecured household debt in the United Kingdom is relatively sparse.[22] The most recent study is that of Chrystal and Mizen (2005), who examine a simultaneous system including consumption, household M4 and unsecured credit using a VECM approach. They identify three cointegrating vectors. That for unsecured lending has the form (Table C):

$$log\ ud/pc = 1.41\ log\ real\ income - 0.68\ (credit\ card\ interest\ rate - bank\ rate) + 0.65\ log\ real\ net\ worth - 2.89\ \Delta log\ pc \quad \textbf{(11)}$$

where *ud* is unsecured debt and *pc* is the consumer expenditure deflator. In the context of the VAR, the Johansen approach finds empirically that the ECM terms for consumption and broad

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[22] At the level of theory, most of the research on unsecured debt has been undertaken with respect to the effects that unsecured debt can have on consumption/saving decisions. See Antzoulanos (1994), Scott (1996), Ludvigson (1999), Carroll (2001), Fernandez-Corugedo (2002) for the theoretical effects of the relaxation of liquidity constraints on consumption decisions. These papers show that relaxing credit ceilings allows agents to increase their consumption for a given level of cash-on-hand. Maki (2000) provides an excellent summary of some of the US empirical literature on consumer credit and the household debt service burden. Recent papers include Murphy (1999), who demonstrates that the debt burden of households is helpful in forecasting future consumption growth, and in particular durable consumption growth. Gross and Souleles (2002) examine credit demand and supply using US credit card data. They find that an increase in the credit limit leads to an immediate and significant rise in debt.

money also enter the model for *Δlog ud/pc* with significant coefficients, see their Table C. In a model, which conditions on the growth rate of current consumption and in current M4, the former enters negatively with a coefficient of –1.6 ($t$=3.5) and the latter positively with a coefficient of 3.9 ($t$=6.9), while the change in the unemployment rate has a positive coefficient, 0.039 ($t$=4.5) and consumer confidence has a significantly positive effect. The ECM for log real *ud* enters with a coefficient of –0.11 ($t$=5.2), see their Table E. Such an equation cannot be given a conventional demand for credit interpretation: unsecured credit can only be understood as part of the system.

Our approach is more conventional: unsecured credit is interpreted in terms of a function of income, lagged assets, interest rates etc, which, unlike current consumption and end-of-quarter money holdings, can plausibly be regarded as given to the individual household. Though at the micro level, asymmetric information is endemic, so that lenders use rules to limit their risk exposure, information about macro aggregates should be broadly symmetric between lenders and borrowers. Data on unsecured credit held by households will therefore incorporate lending rules, as well as what credit demand could have been in the absence of lending ceilings, both, in turn, reflecting the aggregate data on income, lagged assets etc. As already noted, the distinctive feature of our approach is in the treatment of credit conditions through the CCI measure.

The difficulties of modelling unsecured debt are considerable. The first is that this is a far from homogeneous category. It includes hire purchase debt – often secured on the value of a car or other expensive durable purchase. The duration of such debt can be as long as four years, and the interest rate can sometimes be discounted as part of a purchase package. It also includes personal bank loans, with not dissimilar durations. Student loans, however, tend to have longer durations. These are the main types of closed-end loans. The other important ingredients are in the nature of 'revolving' credit, with short durations. Maki (2000) points out that, in the United States, revolving credit has grown from around 1% of personal disposable income in 1970 to around 8% in recent years, now making up around 40% of total unsecured consumer credit. It seems likely that much of this growth is accounted for by the growth of credit card debt, the rest being largely bank overdrafts up to pre-arranged ceilings. The second difficulty, that of measuring the relevant interest rate, stems from the first. Not only do interest rates differ by type of loan and by lender, but much of credit card debt, where bills are fully paid off monthly, is interest free. The third difficulty, measuring debt service ratios, which add interest costs to repayment rates, is related. The Bank of England calculates estimates of debt service ratios, excluding repayments of principal, but only for the past few years, see *Financial Stability Review*, June 2002, page 82. As Maki (2000) makes clear, the US estimates are, in part, based on crude assumptions such as that the minimum monthly payment on credit card debt is 2.5% of the outstanding debt, and on approximate data on the durations of closed-end loans.

We model unsecured debt as an ECM, with the dependent variable, the log-change of unsecured debt, *Δlog UD*. We estimate the equation in the form **(7)**, where $\alpha_u$ is the speed of adjustment. A key component of the ECM, is the log ratio of *ud(-*1*)/income*. But the general form of the ECM includes other levels effects: log per capita real income, several alternative measures of the log nominal interest rate[23] and of the real interest rate, interest rate spreads, the rate of return in housing, the log of the ratio of the number of credit cards outstanding to the adult population, log ratios of liquid, illiquid financial and housing assets to income, the proportion of population in the 20-34 age group, consumer confidence, and various risk indicators discussed above entering the common RISK factor. Dynamic terms included the change in the unemployment rate, next year's income growth, and demographic change. Three dummies are included (see below).

Table A1 shows the baseline model estimated for 1976 Q1 to 2001 Q4. The parameter estimates are consistent with almost all the sign priors stated in Section 4, though some effects are insignificant. We begin our discussion with interest rate effects, where we find two to be very significant. The first is the lagged spread between Barclays Bank credit card rate and the mortgage rate, with, as expected, a negative coefficient. The second is the rate of return in housing, $ror_{t-1}$ defined above. The two effects can be re-parameterised into a negative spread effect, a conventional negative real credit card interest rate effect and the real rate of change of house prices.[24] Given this parsimonious specification, we checked for other interest rate effects, including other forms of the spread using the personal loan rate from another bank and bank base rate, log nominal rates and real rates. All proved insignificant. For the record, we show the least insignificant, the effect of the real bank base rate. The real rate of change of house prices can, perhaps, be thought of as a general confidence effect, empirically more relevant than the insignificant confidence index.[25] Interest rate expectations, proxied by the spreads between the one year gilt yield and the base rate, and the five-year gilt yield minus base rate, proved insignificant in this equation, and indeed in all other equations.

Other features of this equation are the long-run income elasticity of 1.59, close to Chrystal and Mizen's (2005), despite including both the significant CCI effect and a significant effect of the log-ratio of the number of credit cards outstanding to the adult population. Note this figure is the sum of the coefficient of 1 from log (unsecured debt/income) plus 0.59 from log per capita per capita real income, graphed in Chart 11. Expected income growth, proxied by the actual growth rate of income four quarters ahead, has a significantly positive effect on unsecured debt, consistent with intertemporal consumption smoothing.

The asset effects suggest a negative coefficient for liquid assets, consistent with our prior. The illiquid financial asset effect is positive, and the housing assets effect negative, but insignificant. Liquid asset and illiquid financial asset to income ratios are shown in Chart 12.

No seasonal dummies are significant, not surprising given unsecured debt is seasonally adjusted. A dummy consisting of 1 in 1995 Q1 and zero elsewhere proxies the announcement of coming

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[23] The repayment part of the debt service ratio is implicitly proxied by a constant proportion of the lagged stock itself, already included in the equation.

[24] Note that since the effects are approximately -0.6(credit card rate-mortgage rate) -0.3(mortgage rate-inflation rate) +0.3(real rate of change in house prices), they can be written as -0.3(credit card rate-mortgage rate) -0.3(real credit card rate) +0.3(real rate of change of house prices).

[25] We entered this as a linear combination of current and lagged values in a common factor in all ten equations and found it to be insignificant throughout.

windfalls from building society demutualisations, and a temporary rise in unsecured debt. A more permanent change occurred in early 1998, as discussed above, when mortgage lenders decided to exempt mortgages with LVRs below 0.9 from mortgage indemnity insurance premia. This created an incentive, at the margin, to increase the unsecured component of borrowing. According to our estimates, this raised the long-run stock of unsecured credit by 7.3%. In 1995, income support for those with mortgages who become unemployed (ISMI) was sharply reduced. As we shall see, this caused the mortgage stock to be lower, in the long term than it would have been otherwise, and by making mortgage borrowing relatively less advantageous, raised the unsecured stock by around 5% in the long run.

The speed of adjustment is around 0.3, suggesting relatively rapid adjustment, or short average loan duration for unsecured borrowing. Our composite indicator, RISK is very significant.(26) Given our definition of the RISK component **(10)**, this suggests that the climate of low inflation, the stable monetary policy framework of recent years and a long period of positive returns in housing, and low possessions rates, has encouraged borrowing in recent years.

The standard error of the equation is around one third of the Chrystal-Mizen unsecured debt equation, even after a degree of freedom adjustment, reflecting our richer specification, as well as the use of the CCI. The long-run direct effect of the latter can be computed by taking its close to peak value of 0.203 in 2001 Q4, multiplying by its long-run coefficient of 2.08 to give 0.42. The implication is that about 0.42 of the rise in the log of unsecured debt from 1980 to 2001 can be attributed to the rise in the CCI. This corresponds to a 52% rise. Between 1980 Q3 and 2001 Q4, our estimated risk factor declined by 0.063. With a long-run coefficient of 1.91, this explains around 0.12 of the rise in the log of unsecured debt over the period, or 12.5%. The log-ratio of unsecured debt to income rose by 1.6 over the period, so the remainder of the rise is explained largely by the growth of real income per capita and by the rise in the number of credit cards per capita, see Charts 10 and 11. However, it must be pointed out that these long-run effects are not general equilibrium effects, since a rise in CCI will itself influence interest rates, asset prices and other variables. They are partial effects, conditional on the interest rates, asset prices and other variables on which we argue unsecured debt depends.

Tests for serial independence up to the 4th order and homoscedasticity of the residuals are all satisfactory. A check on parameter stability is provided by the last two columns of Table A1, showing the estimates over the 1976 Q1 to 1992 Q4 sample. The standard error is very similar for the shorter sample and the great majority of the parameters are under one standard deviation from the full-sample estimates.(27)

### *5.2 The equation for mortgage debt*

There is a large volume of previous research on the determination of the UK stock of building society mortgages, but this peters out by the mid-1980s, as the entry of the banks into the

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(26) Note that interest rate volatility *per se* made no significant contribution to the RISK factor.

(27) However, we have set the parameter of the mortgage possessions rate in the RISK factor to its full-sample value since the mortgage possessions rate has insufficient variation to be properly identified over this shorter sample.

mortgage market made this both harder to model and less relevant. Anderson and Hendry (1984), Meen (1985) and Wilcox (1985) are the last significant studies. Meen reviews previous work comprehensively. As he makes plain, all the previous studies took into account that before 1980 mortgage demand had been in an almost continuous excess demand state. Indeed, Meen estimates a measure of excess demand and so the severity of mortgage rationing, MRAT, defined to be the percentage deviation between the flow demand for mortgages and the actual mortgage flow, MRAT is positive for 1963 Q1 to 1980 Q3, before turning negative. Meen's model does not give a long-run solution for mortgage demand, though there is a solution for the long-run stock of building society mortgages conditional on the stock of deposits in building societies. Meen's equation for the rate of growth of building society mortgages, estimated for 1963 to 1983, has a standard error of around 0.0026.

Wilcox (1985) follows a different approach. He takes the average LVR for first-time buyers (FTBs) as an indicator of mortgage rationing, following Kent (1980). The long-run solution for his equation, estimated for quarterly data for 1969-83 on building society mortgages, can be parameterised as:

$$\log(bsd/pdi) = constant + 0.4 * \log real\ pdi - 0.32 * \log abmr + \log housing\ stock$$

$$+ 1.4 \log LVR \qquad \textbf{(12)}$$

where *bsd* is the stock of building society mortgages, *pdi* is personal disposable income, *abmr* is the tax-adjusted mortgage interest rate, the housing stock is defined as housing wealth scaled by the mix-adjusted house price index and *LVR* is the average loan to value ratio for first-time buyers for building societies. The equation, estimated in equilibrium correction form, also contains dynamic terms in log house prices, the interest rate and LVR and has a coefficient of –0.062 on log *bsd(*-1*)*, measuring the speed of adjustment. The equation standard error is 0.0029.

Section 4 outlined the relevant variables in our equation for the total stock of mortgage debt. The equation has the same general form as equation **(10)**, with the dependent variable $\Delta \log SD$, where *SD* is the stock of mortgages held by the personal sector. After extensive reduction from a more general dynamic specification, we arrive at the model shown in Table A2. This has a speed of adjustment of 0.061, almost equal to that of Wilcox (1985), and less than one quarter of that corresponding to unsecured debt.

