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HOUSEHOLD LEVERAGE AND THE DEDUCTIBILITY OF HOME MORTGAGE INTEREST: EVIDENCE FROM UK HOUSE PURCHASERS

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ABSTRACT

During the last quarter century, mortgage interest deductibility has been gradually phased out. In 1974 a ceiling was set on the size of the mortgage eligible for interest deductibility (£30,000 since 1983), and, beginning in 1993, the maximum rate at which interest under that ceiling could be deducted was reduced in four steps to zero in 1999. The combination of these changes gives a rich array of different debt tax penalties for different households in different years. We analyze over 117,000 loans originated in the UK during the 1988-91 and 1995-98 periods to finance home purchases. We first estimate a logit to predict whether a household's loan exceeds the £30,000 ceiling. These predicted probabilities are then employed to construct debt tax penalty variables that are used to explain household LTVs on loans to finance home purchases. The penalty variables depend on the predicted probability of having a loan that exceeds the ceiling, the market mortgage rate, and exogenous household specific tax rates. From these results we compute estimates of the impact of removing deductibility on initial LTVs in the UK and on the weighted average cost of capital for owner-occupied housing. Removal of deductibility is estimated to reduce initial LTVs, which mitigates the rise in the weighted average cost of capital, by about 30 percent, with the reduction varying with household age, loan size (above or below the £30,000 limit) and tax bracket.

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Household Leverage and the Deductibility of Home Mortgage Interest: Evidence from UK House Purchasers

Introduction

Periodically people propose removal of the home mortgage interest deduction in the U.S. (Follain and Melamed, 1998). The primary motivation for such proposals is recapture of tax revenue lost by the deduction – it is a major "tax expenditure." According to Follain and Melamed the official annual expenditure in the middle 1990s was \$40 to \$50 billion.[1] Numerous advocates would prefer to use these funds in a multitude of different ways. A secondary argument for removal of the deduction is that the expenditure is sharply skewed toward higher income households who are more likely to be homeowners and to finance large houses.

On the other hand, the mortgage interest deduction encourages home ownership and others argue that home ownership provides many positive externalities and thus ought to be encouraged. These include that ownership leads households to better maintain their dwellings and to raise children that do better on achievement tests and have fewer behavioral problems (Haurin, et. al., 2002). Moreover, eliminating the mortgage interest deduction wouldn't remove the fundamental tax advantage to home ownership – the favorable tax treatment of capital gains and imputed rents (Hendershott and Slemrod, 1983), but would just restrict the advantage to wealthy households that do not need to use debt finance (Woodward and Weicher, 1989).

This paper is not about the appropriateness of the mortgage interest deduction. Rather it is about the impact of the deduction on the use of debt to finance house purchases. This topic is crucial to both the amount the deduction lowers government tax revenue and the impact of deductibility on homeownership. If households were to sell taxable bond holdings to mortgage lenders and pay off their entire mortgage debt in response to elimination of deductibility, the government would gain no tax revenue and the cost of financing home ownership would be unchanged (assuming households and lenders pay the same tax rate). Portfolio reallocations with no real or tax consequences would be the sole result. At the other extreme, if households

[1] Inland Revenue estimated the expenditure to be nearly £8 billion in 1990/91 (Devereux and Lanot, 2001, p 2).

did not reduce their leverage, their after-tax income would fall and both the cost of homeownership and government tax revenues would rise significantly. Estimating where between these polar extremes household behavior lies is the purpose of this paper.

The fundamental tax advantage to owner-occupied housing is the generally low taxation of the return on the equity invested in the house (Hendershott and White, 2000). Few countries tax capital gains (the U.S. excludes the first $500,000 in gain), and, while a few European countries tax imputed rents (the U.S. does not), they are taxed at lower effective rates than private market rents are taxed. The magnitude of the fundamental tax advantage is directly related to the levels of both nominal pretax asset returns in the economy and household marginal income tax rates. The higher the level of returns and/or tax rates, the more valuable is the low taxation of the returns on owner-occupied housing. Because the tax advantage increases as the marginal tax bracket of the household increases, the demand for owner-occupied housing is greater the higher the tax bracket of the household (holding after-tax income constant). The housing tax advantage is clearly less in countries with flat (low) tax rate schedules.