A key component is log real per capita income where, after testing, we impose the same long-run coefficient as in the unsecured debt equation.[28] The long-run income elasticity of around 1.59 is close to Wilcox's 1.4. The long-run coefficient on the log of the adjusted building society mortgage interest rate is -0.39, marginally higher than the estimate of Wilcox. For example, a rise in the nominal mortgage rate from 6% to 7%, other things being equal, would reduce the mortgage stock by 6.2% in the long run. The spread between the credit card rate and the

[28] We also examined an alternative specification with an income elasticity of one but including the lagged ratio of the number of owner-occupied houses to the number of adults between 20 and 70. The fit is a little worse, but the CCI estimated from the whole model is very close to that reported below.

mortgage interest rate has a positive coefficient indicating that a fall in the mortgage rate relative to the credit card rate encourages a switch from unsecured to mortgage borrowing, other things being equal, though the effect is smaller than the parallel effect in the unsecured debt equation.(29) The real rate of interest has a significant, but small effect: a 1 percentage point rise reduces the mortgage stock by 0.7% in the long run. The implications of the nominal interest rate effect are important: a decline in inflation, with the real rate constant, reducing nominal rates and the 'front-end loaded' current debt service ratio, will increase mortgage debt, see Kearl (1979). A decline in inflation, with no change in the nominal rate, and so a rise in the real rate, leaves the mortgage debt to income ratio only marginally lower, even though future debt service ratios are higher with lower inflation. This finding suggests that households suffer from an element of inflation illusion, or at least an excessive concern about their short-term ability to finance debt. The Miles Reviews of the mortgage market (2003, 2004) come to similar conclusions, arguing that both consumers and financial advisers are poorly informed about longer-run costs and risks. An alternative interpretation is that low inflation is associated with lower risks of interest rate rises and of income surprises, and that this is encouraging households to carry heavier debt burdens. However, we have already controlled for at least part of this effect though our volatility measure of inflation included in RISK, to which it makes an important contribution.

The long-run solution also includes the proportion of adults in the 20-34 year old age group, plotted in Chart 10, and wealth effects. The log ratio of liquid assets to income has a significant negative effect on log mortgage debt, since the greater the liquidity of households, the lower the need for debt. Illiquid financial wealth has a positive but insignificant effect, but log housing wealth/income has a long-run coefficient of 0.29. The RISK factor is significant, indicating that mortgage borrowing, like unsecured borrowing, is encouraged by a low volatility environment.

Between 1980 Q3 and 2001 Q4, the log ratio of mortgage debt to disposable household non-property income rose by 1.02 (equivalent to a 177% rise in the ratio). The long-run partial effect of the CCI on log mortgage debt in this period is 0.95 (the product of the rise in CCI of 0.203 and its long-run coefficient of 4.68). Given that positive effects on the long-run level of log mortgage debt/income are also coming from real per capita income (with an income elasticity of 1.59), from the fall in the RISK factor, contributing a long-run effect of 0.13, from the fall in the nominal mortgage rate, contributing 0.30 in the long run, and from the rise in the housing wealth to income ratio (to which, however, adjustment will have been far from complete by 2001 Q4) one might wonder what are the offsetting factors. Over the period 1980 Q3 to 2001 Q4, the rise in the log liquid assets/income is the biggest, *ceteris paribus*, implying a decline of 0.74. The fall in the fraction of the population aged 20-34, and the rise in the real interest rate contribute declines of 0.12 and 0.05. In the long run, we estimate that the reduction in income support for mortgage interest (the ISMI dummy) in 1995 reduced mortgage debt by around 15%, other things being equal. This was, however, largely cancelled by the elimination of mortgage indemnity insurance premia in 1998 for mortgages with LVR below 0.9, which we estimate increased mortgage debt by around 15% in the long run. It seems that, as expected, this

(29) We expect the effect to be smaller in absolute size since, for a given switch of funds from one source of borrowing to the other, the percentage response for larger mortgage debt should be smaller.

reduction in mortgage costs for the bulk of mortgages, strongly outweighed the switching effect to unsecured debt discussed in Section 4.

The dynamics include the demographic change variable reflecting changes in the proportion of the population in the key mortgage borrowing age group, and the four-quarter change in the unemployment rate, which plays a direct role as well as its indirect role through RISK. Expected income growth proved insignificant, suggesting that mortgage debt is less relevant for intertemporal consumption smoothing at a one year horizon than is unsecured debt. However, the hypothesis that the coefficient is the same as in the unsecured debt equation cannot be rejected, and since the long run income elasticity was found to be the same in the two equations, this seems a reasonable restriction to impose. The equation includes seasonals (the mortgage debt data are not seasonally adjusted), implying that the second and third quarters experience greater mortgage growth. A dummy taking the form of 0.25 in 1988 Q2 followed by 1 in 1988 Q3, and zero thereafter, measures the effect of Chancellor Nigel Lawson's announcement in March 1988 that on 1st August multiple mortgage interest tax relief would be abolished.

The equation standard error is 0.00260, without correcting for degrees of freedom. Assuming that 21 degrees of freedom are lost, from the 18 parameters in the function, plus another 3 apportioned to the contribution of that equation in the estimation of the CCI, gives a standard error of 0.00288.(30) This is the same as for Wilcox's model, but higher than Meen's equation, but since these models covered only the more homogeneous building society component of mortgages, this can be considered to be satisfactory.

Tests for serial independence up to the 4th order and homoscedasticity of the residuals are all satisfactory. A check on parameter stability is provided by the last two columns of Table A2, which shows the estimates over the 1976 Q1 to 1992 Q4 sample. The asymptotic standard error is the same for the shorter sample, but correcting for degrees of freedom, it is higher. As for the unsecured debt equation, the majority of the parameters are under one standard deviation from the full-sample estimates, and all are under two standard deviations away.

*5.3 The equations for PLIR*

We know of no previous work modelling the proportion of high loan to income mortgages to first-time buyers. We have data on PLIR classified by age (under/over 27) and region (North/South). The equation has the form

$$\Delta y_t = \alpha(f(z_t) + \beta(f(z_t) - f_0)^3 - y_{t-1}) \qquad \textbf{(13)}$$

where $y$ is the log-odds-ratio of PLIR, $f(z_t)$ is a linear function of the various drivers of $y$, and $f_0$ is the average across age and regions of the maximum observed value of $y$. When $f(z_t) = f_0$, the long-run value of $y$ is $f_0$, and near this value the non-linearity is unimportant. When $\beta$ is positive, as $f(z_t)$ falls further and further below this value, the cubic term becomes more and more negative,

(30) This suggests that the reported t-ratios in Table 1B should be multiplied by a factor 0.895 to incorporate the degree of freedom correction.

so that $y$ falls below the value otherwise predicted by $f(z_t)$ and $y_{t-1}$. Without this non-linearity, the model finds it slightly more difficult to capture the low values of PLIR reached in 1980, before credit conditions eased and at a time of high interest rates and recession. Otherwise, the type of curvature implied by the log-odds-ratio, seems to capture well the behaviour of PLIR.

The speed of adjustment $\alpha$ is estimated at 0.44. The estimated long-run effects of CCI and the RISK factor are both highly significant, though lower than in the PLVR equations, discussed in the next subsection. The long-run coefficient on the log income/house price ratio is –1.8, though the negative income effect is offset by the coefficient of 3.0 on log real income minus trend. The implication is that high real house prices tend to force up LIRs, as argued in Section 3.3. The log of the mortgage rate has a strong negative effect with a long-run coefficient of –0.89, suggesting that debt-service considerations are relevant for LIR rules followed by lenders and for borrowers themselves. But increases in mortgage rates over the previous two years also have a strong negative effect on PLIR. It is possible that the effect being captured is not just on interest rate expectations, since changes in interest rates tend to be positively auto-correlated, but perhaps also on economic conditions in the labour and housing markets. This may be why the change in the unemployment rate, relevant in the mortgage debt equation, proves to be insignificant here, except via the RISK factor.

The ISMI dummy has a negative coefficient, though insignificant and set to zero here. The dummy for the 1998 elimination of mortgage indemnity premia for LVRs below 0.9 would be expected to have a larger effect in the PLVR equation. Indeed, its coefficient in the PLIR equation is negative, though not precisely estimated. The proportion of couples in the sample has the expected negative effect, reflecting the lower LIRs offered by lenders on joint incomes.

An important consideration when modelling mortgage data is the sample selection issue. We argued in Section 3.3 that the variable representing the sample selection effect of the entry of banks is difficult to sign *a priori*, while the variable representing the sample selection effect of the entry of centralised mortgage lenders should have a negative coefficient. Both effects prove negative, though only the latter is significant. Charts 6 and 7 confirm that PLIR for building societies rose at the time. However, our results suggest that it is likely that PLIR for building societies and banks together rose by even more.

The dynamics also include the change in the log-odds ratio of PLIR lagged one quarter, with a negative coefficient, suggesting smoothing in the dependent variable. Other dynamic terms are the rate of change and the rate of acceleration of regional house prices, partly compensating for the fact that the log ratio of income/house price enters at a one-quarter lag.

Between 1980 Q3 and 2001 Q4, the log-odds ratio of PLIR rose, on average, by around 2.2.(31) Of this rise, the long-run partial contribution of CCI is 0.57 and of the decline in RISK is 0.27. The decline in the nominal mortgage interest rate contributes 0.67, and most of the rest is

(31) Based on a four-quarter moving average of data for 1980 Q3 and 2001 Q4, and taking the simple average of the data over the two regions and age groups.

explained by the rise in the average house price/income ratio (a long-run effect of 0.27) and by the higher value of real income minus trend in 2001.

There are some symptoms of heteroscedastic residuals. The latter can be traced to large residuals in 1980, when the proportion of high LIR loans fell to the lowest level in the sample. Our reported t-ratios are robust, incorporating a heteroscedasticity correction. A check on parameter stability is provided by the last two columns of Table A2, which show the estimates over the 1976 Q1 to 1992 Q4 sample. The standard errors tend to be higher for the shorter sample and the great majority of the estimated parameters are under two standard deviations from the full-sample estimates.

*5.4 The equations for PLVR*

The only previous work modelling the proportion of high LVR loans, of which we know, is Muellbauer (1997).[32] Muellbauer analyses annual data, on eleven UK regions, for PLVR for 1971-95, extrapolating missing PLVR data for 1971-73 from average regional LVR data and a simple econometric model. His model, incorporating a CCI, confirms most of the priors set out in Section 3.4. More specifically,

$$\log(\text{PLVR}/(1-\text{PLVR}))_t = \underset{(9.0)}{0.33}^* \log(\text{PLVR}/(1-\text{PLVR}))_{t-1} - \underset{(4.7)}{0.083}^* \log(\text{hp}_{it}/\text{pc}_t)$$

$$+\underset{(6.1)}{0.33}^* \Delta \log ry_{it} - \underset{(6.1)}{0.16}^* \Delta \log hp_{it} - \underset{(12.7)}{1.88}^* abmr_{it} + \underset{(4.9)}{0.48}^* \Delta \log pc_{it} + \underset{(2.8)}{0.08}^* \Delta(\text{Gallup}/100)_t$$

$$-\underset{(6.5)}{0.15}^* \text{arorse}_{t-1}^{**} + \underset{(2.3)}{0.12}^* \text{rorsem}_{t-1}^{**} + \textit{CCI dummies} \qquad \textbf{(14)}$$

Here, *hp* refers to the house price in the *i*th region, *pc* is the consumer expenditure deflator for the United Kingdom, *ry* is real regional non-property income, *abmr* is the tax-adjusted mortgage interest rate using the *i*th region tax adjustment, Gallup is the Gallup Poll measure of consumer confidence in December of the previous year, and *arorse*** and *rorsem*** are risk factors proxying the level and volatility of housing returns. Absolute values of t-ratios are shown in parentheses.

Thus, the log real house price index and its nominal rate of change have negative coefficients; the growth rate of income has a positive coefficient; the nominal interest rate has a negative coefficient, while inflation has a positive effect, suggesting an element of real as well as nominal interest rate effects. The annual change in an index of consumer confidence has a positive coefficient, while two risk indicators based on the rate of return in housing in the South East have

[32] Wilcox (1985) and Muellbauer and Murphy (1993) had modelled the average LVR for FTBs. Wilcox, however, does not control for market conditions, except through the ratio of building society deposits to building society mortgages, a proxy for the societies' liquidity.

the expected signs, suggesting that greater volatility of returns dampens the proportion of high LVRs, and that a recent history of negative returns also dampens high LVRs. As Muellbauer (1997) acknowledges, a defect of the estimated model is its failure to deal with the sample selection problem (the estimated CCI turns down temporarily in 1983 and 1987). Also, the model is based only on LVR data instead of the more comprehensive data of this paper.

Turning to the current study, the ECM for the log-odds ratio of PLVR was specified in a similar form to that for the PLIR, and incorporates a similar non-linearity through a cubic term, which proved insignificant. Again, there are fixed effects by age and region. The speed of adjustment at 0.52 is a little higher than that of the PLIR equations. The coefficients on CCI and on the RISK factor are set to the value 10. As explained above, the CCI and RISK coefficients in one equation must be set, to achieve identification, given that the parameters of the spline function, which governs the shape of the CCI function, and the parameters of the RISK function are estimated.

The coefficient on the log income/house price ratio is 0.67 and significant, consistent with the posited negative real house price effect. The rate of growth of house prices also has the posited negative effect. The log mortgage rate enters with a four-quarter moving average, with a significant negative coefficient, and there is also a significant negative 'shock' effect of the current change in the mortgage rate, perhaps also forecasting further rate rises. The real mortgage rate has a negative but insignificant coefficient.

The step dummy for 1998 Q1, capturing the abandonment of mortgage indemnity insurance payments for those with LVRs below 0.9, has a strong negative coefficient (and enters as a moving average with the same weights in all ten equations). As expected, this pricing shift created an incentive for borrowers over this threshold, especially those who would have been only just above, to bring their LVRs below 0.9, and pushed down PLVR. The 1995 ISMI dummy also has a significant negative coefficient, reflecting the increased risks faced by borrowers, with the tightening of income support for the unemployed with mortgage commitments. The effect is substantially larger than for the PLIR equations, for no obvious reasons.

As Charts 8 and 9 illustrate, PLVRs for older borrowers tend to be substantially lower than for younger borrowers, while the PLIR differences are much less pronounced. Clearly younger borrowers have had less opportunity to save for a deposit. From the early 1990s, there has been a substantial rise in the average age of FTBs.[33] Since the under 27 category is bounded by the age 27, the rise has been more noticeable in the over 27 age group. One would expect this to account for some of the downward drift in PLVRs in the second half of the 1990s. Indeed, when we enter the deviation in the average age of the over 27 group in each quarter from the average over the whole sample, we find a significant negative coefficient.

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[33] Note that 'first-time buyer' is defined as someone whose previous tenure was not in owner-occupation. Some in this category may therefore have had a spell as owner-occupiers, returned to renting, before switching back (Holmans (2001)).

Finally, to turn to the sample selectivity proxies discussed in Section 5.3, the proxy for sample selection due to the entry of banks is positive, consistent with the view that initially the banks targeted existing customers with more significant deposits, so leaving building societies with cash-poor borrowers and so higher PLVR. A negative coefficient for centralised mortgage lenders is also consistent with prior expectations. Thus, when the down-market centralised mortgage lenders gained market share in the second half of the 1980s, this pulled down the PLVRs reported for building societies, and made them a negatively biased estimate of those for the whole market.

Comparing 1980 Q3 and 2001 Q4, the average log-odds ratio has risen by around 1.79 (using the four-quarter moving average and averaging over age and region). The long-run partial contribution of CCI over the period to this rise is 2.03, the fall in nominal mortgage rates contributes 1.05, and RISK 0.63. The key offsetting effects are three: the negative effect (of 0.84 in the long run) of the abolition of the mortgage indemnity premium in 1998 for LVRs below 0.9, the negative effect (of 0.61 in the long run) of the tightening of ISMI (income support for mortgage interest) in 1995, and the negative effect (around 0.1 in the long run) of the rise in house price/income ratios.

Tests for serial independence up to the 4th order and homoscedasticity of the residuals are all satisfactory. A check on parameter stability is provided by the last two columns of Table A4, which shows the estimates over the 1976 Q1 to 1992 Q4 sample. The standard errors tend to be higher for the shorter sample and, as for the other debt equations, the great majority of the parameters are under two standard deviations from the full-sample estimates.

*5.5 The estimated RISK*

We fix the coefficient of RISK (equation **(10)**) in the PLVR equation at 10 so that we expect the $v_i$'s to be negative, except for the negative housing return risk proxy. The results are in Table A5. The most significant of the three terms is $v_1$: a fall in inflation volatility has sizable positive effects on both types of debt and on the proportion of high LVRs and LIRs. The proxy for negative housing return risk is also very significant, while the change in the unemployment rate and the possessions rate are more marginal. The $\delta$ coefficient is estimated to be quite close to 0.5, while $\delta_1$ is estimated to be around 1, a restriction we impose. This means that the possessions rate enters as the twelve-quarter moving average, lagged two quarters. Chart 14 shows the estimated RISK term where a rise denotes a reduction in risk.

*5.6 The estimated CCI*

Table A6 shows estimates of the parameters of the CCI function. Note that the last quarter of 1980 marks the start of the rise in CCI, handled by a fourth quarter dummy. Otherwise, piecewise linear splines, shifting in quarter one of each year, are used to model CCI. These are constructed by defining step dummies for each year, stepping from 0 to 1 in the first quarter, and remaining at 1 thereafter. The four-quarter moving average converts the step into a trend going from 0 in the previous year's fourth quarter to 1 in the current year's fourth quarter, thenceforth remaining at 1. We estimate the coefficients on each of these terms, subject to the restriction that these effects are all zero before 1980 Q4, and that in the 1980-89 and 1994-2001 periods, no negative reversals take place: such reversals can be ruled out given the institutional background set out in Section 2. These restrictions imply a zero coefficient in 1983 and in 1987. Zero restrictions were also imposed on the coefficients in 1994, 1996, 1997, 1998 and in 2000, either because the unrestricted coefficients would have been negative, though none significantly so, or because the estimated coefficients were very close to zero.

To account for possible variations in CCI before 1980, we include the four-quarter change of the consumer credit controls dummy. This should reflect the stance of the authorities to expansion of credit more generally. Its coefficient is negative and significant. The lagged liquidity ratio of building societies up to 1980 Q3 is another indicator of ease of mortgage credit before the credit markets liberalised. Building societies flush with liquidity are more likely to lend. The liquidity ratio lagged one quarter has a significant positive coefficient. We also investigated the mortgage-rationing indicator, MRAT, from Meen (1985) for the period up to 1980 Q3, after which the CCI dummies begin to operate. The coefficients are *positive* for the current value and lags up to two quarters, and significantly so at a lag of one quarter. This suggests that greater rationing is associated with higher values of debt growth and looser ceiling on LVRs and LIRs. In our view, this casts some doubt on the short-run dynamics of Meen's indicator, though it does show a fall at the end of 1980 and remains low, indicating an easing of rationing at this time. Chart 13 shows our estimated CCI and the real tax-adjusted mortgage interest rate.[34]

An important question concerns the downturn in CCI from 1990, reaching a trough in 1993, before turning up again. One might ask whether this is a genuine credit supply shift, or reflects the risk perceptions and negative outlook on both sides of the market during this period when mortgage possessions ran at record levels (Chart 11). We control for risk perceptions as noted above, and we have included or tested for an extensive set of economic factors including consumer confidence and next year's income, but one can never be entirely sure that these controls are adequate. The description of the evolution of credit conditions given in Section 2 suggests that the biggest source of a downward supply shift was the change in mortgage indemnity insurance contracts available to lenders. In the post-war period, there had never before been a time of sustained falls in nominal house prices, and with hindsight, the insurers had underpriced credit risk in the late 1980s.[35] However, the result of these misperceptions was that, for given economic conditions, mortgage borrowers had had greater access to credit in the 1987-90 period than in 1991-94. For modelling consumption, house prices, housing turnover and subsequent mortgage defaults, the interpretation of a fall in CCI for the period 1991-93, when the insurers sharply raised their premia, does seem to point in the right direction.

One possible area for concern is the question of house price endogeneity, even though we use house price indices defined for all types of buyers and not just first-time buyers. The only place

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[34] This helps to explain, given the positive correlation in the early 1980s, why it is common to find weak or perversely signed real interest rate effects in mortgage and in consumption equations which omit a CCI effect, see Aron and Muellbauer (2006) for evidence on the latter point.

[35] It is also possible that an element of herd behaviour on the part of lenders, see Herring (1999), may have contributed to underestimation of risk in the late 1980s.

where this could be a problem is in the PLIR and PLVR equations, where contemporaneous values of house price changes enter. Everywhere else, including in housing wealth terms and measures of rates of return in housing, we use lagged house price data. If we respecify the PLIR and PLVR equations, replacing terms in $\Delta \log hp_t$ with its lags and current and lagged changes in mortgage interest rates, the results are very little changed. Indeed the graphs of CCI are visually virtually indistinguishable.

Cointegration issues seem relatively straightforward, even though formal analysis using the Johansen method is impossible in this set-up, given that CCI is estimated from the data. Augmented Dickey-Fuller tests confirm the I(1) status of the following variables: the log unsecured debt and mortgage debt to income ratios, the log changes in nominal unsecured and secured debt, the four log-odds ratios for PLIR and PLVR respectively, log real per capita income, the real mortgage interest rate, the log nominal mortgage rate, the three log asset to income ratios, the age deviation for first-time buyers aged over 27 (see Chart 15) and the share of couples among first-time buyers. The proportion of the population aged 20 to 34 is I(2), in this 26-year sample, but since its variance is very low, this is unlikely to cause problems. The rate of return in housing is I(1) but not far from the I(0) borderline. The composite RISK indicator is clearly I(1), as are most of its ingredients individually, and so, of course is CCI.(36) Cointegration between the variables specified in each of the ten equations looks unproblematic,(37) and the extensive use of sign priors based on economic theory and institutional knowledge has played an important part in arriving at a well-determined specification. We have constructed ECM terms consisting of the I(1) terms in each equation and weighted these by their estimated coefficients. Dickey-Fuller tests applied to each of these confirm that they are all I(0).

## 6. Empirical results: interaction effects with the credit conditions index and RISK

In the previous section we presented estimates of the ten-equation system in which the CCI enters as an additive effect in each equation.(38) We now consider a range of interaction effects between the CCI and a number of economic variables. One important interaction effect is likely to occur between uncertainty about economic conditions and the CCI: the higher the latter, the weaker the negative effects of uncertainty on debt levels and on LVRs and LIRs. The reason is that with easier credit access, borrowers are likely to find it easier to borrow in the event of temporary difficulties, eg because of higher interest rates or lower incomes. It is also possible, from the credit supply side, that more competitive conditions led to a more tolerant attitude by lenders to uncertainty. We represent this effect by replacing the RISK term in every equation by the term $RISK(1+\phi CCI)$, where we expect $\phi$ to be negative.

(36) Results from these tests are available on request from the authors.
(37) One might query the fact that the growth rates of nominal debt are I(1). However, one can reformulate these as growth rates of real debt, and include the inflation rate on the RHS. One can accept the hypothesis that the coefficient on the inflation rate is -1 in both equations, hence the simplification of the dependent variables to nominal log changes. The growth rate of real unsecured debt is clearly I(0), while that of secured debt is borderline I(0)/I(1). However, conditioning on CCI and the change in the proportion of the population in the age group 20-34, makes the growth rate of real secured debt clearly I(0).
(38) This corresponds to a concept Hendry (1999) has termed 'co-breaking'. The CCI represents the intercept-equivalent effect of the structural breaks associated with financial liberalisation. When the effect is additive in each equation, then by taking a simple linear transformation of pairs or other combinations of equations, it is possible to eliminate the effect of the structural breaks.

As far as the two debt equations are concerned, with more liberal credit conditions, housing collateral is likely to receive a larger weight in the mortgage equation and liquid assets an even more negative one (since the positive role of aggregate household liquidity in financing debt will be diminished). We represent the effect by interacting log (*housing assets*$_{t-1}$/*liquid assets*$_{t-1}$) with CCI, and expect a positive coefficient.[39] And since intertemporal substitution should have been more important as a motive for borrowing, the real interest rate should play a bigger role as CCI rises, see Aron and Muellbauer (2006) for the parallel effects on consumption. It is probable that as the real interest rate effect becomes more negative, the nominal interest rate effect becomes less so, as front-end loading becomes less important and we test for this. As intertemporal substitution becomes more important with rises in CCI, so income growth expectations should become more important, suggesting a positive coefficient on (*CCI*)(*income growth*$_{t+4}$). However, uncertainty also interacts with income growth expectations, see Muellbauer and Lattimore (1995) for discussion of this effect on consumption, and hence asset and debt decisions. We represent this through the interaction effect

$$[RISK(1+\phi CCI) + constant]\,(income\ growth_{t+4}),$$

where the constant is calibrated to keep the term in the square bracket non-negative. Note that RISK becomes smaller as uncertainty increases and, with $\phi$ negative, a higher value of CCI will increase the overall weight on *income growth*$_{t+4}$. We include both this term and the simpler interaction effect between income growth and CCI in the debt equations.

As far as the PLIR and PLVR equations are concerned, one would expect effects in precisely the same direction as the debt effects just described. As far as average house price/income ratios are concerned, one might expect the negative effects in the PLVR equations to moderate somewhat as CCI rises since, in a more liberal credit regime, lenders will have taken a more relaxed attitude to the risk of house prices falling. The effect on the PLIR equations is less clear *a priori.* However, given the importance of house price income ratios in the PLIR equations, it is important to test for an interaction effect.

Extending the model to include interaction effects is fairly straightforward. Estimation is more difficult, as the complexity of the model can generate local peaks in the likelihood function. This is particularly so when the CCI interacts with an I(1) variable. It is also important to demean the variables whose interactions with the CCI are to be estimated, since otherwise arbitrary shifts in the intercept roles of the CCI will take place. We subtract means for the period 1980 Q4 to 2001 Q4 from all variables interacted with CCI. In Table B, we present estimates of a model with interaction effects, after some insignificant terms have been eliminated. Note that in the PLIR and PLVR equations, the composite nominal interest rate terms containing level effects and dynamics are interacted with CCI; ie, the *relative* coefficients on level and dynamic nominal interest rate effects are unchanged as CCI varies. Also, since the composite nominal interest rate terms have negative signs, we expect negative signs on their interaction effects with CCI.

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[39] We test and accept the hypothesis that the coefficient on log (liquid assets/income) is minus the coefficient in log (housing wealth/income).