In the quarter century after 1938, the UK sharply reduced the relative taxation of equity-financed owner-occupied housing.[2] When income taxation was reintroduced in 1842, imputed rent was set equal to an assessed value, which equalled an estimate of market rate and was taxed under ‘Schedule A’ of the income tax system, and mortgage interest (all household interest payments) was fully deductible (Hills, 1991). Reassessments were made every five years until 1935. By 1961, when the next reassessment was undertaken, imputed rent had been eroded by inflation to only a third of market rent. In 1963 the Conservative Government abolished taxation of imputed rents altogether, increasing and making permanent the low taxation of this component of return. The tax advantage to the capital gains component of return commenced when the capital gains tax, introduced in 1965, exempted gains on owner-occupied housing.

The deductibility of home mortgage interest is a means of extending the fundamental tax advantage of owner-occupied housing, the low taxation of the return on equity invested in housing, to the numerous younger, less wealthy households who cannot finance their purchase entirely with equity. Most developed

[2] During the 1980s the UK and many other countries sharply increased the relative taxation of equity-financed owner-occupied housing by significantly cutting the tax rates applied to other capital income.

countries allow a mortgage interest deduction, although many European countries limit it to a fixed amount or allow the deduction to be taken only at a tax rate less than that of many household marginal rates. In contrast, the Commonwealth countries -- Australia, Canada, New Zealand and now the UK – do not allow this interest deduction.

In fact, interest has never been *fully* deductible in the U.S. Low income households or households with low mortgage debt living in states with low house prices and low taxation (state taxes and mortgage interest are the two largest deductible expenses) would select not to itemize expenses because taking the standard deduction would lower their taxes (Ling and McGill, 1998). Further, even if a household did itemize, not all mortgage interest was effectively deductible (the amount of interest that raised total deductible expenses to the standard deduction was "wasted"). The amount of wasted interest (and the number of households that chose not to itemize) grew following the 1986 tax act for two reasons (Hendershott, Follain and Ling, 1987). First, a number of expenses that were previously deductible could no longer be itemized, probably the most important being the interest on consumer credit debt. Second, the standard deduction was sharply increased. The 1986 act also phased out itemized deductions when household income rose above threshold levels, limiting deductibility for very high income households to as little as 20 percent of their interest paid.

Follain, Ling, and various associates have used the change in the effective deductibility of mortgage interest induced by the 1986 tax act to test the hypothesis that household leverage is sensitive to the tax penalty associated with debt (Follain and Ling, 1991, Ling and McGill, 1998, Follain and Dunsky, 1997, and Dunsky and Follain, 2000). In each case, the leverage of individual households was found to be related significantly to the effective deductibility of mortgage interest. This work, which requires forecasting various unavailable household expenses and determining whether households would select to itemize or take the standard deduction, is innovative indeed. Using the Dunsky and Follain estimates, Follain and Melamed (1998) built a simulation model and predicted that removal of the mortgage interest deduction would lower mortgage debt by 41 percent.

The 41 percent estimate is roughly consistent with the aggregate comparison between Australia (AU) and the U.S. made by Capozza, Green and Hendershott (1996). They relate the LTVs of nearly 12,000 U.S. households in the 1989 Survey of Current Finances to the age of the household head and the log of income. This mimics the LTV estimates of Bourassa and Hendershott (1994) for just over 4,000 Australian households in 1986. Because interest is not deductible in Australia and is in the U.S., one would expect that the LTVs would be lower at all ages in Australia than in the U.S., and they are. The predicted U.S. (and AU in parentheses) LTVs for households of ages 25-29, 40-44, and 55-59 are 0.56 (0.42), 0.34 (0.12) and 0.16 (0.01).

Mortgage interest in the UK was fully deductible until 1974. At that time, a £25,000 ceiling was introduced on the size of mortgage eligible for interest deductibility. Given that the mean house price was £10,000, this ceiling affected few households. But because the ceiling was not indexed, it became progressively more binding over time as nominal house prices rose, and by 1990 it affected half of purchase loan originations. In addition, in 1993 the tax rate at which interest on debt below the ceiling could be deducted was lowered below the maximum rate at which income was taxed. In 1999 this rate was lowered to zero; deductibility was thus eliminated altogether.