The unsecured debt equation alters least compared with Table A than the other equations. The three differences are first, the replacement of RISK by $RISK(1+\phi CCI)$; second, the replacement of plain one year ahead income growth by $[RISK(1+\phi CCI) + constant]$ ($income\ growth_{t+4}$), which dominates both expected income growth and its interaction with CCI; and third, the interaction of CCI and the real base rate, which is significant, while the plain real base rate in Table A had not been significant. The discussion in Section 5.1 of the contribution to the rise of unsecured debt/income of different long-run factors is little changed for this new specification. The main difference is that with a slightly lower income elasticity, and somewhat lower (and more plausible) estimated contributions of housing wealth/income and of the rate of return in housing, the combination of CCI, RISK and the proportion of credit card holders explains a slightly higher proportion of the rise in the debt/income ratio.

In the mortgage debt equation, the replacement of RISK by $RISK(1+\phi CCI)$, and the replacement of plain one year ahead income growth by $[RISK(1+\phi CCI) + constant]$ ($income\ growth_{t+4}$) also occurs, with the latter coefficient constrained to be the same as in the unsecured debt equation, an acceptable restriction. Interaction effects between CCI and nominal and real mortgage interest rates are insignificant and small in magnitude, though in accord with sign priors, and have been set to zero. The interaction of the CCI with the change in the unemployment rate has a positive effect, reducing the negative impact of rising unemployment on mortgage debt. This suggests that greater credit availability reduces the effect of income uncertainty on debt and supports the interpretation of the change in unemployment as an income uncertainty effect, additional to the RISK term. Another numerically important, although not very precisely estimated effect, is the interaction of CCI with the log ratio of housing wealth to liquid assets. This implies that when CCI is zero, the point estimate of the long-run elasticity of housing wealth with respect to mortgage debt is 0.28. At the CCI peak of 0.249, the point estimate has doubled to 0.57. This interaction effect is consistent with the international evidence presented by Goodhart *et al* (2004) that, after financial liberalisation, property prices explain more of the growth of bank lending than before.

This interaction effect needs to be taken into account in calculating the contribution of CCI to the rise in the mortgage debt/income ratio from 1980 Q3 to 2001 Q4. The overall contribution is little altered compared with the discussion in Section 5. The additive CCI and RISK contributions are a little lower, mainly because of the interaction effect of CCI with housing wealth.

In the PLIR equations, the interaction effect with CCI suggests a small (under a quarter) reduction in the effect of the income to house price ratio - though we had no prior on the direction of this effect. As expected, the (negative) composite nominal interest rate effect is reduced as CCI rises, while the interaction with the real interest rate is negative and significant. This suggests that, as refinancing becomes easier, the front-end-loading problem associated with a rise in nominal rates matters less, but a rise in real rates matters more. The one year ahead income growth effect appears in interaction with CCI, while the effect without interaction and the effect in interaction with $[RISK(1+\phi CCI) + constant]$ are both less significant and therefore omitted. In the explanation of the rise in the log-odds ratios of PLIR from 1980 Q4 to 2001 Q4, compared to the discussion in Section 5.3 for Tables A1 to A6, Tables B1 to B6 suggest a somewhat lower additive effect for CCI, a somewhat lower contribution of the house price income ratio and a somewhat lower contribution from the decline in nominal interest rates. These were offset by somewhat larger contributions from RISK, from the rise in real interest rates and from the deviation from trend of real income.

In the PLVR equations, the interaction effect with CCI implies a roughly two-thirds reduction in the log (income/house price) effect at the peak value of CCI, suggesting a reduced concern over future house price falls. As in the PLIR equations, the negative effect of nominal interest rates on the proportion of high LVR loans shrinks somewhat as credit conditions ease, while the negative real interest rate effect expands. There is also a notably significant interaction of our proxy for income growth expectations with credit conditions, as theory predicts. Neither the alternative interaction effect with [$RISK(1+ \phi CCI) + constant$], or the simple income growth expectations proxy effect is significant. One interesting difference from the Table A4 results is the significance of the income term, entering as the deviation from its long-run trend, and paralleling its role in the PLIR equations. The discussion of the contribution of long-run effects in the rise of the log-odds ratios for PLVR from 1980 Q3 to 2001 Q4 in Section 5.4 needs little amendment, except to note the reduced (negative) role for the house price/income ratio and the reduced role for the nominal mortgage rate, the increased (negative) role for the real interest rate and the increased (positive) contribution of the deviation of real income from trend.

The shape of the estimated 'interaction effects CCI' is not very different from the one coming from the base specification of Section 5. Chart 13 plots the two against each other. Chart 14 shows the RISK term but in the form $RISK(1+ \phi CCI)$, which naturally has a somewhat different profile from the RISK term estimated in Tables A1 to A6, where all interaction effects were excluded. The results for CCI are again completely insensitive to replacing current house price changes by lags. The log-likelihood of the equation system improves by 30 when the interaction effects are included and the goodness of fit of most of the individual equations improves. Parameter stability is satisfactory as indicated by the estimates for the 1976-92 sample, despite the increased complexity of the model.

## 7. Conclusion

We have estimated an index of credit supply conditions facing households in the 1976-2001 period. The index was derived as a common factor in ten credit indicators subject to broad priors, consistent with the historical account of financial deregulation and other developments outlined in Section 2. Two of the ten credit indicators are aggregate unsecured debt and mortgages (secured debt). The remaining eight consist of the fractions of high loan to income ratio and high loan to value ratio mortgages for UK first-time house buyers split by age and regions. Around 1 million individual observations from the Survey of Mortgage Lenders, and its predecessor, were aggregated to produce 832 data points in these eight indicators. To ensure that, as far as possible, our CCI is not subject to the criticism that it is endogenous, we have tested for and included an exhaustive set of economic controls. Working with general specifications was made feasible by careful consideration of sign priors to ensure the estimation of meaningful relationships. The economic controls included nominal and real interest rates, a measure of interest rate expectations and of inflation and interest rate volatility, mortgage and housing return risk indicators, house prices, income, a proxy for expected income growth, the change in the unemployment rate, demography, consumer confidence, portfolio wealth components, proxies for sample selection bias and institutional features.

Effectively, by construction, our CCI should be independent of these controls. A number of factors can explain a major, sustainable rise in CCI. The most obvious of these is the reduction and ending of restrictions on competition which had been prevalent in the 1970s, when real after-tax interest rates on borrowing were negative for eight years.[(40)] Beyond this, rational lenders should be pricing in the possible risk costs: the CCI could then rise by lenders using better credit screening methods, or be better able to offload risks on other financial institutions, perhaps because of more efficient system-wide risk sharing, or simply by being prepared to experience an increase in losses on their household lending portfolios, or some combination of the above. It is true, as we have seen, that real interest rates on mortgage lending rose sharply in the early 1980s, paralleling the rise in the CCI, and consistent with liberalisation and increased risk pricing. The increased use of securitisation of mortgage loans in recent years is a sign that risk sharing may be more extensive than previously.

Potential applications of the CCI are in modelling aspects of personal sector behaviour (consumption, money demand, the housing market and mortgage default rates). The empirical literature on the effects of financial liberalisation, which is closely related to our CCI measure, on UK consumption does not always find significant or plausible effects. Despite some early successes, (Bayoumi (1993a,b), Muellbauer and Murphy (1993), Darby and Ireland (1994) and Caporale and Williams (2001)), Sarno and Taylor (1998), and more recently Fernandez-Corugedo and Price (2002)[(41)] find no role for financial liberalisation, and Bandiera *et al* (2000) find mixed results for a group of developing countries. Aron and Muellbauer (2006) suggest two reasons for this: poor measurement of financial liberalisation or of credit conditions indicators and an inappropriate empirical model, particularly the use of Euler equations that remove long-run information. They argue that the CCI has multiple effects in a consumption function: an intercept effect, an interaction effect with housing wealth,[(42)] and interaction effects with uncertainty, growth expectations and the real interest rate. They find all of these to be significant on UK data. They also estimate a credit conditions index for South Africa, using institutional priors, from a two-equation debt and consumption system. Their results suggest that starting in 1981, credit conditions for consumers were liberalised progressively and that this played a major role in explaining rises in debt to income and consumption to income ratios, despite the absence of any house price boom in this period. In both countries they find a faster

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[(40)] Caprio *et al* (2001) consider the international experience of 'financial repression' and subsequent liberalisation and the wider macroeconomic implications of liberalisation.
[(41)] Darby and Ireland found that the degree of financial liberalisation, measured by Muellbauer and Murphy's (1993) FLIB indicator had a significant role in a forward-looking consumption function for the United Kingdom estimated over the period 1969 Q1 to 1990 Q2. Caporale and Williams use the same methodology as Darby and Ireland, extending their sample to 1995 Q4 and find that FLIB continues to explain consumption behaviour. Fernandez-Corugedo and Price (2002) extend the sample to 1998 Q4 but find that FLIB does not help to explain consumption behaviour in the United Kingdom.
[(42)] See Aoki *et al* (2004) for a related argument for why the housing wealth effect shifts as transactions costs for accessing collateral fall.

speed of adjustment and more sensible and precise estimates of interest rate and wealth effects than in current consumption functions which exclude CCI effects.[43]

Cameron, Muellbauer and Murphy (2006) have used the CCI measure constructed here in modelling UK house prices in a regional panel. They find that CCI has a significant positive effect on real house prices in the long run. Moreover, they find significant interaction effects: at higher values of CCI, real interest rates become more important, while the effect of nominal interest rates declines, though remaining significant. The effect of current income growth weakens somewhat at higher values of CCI, suggesting short-run cash-flow constraints become less important.

As far as the interpretation of conditions towards the end of our sample is concerned, our evidence is that low nominal interest rates and the low inflation and interest rate uncertainty environment of recent years, and high real asset prices and real incomes largely explain the rise since the late 1980s in the ratios to income of secured and unsecured debt. Our estimates only cover the period up to the end of 2001, but at that point our preferred index of credit supply conditions was estimated to be higher than at any previous point although only modestly above the previous peak.

(43) Muellbauer and Murphy (1993) incorporated interaction effects but not the intercept role of a CCI.

**Data appendix**

## A. National data

*Non-property income (LY)*. These series are nominal and seasonally adjusted. Its construction is based on the guidelines produced in the Medium Term Macro Model by the Bank of England, pages 58 and 62. More specifically the formula to construct the series is given by the following ONS series: (*rpqk-royl+royt-nrjn+royh*) where *rpqk* denotes total disposable income, *royl* is property income received, *royt* is property income paid, *nrjn* is households gross operating surplus including gross mixed income and *royh* is mixed income. Effectively, *LY* is personal disposable income (*pdi*) minus pre-tax property income (*propy*). However, *pdi* - (1-*tp*)* *propy* would have been more appropriate, where *tp* is the unobserved tax rate on property income. Thus, if *npdi* is the desired measure of personal disposable non-property income,

$$\log npdi \cong \log LY + tp*propy/LY.$$

We do not have good estimates of *tp* and take a proxy for *tp* to be 0.5*(*total direct taxes paid by households/personal income*). Since part of property income is untaxed imputed rent and since other parts of interest income are untaxed, it seems likely the tax rate on property income is lower than the average tax rate on all income, hence the 0.5 factor. It seems likely that this is closer to the true value than the value of zero, implicitly assumed by the Bank.

*Unsecured debt (UD)*. These series, defined as consumer credit, come from the Bank of England's *Monetary and Financial Statistics* publication, code *vzri* in Table 6.1. Because the series are only available from 1987 we spliced them back to 1975 using the consumer credit series analysed by Chrystal and Mizen (2005). The series are nominal and seasonally adjusted.

*Secured debt (SD).* These series come from the ONS code *amwt* (see *Financial Statistics*, Table 3.2). The data are nominal and not seasonally adjusted.

*Consumer confidence*. These series come from GfK Marketing Services, and represent the total balance, that is the sum of the percentage of positive responses minus that of negative responses, indicating personal confidence about one's own finances and also confidence about the economy.

*Liquid assets*. These are defined as *nnmp.q+nnmy.q*, the sum of currency and deposits plus securities other than shares and are nominal and not seasonally adjusted (see Table AA64 in *Economic Accounts* for more). Prior to 1987, the equivalent series are given by the old ONS codes *aldo-rewg-amwv-aqhg-reyx-akui-aldj-rhht-amxf-rraq*.

*Illiquid financial assets*. Defined as the difference between total financial assets (definitions *aldo.q* (old ONS code) and *nnml.q* (new ONS code found in Table AA64) in *Economic Accounts*) and liquid assets (defined above). The series are nominal and in current prices.

*Housing wealth*. Housing wealth is constructed by Bank staff and is nominal and seasonally adjusted. The end-of-year figures coincide with ONS data on personal sector balance sheets.

*Price deflator (PC)*. This is the consumer price deflator obtained by dividing nominal by real consumption from the ONS.

*Unemployment rate*. These series, based on the claimant count definitions, come from *Labour Market Statistics*.

*The after-tax mortgage rate*. Series constructed by housing market analysts at the Bank of England. They build in a tax adjustment based on Inland Revenue estimates of the cost of mortgage interest tax relief.

*Population of working age*. These series come from the ONS's *Monthly Digest of Statistics* and *Labour Market Trends*.

*Proportion of young*. This is defined as the ratio of the population aged between 20 and under 35 to the population aged between 20 and under 70.

*The minimum lending rate*, later bank rate and then repo rate, is the key short-term interest rate, published in *Economic Trends*, *Financial Statistics* and the Bank's website.

*Hire purchase controls measure*. This measure was used in Bank and HM Treasury models of the 1970s and 1980s, see Townend (1976).

*Liquidity ratio of building societies* (up to 1980 Q4). This is defined as the ratio of cash and short-term investments to total assets at the end of each period and comes from *Financial Statistics* Table 8.6.

*The number of credit cards divided by the population of working age* (CREDO). The number of credit cards in circulation comes from the British Bankers' Association.

*Rate of return in housing*. It is defined as the yearly change in log house prices, lagged one quarter, minus the after-tax mortgage rate plus 0.02, an estimate of imputed rent minus taxes and maintenance costs as a proportion of the value of a dwelling.

*Demutualisation dummy*. This is a dummy for expected windfalls from demutualisation of building societies in 1995 and takes the value 1 in 1995 Q1 and zero otherwise.

*Mortgage indemnity premium (MIP) dummy*. Step dummy for abolition of the premium from 1998 Q1 for LVRs under 0.9.

*Tax relief abolition dummy*. Dummy for 1988's budget announcement in March that multiple mortgage interest tax relief would be abolished on 1st August, and restricted to one relief per property. The dummy is 0.25 in 1988 Q2 and 1 in 1988 Q3, and otherwise zero.

*Possessions*. The series comes from CML's *Housing Finance* and is defined as the annual number of possessions divided by the number of mortgages outstanding.

*House prices (hp)*. Series from the Department of the Environment, Transport and the Regions, now the Department for Communities and Local Government, *Housing Finance* Table 8. Based on the weighted average of regional mix-adjusted indices for all buyers, all housing types, discussed below.

## B. Regional data

We first briefly define the main sources for our regional data, the Survey of Mortgage Lenders and the New Earnings Survey and then describe the data series in some detail.

### *B1. Data extracted from SBSM/SML*

#### B1.1. Characteristics of SBSM/SML

The Survey of Building Society Mortgages (SBSM) and Survey of Mortgage Lenders (SML) were originally commissioned by Department of the Environment to construct a mix-adjusted house price series. These surveys are available in electronic format for the years 1975 to 2001 from the Data Archive at the University of Essex. Unfortunately, the year 1978 is missing. We have interpolated the 1978 data.

A structural break occurs in the surveys in 1992 Q2. Prior to that date, the survey only included building societies (the Abbey National being the exception as it remained in the sample after it became a bank in 1988). The transformation of the Abbey National to a bank prompted the creation of the Council of Mortgage Lenders (CML) in June 1989. This led to the modification, in 1992 Q2, of the SBSM to accommodate all members of the CML, not only building societies.

The surveys take a 5% sample of all loans granted (by building societies prior to 1992 Q2 and by all members of the Council of Mortgage Lenders thereafter). The questionnaire provides detailed information on the following characteristics: the loan amount, the price of the house at completion, the income of the borrower(s), the age of the borrower(s), the region where the house was purchased, the previous tenure of the borrower(s) (whether it is a first-time buyer, or an owner-occupier), whether price discounts were obtained (through right to buy schemes), the interest rate on the mortgage and type of mortgage, the length of the mortgage, the number of borrowers (prior to 1983 the electronic records do not permit extraction of the number of borrowers), the sex of the borrowers, the type of the dwelling (such as a detached, semi-detached, bungalow, etc) number of rooms.

B1.2. Variables extracted

From the SBSM/SML we obtained three quarterly series: the proportion of loan to value ratios in excess of 90% (PLVR), the proportion of loan to income ratios in excess of 2.5 (PLIR) and the after-tax mortgage interest rate.

These series correspond to first-time buyers only and exclude those receiving price discounts or those under the right to buy scheme. Moreover, each of these variables is constructed by region and age group (see below for more). These three series are derived as follows:

1) We first omit observations where relevant data are missing (such as age, income, house price, or information about price discounts or the previous tenure of the household).
2) We discard local authority and housing association tenants buying a house with a price discount.
3) We omit all sitting tenants not covered under 2).
4) We split the data into two age categories, those under 27 and those aged 27 and over.
5) We further split the data into those living in the South (defined as the regions Greater London, South East, South West and East Anglia) and the North (the rest of UK regions).
6) From this subsample of the data set, we construct PLVR, PLIR and the after-tax mortgage rate.

The loan to value ratio is defined as the amount advanced at completion by the lender divided by the house price. The loan to income ratio is defined as the advance at completion by the lender divided by the total income of the borrower(s). The derivation of the after-tax mortgage rate is given by the following formula:

$$abmr=(x*bmr*(1-t)+(advance-x)*bmr)/advance$$

where $x$ is the amount of the loan for which the tax discount is applicable (eg there was a maximum of £25,000 from 1974 to 1983 and £30,000 from 1983), *bmr* is the interest rate paid on the mortgage, *advance* relates to the advance made by the lending institution, and $t$ is the appropriate tax rate for each individual (from 1991-93 it is just 25%, 20% in 1994, 15% from 1995, 10% from 1998 and zero from 2000).

*B2. Extraction of NES data*

The New Earnings Survey (NES) was an annual survey based on national insurance records providing comprehensive information about earnings and hours data each April. From an electronic file for 1975 to 2001, data were extracted on weekly earnings[44] for full-time manual and non-manual men, and for women workers by age and region (North/South). The data in the electronic file are more complete, including late returns, than the data published each year in the annual reports of the NES.

*B3. Regional income variable from NES, SBSM/SML; regional house prices*

Construction of the chain index for regional income by age is done in the following steps:

1) Using the earnings data from the NES, we aggregate non-manual and manual men for each age and region using the following formula:

   0.75*non-manual earnings + 0.25*manual earnings to give men's earnings.

2) For each age and region we construct couple's earnings as

   0.5*(men's earnings + women's earnings).

3) From 1983 onwards we have weights for each age and region of single men, single women and couples who are first-time buyers. These weights are obtained the SBSM/SML data sets and exclude individuals who have a price discount (see above). The weights add to one for each age and region.
4) We assume that the pre-1983 weights for males, females and couples are the same as the 1983 weights.
5) A chain index of the annual earnings index for each region and age is constructed as follows:

   dlog(earnings index)(t) = female weight(t-1) * dlog(female earnings)(t) + couple weight(t-1) * dlog(couple earnings)(t) + male weight(t-1) * dlog(male earnings)(t).

   The index is benchmarked to 1986.

6) To obtain quarterly series, we interpolate the data using the monthly average earnings index for Great Britain.

Regional house price data came from the mix-adjusted series for all types of buyers and types of housing published by the Department of Local Government, Transport and the Regions (now Department for Communities and Local Government), *Housing Finance* Table 8. These indices are scaled to the average value of first-time buyers' dwellings in 1995.

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(44) Such data could have been extracted from the SML but are likely to be too subject to sample selection problems. For example, if unemployment rises, the income profile of those selected both by themselves and by lenders to be successful FTBs may well improve, as more risky prospects are selected out, giving a spuriously positive impression of the economic environment.

## Charts and tables

**Chart 1: Share of banks and centralised mortgage lenders**

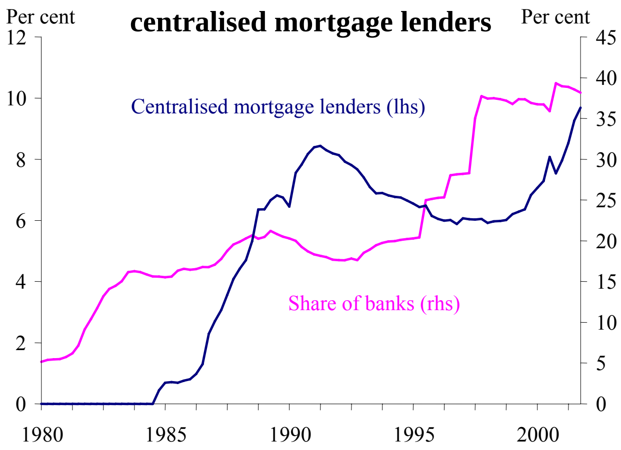



**Chart 2: Log consumption to income and log house prices to income**

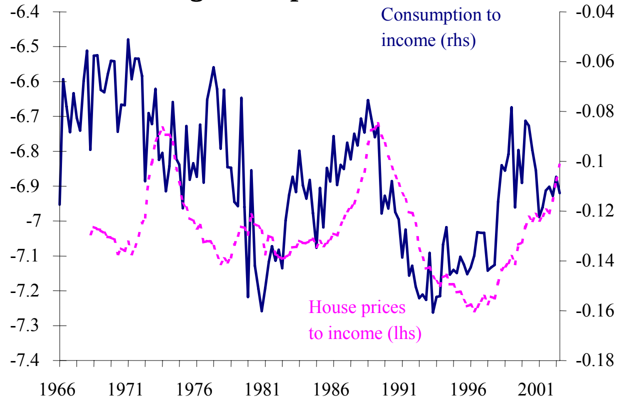
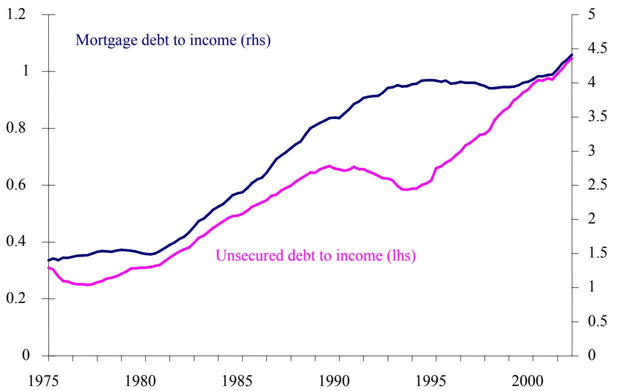



**Chart 3: Ratios of mortgage debt and unsecured debt to non-property income**



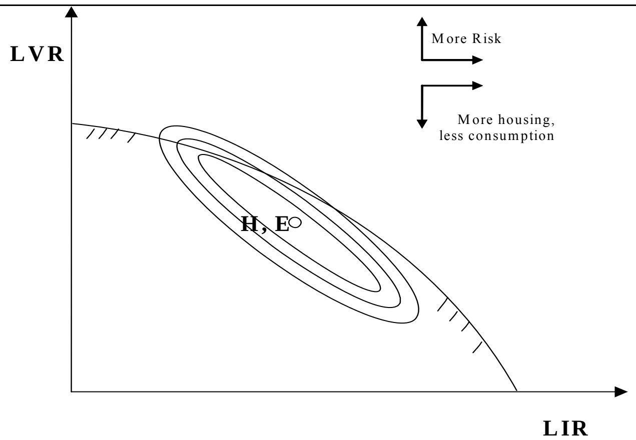




**Chart 4a: Unconstrained case**

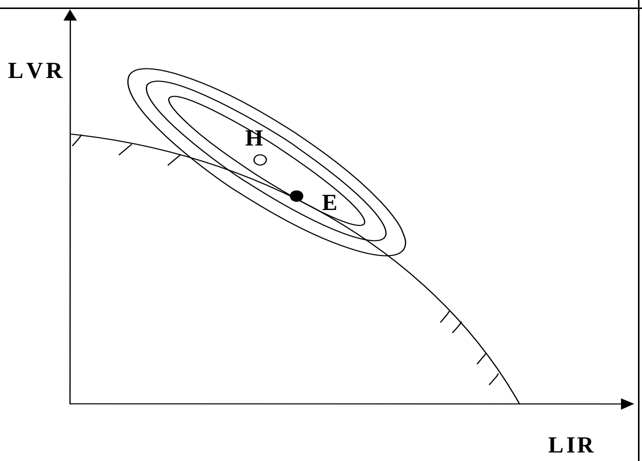



**Chart 4b: Constrained case**

**Chart 5: Aggregate loan to value ratio and loan to income ratio, FTBs**

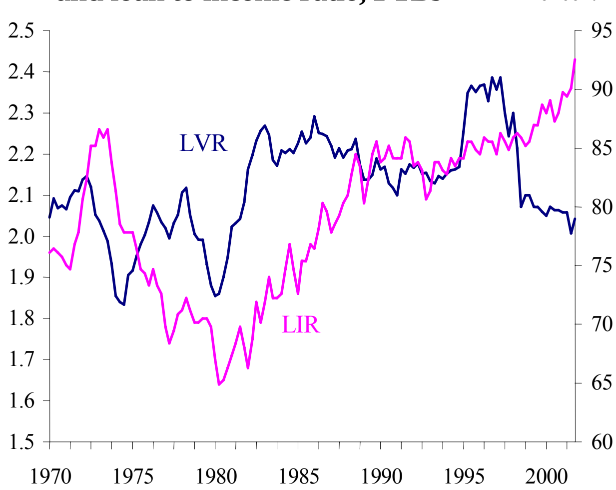


**Chart 6: % LIR ≥ 2.5 in the North**

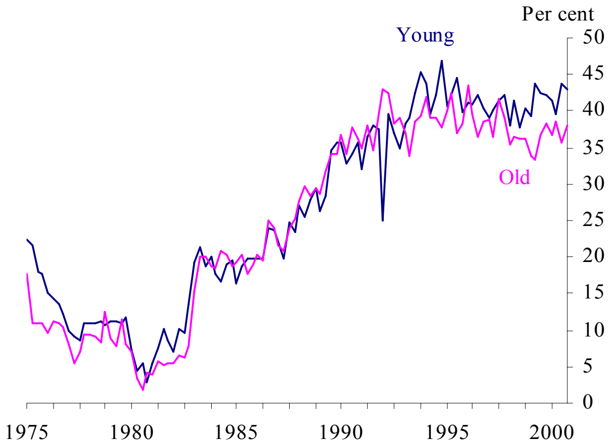



**Chart 7: % LIR ≥ 2.5 in the South**

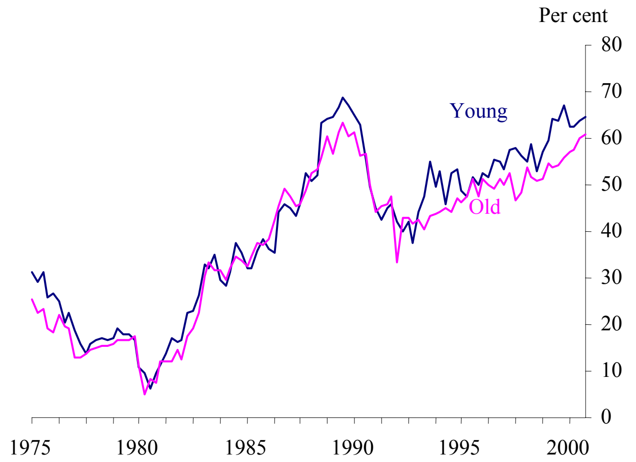



**Chart 8: % LVR ≥ .9 in the North**

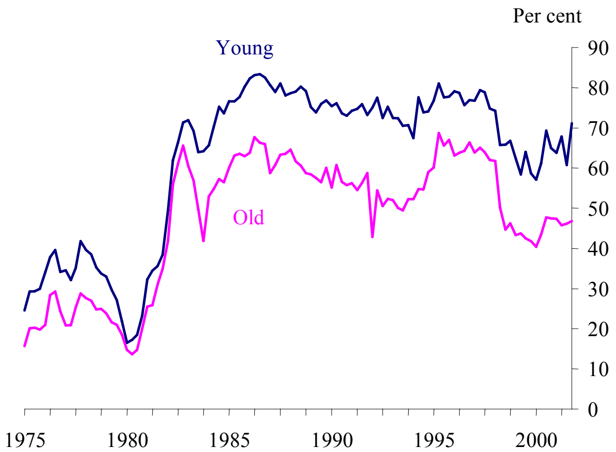



**Chart 9: % LVR ≥ .9 in the South**

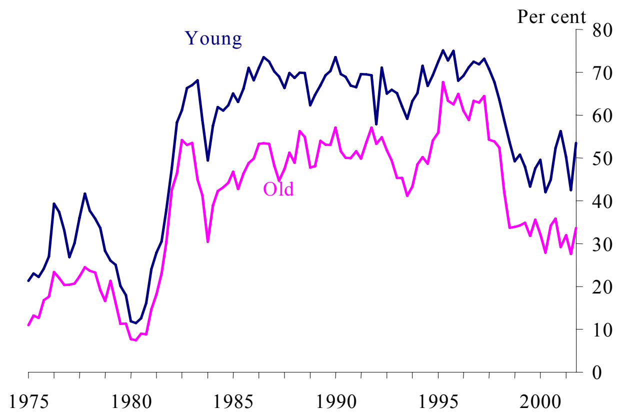



**Chart 10: Proportion of credit cards in population and proportion of 20-35 year olds**

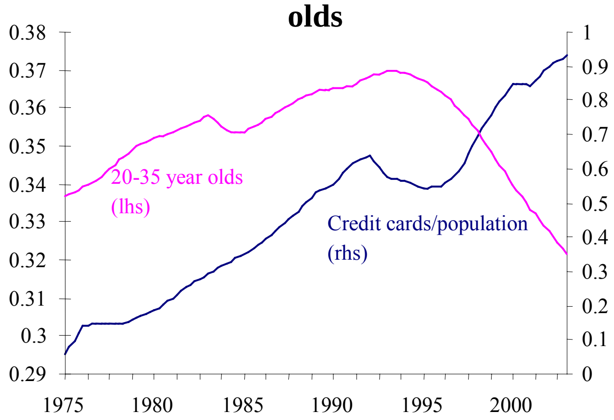
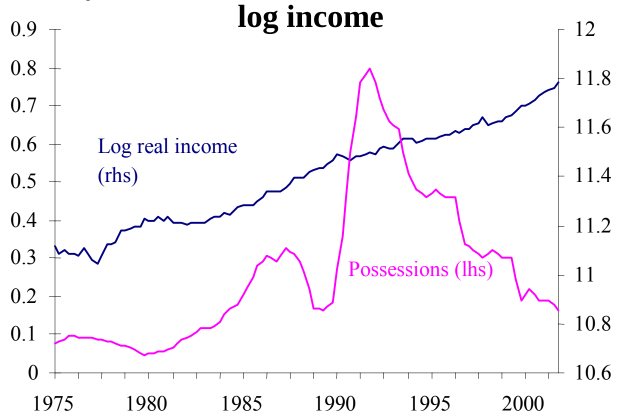
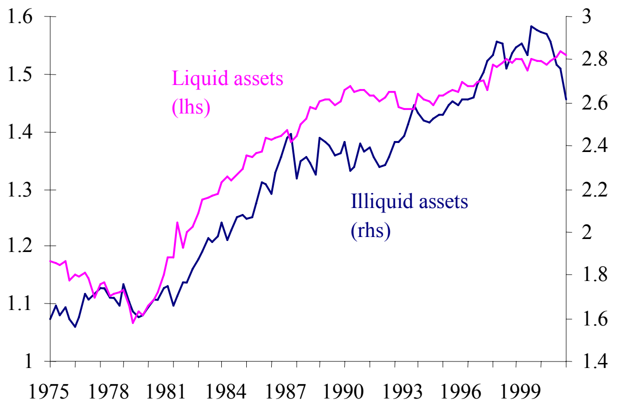


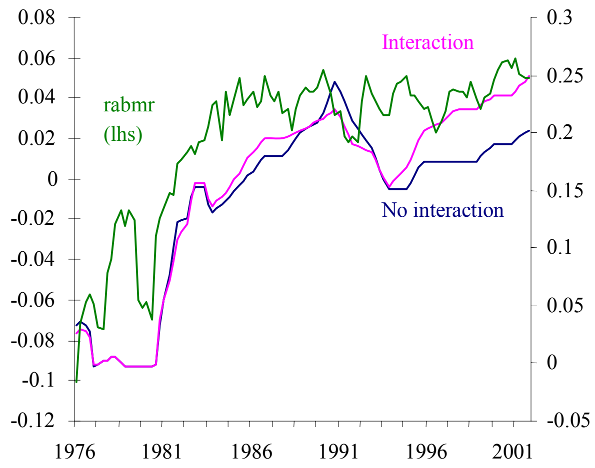

**Chart 11: Annual possessions to number mortgages outstanding and real per log income**



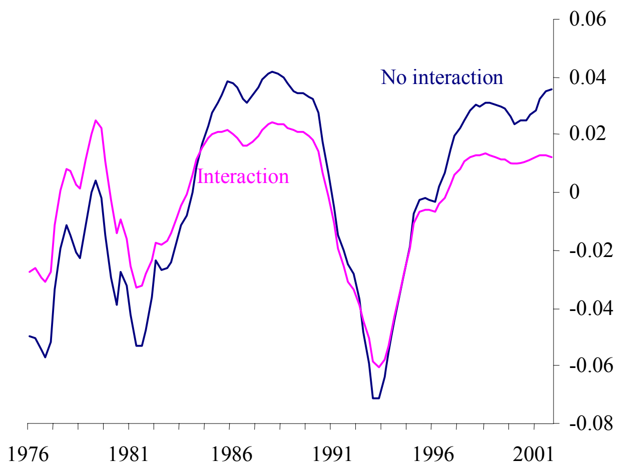
## Chart 12: Ratios of liquid and illiquid assets to income




## Chart 13: Credit condition indicators and after-tax real mortgage rate




## Chart 14: Implied risk measures




## Chart 15: Age deviations for the North and South for borrowers over 27 years old

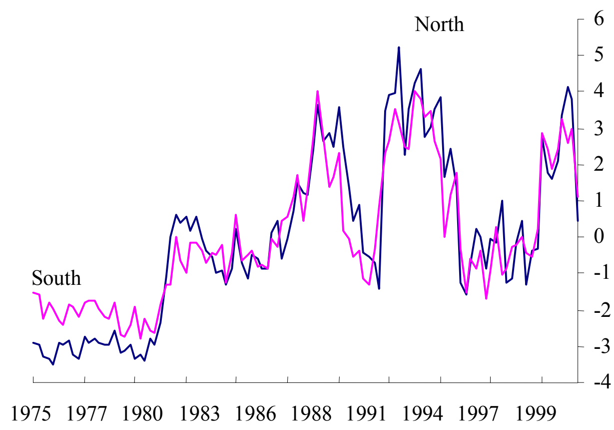


**Table A1: Parameter estimates for the log change in unsecured debt, Δ logUD**

| | Sample 1976Q1-2001Q4 | | Sample 1976Q1-1992Q4 | |
|---|---|---|---|---|
| **Parameter attached to variable** | **Coefficient** | **Absolute t-ratio** | **Coefficient** | **Absolute t-ratio** |
| speed of adjustment (log unsecured debt$_{-1}$/income) | 0.31 | 9.7 | 0.30 | 9.6 |
| Intercept | -0.67 | 2.4 | -1.16 | 4.4 |
| CCI | 2.08 | 6.2 | 1.97 | 6.2 |
| RISK (volatility of inflation etc) | 1.91 | 8.8 | 1.46 | 8.3 |
| Spread | -0.74 | 4.6 | -0.85 | 5.3 |
| demutualisation dummy | 0.15 | 8.9 | - | - |
| $\lambda$MIP dummy + (1-$\lambda$) MIP dummy(-1) | 0.07 | 5.6 | - | - |
| weight on current MIP dummy ($\lambda$) | 0.48 | 7.4 | - | - |
| log real income per capita | 0.59 | 4.7 | 0.80 | 5.3 |
| income growth (+4) | 0.41 | 3.2 | 0.60 | 3.5 |
| real base rate (-1) | -0.011 | 1.2 | - | - |
| rate of return in housing | 0.46 | 6.3 | 0.46 | 6.1 |
| log liquid assets (-1)/income | -0.29 | 1.7 | -0.41 | 2.2 |
| log illiquid financial assets (-1)/income | 0.07 | 2.2 | 0.10 | 3.0 |
| log housing assets (-1)/income | -0.11 | 1.7 | 0.02 | 0.3 |
| log proportion of credit cards (-4) | 0.18 | 3.8 | 0.08 | 1.5 |
| ISMI dummy (-1) | 0.05 | 4.3 | - | - |
| | | | | |
| Std. error of regression | 0.00608 | | 0.00600 | |
| R-squared | 0.894 | | 0.900 | |
| LM heteroscedasticity test | P=0.571 | | P=0.521 | |
| Durbin-Watson | 1.89 | | 2.11 | |
| LM AR4 test | P=0.663 | | P=0.179 | |

**Table A2: Parameter estimates for the log change in secured (mortgage) debt, Δlog SD**

| | Sample 1976Q1-2001Q4 | | Sample 1976Q1-1992Q4 | |
|---|---|---|---|---|
| | | | | |
| **Parameter attached to variable** | **Coefficient** | **Absolute t-ratio** | **Coefficient** | **Absolute t-ratio** |
| | | | | |
| speed of adjustment (log secured debt$_{-1}$ /income) | 0.061 | 5.1 | 0.067 | 5.1 |
| Intercept | 1.3 | 1.5 | 0.4 | 0.4 |
| CCI | 4.68 | 5.4 | 3.74 | 5.2 |
| RISK (volatility of inflation etc) | 2.08 | 3.6 | 2.22 | 4.4 |
| Spread | 0.59 | 2.0 | 0.53 | 1.9 |
| seasonal 1 | -0.058 | 4.2 | -0.071 | 3.5 |
| seasonal 2 | 0.024 | 1.9 | 0.034 | 2.2 |
| seasonal 3 | 0.053 | 4.1 | 0.066 | 3.8 |
| log real income per capita | As in Table A1 | | As in Table A1 | |
| income growth (+4) | As in Table A1 | | As in Table A1 | |
| tax relief abolition dummy | 0.23 | 4.4 | 0.19 | 4.3 |
| λMIP dummy + (1-λ) MIP dummy(-1) | 0.15 | 3.5 | - | - |
| log adjusted mortgage interest rate | -0.39 | 6.0 | -0.35 | 6.2 |
| real adjusted mortgage rate (-1) | -0.0071 | 2.1 | -0.014 | 4.2 |
| $\Delta_4$ unemployment rate | -0.040 | 4.0 | -0.037 | 3.9 |
| log liquid assets (-1)/income | -1.81 | 2.9 | -1.39 | 2.3 |
| log illiquid financial assets(-1)/income | 0.07 | 1.0 | 0 (fixed) | - |
| log housing assets(-1)/income | 0.29 | 2.9 | 0.34 | 2.8 |
| Δ population proportion aged 20-34 | 14.4 | 3.1 | 12.7 | 2.4 |
| population proportion aged 20-34 | 3.7 | 3.1 | 4.1 | 1.9 |
| ISMI dummy(-1) | -0.15 | 3.3 | - | - |
| | | | | |
| Std. error of regression | 0.00260 | | 0.00260 | |
| R-squared | 0.966 | | 0.937 | |
| LM heteroscedasticity test | P=0.547 | | P=0.776 | |
| Durbin-Watson | 1.98 | | 1.89 | |
| LM AR4 test | P=0.556 | | P=0.640 | |

**Table A3: Parameter estimates of Δ log-odds ratio of PLIR (proportion of loan to income of 2.5 or more for FTBs)**

| | Sample 1976Q1-2001Q4 | | Sample 1976Q1-1992Q4 | |
|---|---|---|---|---|
| | | | | |
| **Parameter attached to variable** | **Coefficient** | **Absolute t-ratio** | **Coefficient** | **Absolute t-ratio** |
| | | | | |
| speed of adjustment (log-odds ratio of $PLIR_{-1}$) | 0.44 | 12..2 | 0.44 | 11.4 |
| intercept for NY | -25.1 | 8.5 | -26.9 | 6.4 |
| intercept NO | -25.6 | 8.3 | -27.5 | 6.3 |
| intercept SY | -24.6 | 8.2 | -26.5 | 6.3 |
| intercept SO | -25.3 | 8.0 | -27.2 | 6.1 |
| Δ log-odds ratio of PLIR (-1) | -0.19 | 4.7 | -0.17 | 5.5 |
| CCI | 2.82 | 5.7 | 2.72 | 5.2 |
| RISK (volatility of inflation etc) | 4.30 | 5.5 | 2.81 | 4.6 |
| share of couples | -1.17 | 5.0 | -0.37 | 1.2 |
| log income(-1) - log hp (-1) | -1.82 | 10.9 | 1.60 | 7.1 |
| log mortgage rate (-1) | -0.89 | 8.9 | -0.69 | 4.3 |
| $\Delta_4$ log mortgage rate | -0.74 | 5.6 | -0.68 | 4.9 |
| $\Delta_4$ log mortgage rate(-4) | -0.30 | 3.5 | -0.27 | 3.5 |
| log real income ma2 (-1) – trend | 3.02 | 9.7 | 3.08 | 6.7 |
| income growth (+4) | 0.6 | 1.3 | 1.10 | 2.8 |
| Δ log hp | 1.5 | 2.5 | 1.9 | 2.7 |
| $\Delta^2$ log hp | 0.7 | 1.8 | 0.5 | 1.0 |
| λMIP dummy+(1-λ)MIP dummy(-1) | -0.06 | 1.0 | - | - |
| sample selection banks | -0.05 | 1.5 | -0.07 | 2.2 |
| sample selection centralised lenders | -0.10 | 2.8 | -0.09 | 2.4 |
| cubic term | 0.20 | 3.5 | 0.31 | 2.4 |
| North, Young | Std. error of regression | 0.130 | | 0.137 |
| | R-squared | 0.975 | | 0.965 |
| | LM heteroscedasticity test | P=0.001 | | P=0.020 |
| | Durbin-Watson | 1.86 | | 1.93 |
| | LM AR4 test | P=0.950 | | P=0.961 |
| North, Old | Std. error of regression | 0.146 | | 0.167 |
| | R-squared | 0.974 | | 0.964 |
| | LM het. test | P=0.000 | | P=0.000 |
| | Durbin-Watson | 2.29 | | 2.33 |
| | | P=0.019 | | P=0.116 |

| | | | | |
|---|---|---|---|---|
| South, Young | Std. error of regression | 0.140 | | 0.144 |
| | R-squared | 0.973 | | 0.970 |
| | LM het. test | P=0.072 | | P=0.201 |
| | Durbin-Watson | 1.48 | | 1.75 |
| | LM AR4 test | P=0.014 | | P=0.024 |
| South, Old | Std. error of regression | 0.127 | | 0.136 |
| | R-squared | 0.977 | | 0.976 |
| | LM het. test | P=0.001 | | P=0.005 |
| | Durbin-Watson | 1.80 | | 1.89 |
| | LM AR4 test | P=0.779 | | P=0.888 |

**Table A4: Parameter estimates for $\Delta$ log-odds ratio of PLVR (proportion of loan to value of 0.9 or more for FTBs)**

| | **Sample 1976Q1-2001Q4** | | **Sample 1976Q1-1992Q4** | |
|---|---|---|---|---|
| | | | | |
| **Parameter attached to variable** | **Coefficient** | **Absolute t-ratio** | **Coefficient** | **Absolute t-ratio** |
| | | | | |
| speed of adjustment (log-odds ratio of $PLVR_{-1}$) | 0.54 | 16.8 | 0.51 | 13.3 |
| intercept for NY | 1.10 | 2.2 | 1.03 | 1.5 |
| intercept for NO | 0.24 | 0.4 | 0.16 | 0.2 |
| intercept for SY | 0.58 | 1.1 | 0.51 | 0.7 |
| intercept for SO | -0.30 | 0.5 | -0.43 | 0.5 |
| CCI | 10 | fixed | 10 | fixed |
| RISK (volatility of inflation etc) | 10 | fixed | 10 | fixed |
| log income (-1) - log hp(-1) | 0.67 | 3.7 | 0.77 | 2.9 |
| log mortgage rate ma4 | -1.37 | 8.9 | -1.61 | 7.2 |
| $\Delta$ log mortgage rate | -1.27 | 4.3 | -1.78 | 4.5 |
| real mortgage rate (-1) | -0.015 | 1.5 | -0.021 | 2.1 |
| $\Delta_4$ log HP | -1.15 | 3.8 | -1.14 | 3.1 |
| ISMI dummy(-1) | -0.61 | 6.2 | - | - |
| $\lambda$MIP dummy+(1-$\lambda$)MIP dummy(-1) | -0.84 | 9.7 | - | - |
| sample selection banks | 0.17 | 3.1 | 0.02 | 0.3 |
| sample selection centralised lenders | -0.13 | 2.8 | -0.16 | 3.6 |
| age deviation for old | -0.036 | 4.7 | -0.044 | 4.2 |

| | | | | |
|---|---|---|---|---|
| North, Young | Std. error of regression | 0.139 | | 0.112 |
| | R-squared | 0.973 | | 0.987 |
| | LM heteroscedasticity test | P=0.307 | | P=0.948 |
| | Durbin-Watson | 1.63 | | 1.46 |
| | LM AR4 test | P=0.176 | | P=0.105 |
| North, Old | Std. error of regression | 0.119 | | 0.150 |
| | R-squared | 0.970 | | 0.966 |
| | LM heteroscedasticity test | P=0.199 | | P=0.057 |
| | Durbin-Watson | 1.52 | | 1.16 |
| | LM AR4 test | P=0.002 | | P=0.000 |
| South, Young | Std. error of regression | 0.141 | | 0.133 |
| | R-squared | 0.967 | | 0.977 |
| | LM heteroscedasticity test | P=0.354 | | P=0.962 |
| | Durbin-Watson | 1.55 | | 1.47 |
| | LM AR4 test | P=0.121 | | P=0.135 |
| South, Old | Std. error of regression | 0.155 | | 0.181 |
| | R-squared | 0.957 | | 0.950 |
| | LM heteroscedasticity test | P=0.161 | | P=0.750 |
| | Durbin-Watson | 1.60 | | 1.27 |
| | LM AR4 test | P=0.070 | | P=0.004 |

**Table A5: Parameter estimates for common RISK factor**

| | **Sample 1976Q1-2001Q4** | | **Sample 1976Q1-1992Q4** | |
|---|---|---|---|---|
| **Parameter attached to variable** | **Coefficient** | **Absolute t-ratio** | **Coefficient** | **Absolute t-ratio** |
| inflation volatility | -1.72 | 7.3 | -2.21 | 7.7 |
| $\Delta_4$ur | -0.0068 | 1.7 | -0.0070 | 1.8 |
| neg. housing rate of return | 0.34 | 2.3 | 0.51 | 2.2 |
| decay factor | 0.53 | 7.3 | 0.48 | 6.9 |
| rate of possession ma12 | -0.066 | 1.8 | -0.066 (fixed) | - |

**Table A6: Parameter estimates for CCI**

| | Sample 1976Q1-2001Q4 | | Sample 1976Q1-1992Q4 | |
|---|---|---|---|---|
| **Parameter attached to variable** | **Coefficient** | **Absolute t-ratio** | **Coefficient** | **Absolute t-ratio** |
| Dum80Q4 | 0.032 | 5.0 | 0.035 | 5.6 |
| Dum81 | 0.090 | 9.5 | 0.107 | 10.5 |
| Dum82 | 0.008 | 0.8 | 0.011 | 1.4 |
| Dum84 | 0.015 | 2.8 | 0.006 | 1.0 |
| Dum85 | 0.018 | 3.9 | 0.021 | 5.3 |
| Dum86 | 0.018 | 3.0 | 0.015 | 3.4 |
| Dum88 | 0.020 | 3.6 | 0.012 | 1.7 |
| Dum89 | 0.008 | 1.7 | 0.03 | 0.6 |
| Dum90 | 0.036 | 5.3 | 0.054 | 5.3 |
| Dum91 | -0.034 | 4.7 | -0.036 | 3.7 |
| Dum92 | -0.023 | 2.7 | -0.022 | 3.1 |
| Dum93 | -0.037 | 5.2 | - | - |
| Dum95 | 0.025 | 2.7 | - | - |
| Dum99 | 0.015 | 3.3 | - | - |
| Dum101 | 0.012 | 1.9 | - | - |
| $\Delta_4$ credit controls | -0.0028 | 6.1 | -0.0032 | 5.7 |
| liquid ratio (-1) | 0.0026 | 2.4 | 0.0029 | 2.4 |

Note: DumT is 4-quarter moving average of step dummy=0 before year T, and 1 from quarter 1 of year T.
Dum80Q4 is step dummy 0 up to 1980Q3, 1 thereafter.

**Table B1: Parameter estimates for the log change in unsecured debt, Δ log UD**

| | Sample 1976Q1-2001Q4 | | Sample 1976Q1-1992Q4 | |
|---|---|---|---|---|
| | | | | |
| **Parameter attached to variable** | **Coefficient** | **Absolute t-ratio** | **Coefficient** | **Absolute t-ratio** |
| | | | | |
| speed of adjustment (log unsecured debt$_{-1}$ /income) | 0.31 | 9.6 | 0.33 | 10.2 |
| Intercept | -1.00 | 3.2 | -1.19 | 4.8 |
| CCI | 1.68 | 5.5 | 1.66 | 5.8 |
| RISK*(1+ϕ*CCI) | 2.73 | 6.6 | 1.87 | 6.1 |
| Spread | -0.46 | 2.9 | -0.63 | 5.0 |
| demutualisation dummy | 0.15 | 8.5 | - | - |
| λMIP dummy + (1-λ) MIP dummy (-1) | 0.05 | 3.3 | - | - |
| λ weight on current MIP dummy | 0.43 | 7.5 | - | - |
| log real income | 0.47 | 4.0 | 0.53 | 3.9 |
| [RISK*(1+ϕ*CCI) + 0.05] (income growth (+4) -0.02) | 7.3 | 3.0 | 6.2 | 2.2 |
| CCI* (real base rate(-1) - 4.33) | -0.026 | 2.5 | -0.016 | 1.4 |
| rate of return in housing | 0.18 | 3.2 | 0.17 | 3.4 |
| log liquid assets (-1)/income | -0.32 | 1.9 | -0.36 | 2.4 |
| log illiquid financial assets (-1)/income | 0.04 | 1.7 | 0.07 | 2.4 |
| log housing assets (-1)/income | 0.13 | 2.7 | 0.19 | 3.2 |
| log proportion credit cards (-4) | 0.22 | 3.7 | 0.18 | 3.3 |
| ISMI dummy (-1) | 0.042 | 2.9 | - | - |
| | | | | |
| Std. error of regression | 0.00616 | | 0.00607 | |
| R-squared | 0.890 | | 0.896 | |
| LM heteroscedasticity test | P=0.373 | | P=0.641 | |
| Durbin-Watson | 2.07 | | 2.13 | |
| LM AR4 test | P=0.851 | | P=0.463 | |

**Table B2: Parameter estimates for the log change in secured (mortgage) debt, Δlog SD**

| | Sample 1976Q1-2001Q4 | | Sample 1976Q1-1992Q4 | |
|---|---|---|---|---|
| | | | | |
| **Parameter attached to variable** | **Coefficient** | **Absolute t-ratio** | **Coefficient** | **Absolute t-ratio** |
| | | | | |
| speed of adjustment (log secured debt$_{-1}$/income) | 0.074 | 5.8 | 0.087 | 5.6 |
| Intercept | 0.09 | 0.1 | -0.34 | 0.4 |
| CCI | 4.29 | 5.9 | 4.11 | 6.0 |
| RISK* (1+ϕ*CCI) | 1.15 | 2.0 | 1.45 | 2.8 |
| spread | 0.21 | 0.8 | 0.21 | 1.0 |
| seasonal 1 | -0.052 | 5.1 | -0.051 | 4.9 |
| seasonal 2 | 0.021 | 2.2 | 0.026 | 2.6 |
| seasonal 3 | 0.044 | 4.8 | 0.048 | 5.5 |
| tax relief abolition dummy | 0.22 | 5.0 | 0.19 | 5.1 |
| λMIP dummy+(1-λ) MIP dummy (-1) | 0.08 | 2.4 | - | - |
| real mortgage interest rate | -0.013 | 3.7 | -0.015 | 4.8 |
| log adjusted mortgage interest rate | -0.29 | 5.5 | -0.31 | 6.0 |
| log real per capita income | As in Table B1 | | As in Table B1 | |
| [RISK*(1+ϕ*CCI) + 0.05] (income growth (+4) -0.02) | As in Table B1 | | As in Table B1 | |
| $\Delta_4$ unemployment rate | -0.072 | 4.4 | -0.050 | 4.3 |
| CCI*($\Delta_4$ unemployment rate) | 0.30 | 2.9 | 0.26 | 2.9 |
| log liquid assets (-1)/income | -1.30 | 2.9 | -1.10 | 2.7 |
| log illiquid fin assets (-1)/income | 0.08 | 1.3 | 0 (fixed) | - |
| log hous. assets (-1)/income | 0.28 | 1.8 | 0.28 | 1.8 |
| CCI*log (hous. assets (-1)/liq assets(-1)) | 1.15 | 1.4 | 1.99 | 2.5 |
| $\Delta_4$ proportion aged 20-34 | 15.7 | 3.0 | 18.6 | 3.9 |
| proportion aged 20-34 (-4) | 4.9 | 2.7 | 5.6 | 2.5 |
| ISMI dummy (-1) | -0.12 | 3.2 | - | - |
| | | | | |
| Std. error of regression | 0.00250 | | 0.00271 | |
| R-squared | 0.968 | | 0.931 | |
| LM heteroscedasticity test | P=0.625 | | P=0.443 | |
| Durbin-Watson | 2.11 | | 1.75 | |
| LM AR4 test | P=0.101 | | P=0.391 | |

**Table B3: Parameter estimates of log-odds ratio of PLIR (proportion of loan to income of 2.5 or more for FTBs)**

| | **Sample 1976Q1-2001Q4** | | **Sample 1976Q1-1992Q4** | |
|---|---|---|---|---|
| | | | | |
| **Parameter attached to variable** | **Coefficient** | **Absolute t-ratio** | **Coefficient** | **Absolute t-ratio** |
| | | | | |
| | | | | |
| speed of adjustment (log-odds ratio of $PLIR_{-1}$) | 0.48 | 11.4 | 0.49 | 10.2 |
| intercept for NY | -1.9 | 0.3 | -10.2 | 1.4 |
| intercept NO | -1.5 | 0.2 | -10.0 | 1.3 |
| intercept SY | -0.9 | 0.1 | -9.4 | 1.3 |
| intercept SO | -0.5 | 0.1 | -9.2 | 1.2 |
| $\Delta$log PLIR(-1) | -0.24 | 4.5 | -0.19 | 4.6 |
| CCI | 4.19 | 6.6 | 3.81 | 5.5 |
| RISK*(1+$\phi$*CCI) | 3.68 | 3.4 | 1.88 | 1.8 |
| share of couples | -1.60 | 6.2 | -0.82 | 2.0 |
| log income(-1) - log hp(-1) | -2.9 | 9.6 | -2.6 | 7.0 |
| CCI*(log income/(-1) - log hp(-1)) | 2.8 | 2.9 | 2.0 | 2.1 |
| log mortgage rate (-1) | -1.59 | 6.0 | -1.19 | 4.5 |
| $\Delta_4$ log mortgage rate | -1.12 | 4.4 | -0.91 | 4.4 |
| $\Delta_4$ log mortgage rate(-4) | -0.61 | 3.7 | -0.49 | 3.3 |
| CCI*composite mortgage rate | -2.9 | 7.1 | -3.0 | 5.4 |
| CCI*real mortgage rate(-1) | -0.19 | 2.4 | -0.11 | 1.0 |
| log real per capita income ma2(-1)-trend | 0.9 | 1.3 | 1.6 | 2.3 |
| CCI*$\Delta_4$log real per capita income (+4) | 4.9 | 0.9 | 7.9 | 1.3 |
| $\Delta$log hp | 1.4 | 2.1 | 1.7 | 2.2 |
| $\Delta^2$log hp | 1.2 | 2.5 | 1.1 | 2.2 |
| ISMI dummy (-1) | -0.06 | 0.8 | - | - |
| sample selection banks | -0.10 | 2.3 | -0.07 | 1.9 |
| sample selection centralised lenders | -0.08 | 1.8 | -0.07 | 1.8 |
| cubic term | 0.06 | 2.2 | 0.12 | 2.0 |
| | | | | |
| North, Young | Std. error of regression | 0.122 | | 0.126 |
| | R-squared | 0.977 | | 0.969 |
| | LM heteroscedasticity test | P=0.000 | | P=0.011 |
| | Durbin-Watson | 2.11 | | 2.14 |
| | LM AR4 test | P=0.943 | | P=0.937 |

| | | | | |
|---|---|---|---|---|
| North, Old | Std. error of regression | 0.142 | | 0.170 |
| | R-squared | 0.975 | | 0.963 |
| | LM heteroscedasticity test | P=0.000 | | P=0.000 |
| | Durbin-Watson | 2.18 | | 2.18 |
| | LM AR4 test | P=0.315 | | P=0.668 |
| South, Young | Std. error of regression | 0.129 | | 0.133 |
| | R-squared | 0.978 | | 0.975 |
| | LM heteroscedasticity test | P=0.118 | | P=0.128 |
| | Durbin-Watson | 1.59 | | 1.38 |
| | LM AR4 test | P=0.121 | | P=0.111 |
| South, Old | Std. error of regression | 0.118 | | 0.131 |
| | R-squared | 0.980 | | 0.977 |
| | LM heteroscedasticity test | P=0.000 | | P=0.001 |
| | Durbin-Watson | 2.11 | | 2.04 |
| | LM AR4 test | P=0.448 | | P=0.551 |

Composite mortgage rate =(log mortgage rate*coeff + $\Delta_4$ log mortgage rate*coeff +$\Delta_4$ log mortgage rate(-4)*coeff)

**Table B4: Parameter estimates for log-odds ratio of PLVR (proportion of loan to value of 0.9 or more for FTBs)**

| | Sample 1976Q1-2001Q4 | | Sample 1976Q1-1992Q4 | |
|---|---|---|---|---|
| | | | | |
| **Parameter attached to variable** | **Coefficient** | **Absolute t-ratio** | **Coefficient** | **Absolute t-ratio** |
| | | | | |
| speed of adjustment (log-odds ratio of $PLVR_{-1}$) | 0.55 | 16.2 | 0.52 | 12.5 |
| intercept for NY | -16.2 | 2.9 | -28.7 | 3.5 |
| intercept for NO | -17.7 | 3.1 | -30.8 | 3.6 |
| intercept for SY | -17.0 | 3.0 | -29.8 | 3.6 |
| intercept for SO | 18.6 | 3.2 | -32.0 | 3.7 |
| CCI | 10 (fixed) | - | 10 (fixed) | |
| RISK*(1+ϕ*CCI) | 10 (fixed) | - | 10 (fixed) | |
| log income(-1) -log hp(-1) | 1.5 | 5.4 | 2.1 | 5.3 |
| CCI*(log income(-1) – log hp(-1)) | -4.3 | 4.7 | -6.1 | 4.0 |
| log mortgage rate ma4 | -1.5 | 6.3 | -1.0 | 2.9 |
| Δ log mortgage rate | -2.2 | 5.3 | -2.5 | 4.9 |
| CCI*composite mortgage rate | -2.8 | 4.3 | -2.3 | 3.4 |
| CCI*real mortgage rate(-1) | -0.31 | 2.2 | -0.59 | 2.7 |
| log real per capita incomema2(-1)-trend | 1.7 | 3.2 | 2.8 | 3.7 |
| CCI*income growth(+4) | 15.8 | 2.5 | 26.7 | 2.8 |
| $\Delta_4$ log hp | -1.2 | 4.0 | -1.3 | 3.6 |
| ISMI dummy (-1) | -0.49 | 4.4 | - | - |
| λMIP dummy+(1-λ) MIP dummy (-1) | -0.89 | 11.3 | - | - |
| sample selection banks | 0.12 | 2.1 | 0.01 | 0.1 |
| sample selection centralised lenders | -0.13 | 2.6 | -0.14 | 3.0 |
| age deviation for 27+ age group | -0.016 | 1.8 | 0.002 | 0.2 |
| | | | | |
| North, Young | Std. error of regression | 0.129 | | 0.103 |
| | R-squared | 0.976 | | 0.988 |
| | LM heteroscedasticity test | P=0.065 | | P=0.790 |
| | Durbin-Watson | 1.81 | | 1.43 |
| | LM AR4 test | P=0.457 | | P=0.156 |
| North, Old | Std. error of regression | 0.111 | | 0.130 |
| | R-squared | 0.974 | | 0.974 |
| | LM heteroscedasticity test | P=0.385 | | P=0.175 |
| | Durbin-Watson | 1.72 | | 1.62 |

| | | | | |
|---|---|---|---|---|
| | LM AR4 test | P-0.023 | | P=0.120 |
| South, Young | Std. error of regression | 0.127 | | 0.118 |
| | R-squared | 0.973 | | 0.982 |
| | LM heteroscedasticity test | P=0.133 | | P=0.234 |
| | Durbin-Watson | 1.85 | | 1.84 |
| | LM AR4 test | P=0.492 | | P=0.766 |
| South, Old | Std. error of regression | 0.152 | | 0.158 |
| | R-squared | 0.961 | | 0.962 |
| | LM heteroscedasticity test | P=0.530 | | P=0.967 |
| | Durbin-Watson | 1.72 | | 1.67 |
| | LM AR4 test | P=0.190 | | P=0.168 |

Composite mortgage rate = (log mortgage rate ma4*coeff +Δ log mortgage rate*coeff)

**Table B5: Parameter estimates for RISK factor**

| | **Sample 1976Q1-2001Q4** | | **Sample 1976Q1-1992Q4** | |
|---|---|---|---|---|
| | | | | |
| **Parameter attached to variable** | **Coefficient** | **Absolute t-ratio** | **Coefficient** | **Absolute t-ratio** |
| | | | | |
| inflation volatility | -1.34 | 6.5 | -1.68 | 6.3 |
| $\Delta_4$ur | -0.014 | 3.5 | -0.013 | 2.6 |
| neg. housing rate of return | 0.63 | 2.3 | 0.88 | 2.3 |
| decay factor | 0.48 | 7.1 | 0.39 | 6.5 |
| rate of possession ma12 | -0.110 | 2.4 | -0.110 (fixed) | - |
| CCI interaction with RISK (ϕ) | -2.79 | 4.9 | -2.70 | 4.7 |
| | | | | |

The RISK factor now enters in the form RISK*(1+ϕ*CCI)

**Table B6: Parameter estimates for CCI**

| | Sample 1976Q1-2001Q4 | Sample 1976Q1-1992Q4 | | |
|---|---|---|---|---|
| **Parameter attached to variable** | **Coefficient** | **Abs t-ratio** | **Coefficient** | **Abs t-ratio** |
| Dum80Q4 | 0.038 | 8.6 | 0.026 | 6.3 |
| Dum81 | 0.069 | 10.9 | 0.073 | 11.0 |
| Dum82 | 0.030 | 4.9 | 0.041 | 7.3 |
| Dum84 | 0.016 | 2.8 | 0.011 | 3.0 |
| Dum85 | 0.026 | 6.5 | 0.028 | 7.7 |
| Dum86 | 0.018 | 2.6 | 0.018 | 3.7 |
| Dum88 | 0.006 | 0.9 | - | - |
| Dum89 | 0.008 | 1.4 | 0.002 | 0.4 |
| Dum90 | 0.010 | 1.4 | 0.021 | 3.1 |
| Dum91 | -0.030 | 4.8 | -0.030 | 4.2 |
| Dum92 | -0.007 | 1.2 | - | - |
| Dum93 | -0.030 | 4.9 | - | - |
| Dum94 | 0.015 | 3.1 | - | - |
| Dum95 | 0.0032 | 4.2 | - | - |
| Dum96 | 0.008 | 1.6 | - | - |
| Dum97 | 0.012 | 1.6 | - | - |
| Dum99 | 0.011 | 2.0 | - | - |
| Dum101 | 0.016 | 1.8 | - | - |
| $\Delta_4$ credit controls | -0.0023 | 6.5 | -0.0019 | 5.9 |
| liquidity ratio(-1) | 0.0023 | 2.5 | 0.0011 | 1.6 |

Note: DumT is 4-quarter moving average of step dummy=0 before year T, and 1 from quarter 1 of year T. Dum80Q4 is step dummy 0 up to 1980Q3, 1 thereafter.

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