The 1988-98 period of gradual removal, where households faced substantially different degrees of deductibility, is an ideal period to study the sensitivity of homeowner leverage to the deductibility of interest and to draw some inferences about the likely impact of the removal of interest deductibility on debt usage and the weighted average cost of capital for owner-occupied housing. Such is the goal of the present paper.

The remainder of the paper is divided into three sections and a conclusion/summary. We first derive debt tax penalty variables and present our estimation strategy. We then describe our database, including how we deal with credit rationing. Finally, we report our results based upon 1988-91 and 1995-98 loan samples.

The Debt Tax Penalty and Form of the Estimation Equations

As noted above, mortgage interest deductibility is a means of extending the fundamental tax advantage of owner-occupied housing to households who use debt finance. Deductibility does not make debt cheaper than equity, rather it maintains tax equality between the two costs. Thus to the extent that the deduction is limited, there is a tax cost or penalty to using debt and usage should be less.

Measurement of the Tax Penalty on Debt

This argument can be formalized in the following way. In general, the weighted average cost of capital for owner-occupied housing is just an average of the debt (CD) and equity (CE) costs where the weights are the loan to value ratio, LTV, and 1-LTV:

$$WACC = LTV(CD) + (1-LTV)(CE). \quad (1)$$

If the costs, CD and CE, both equal the after-tax interest rate, (1-t)i, then WACC = (1-t)i (we abstract from risk premia). However, if a tax penalty (pen) is imposed on debt usage, its cost is (1-t+pen)i and

$$WACC = (1-t)i + LTV(pen)i. \quad (2)$$

If the penalty is the nondeductibility of interest, pen = t and the WACC is increased by the product LTVti.

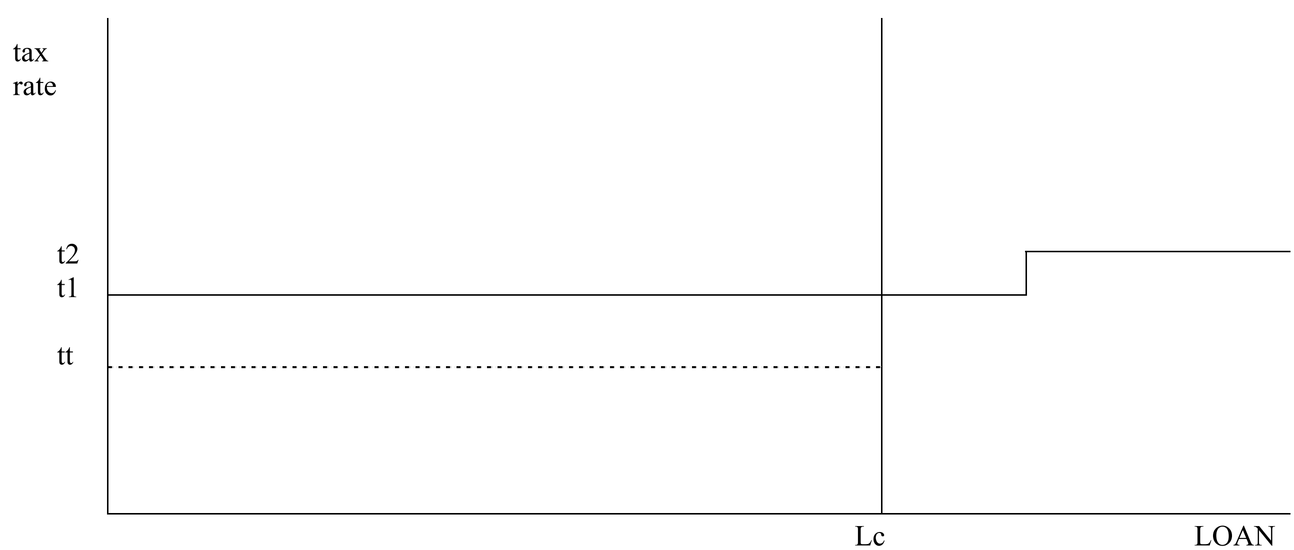
How much the imposition of the tax penalty raises the WACC depends on how much households change LTV in response to the loss of deductibility. The more households reduce LTV, the less the cost is increased and thus the less will be the reduction in homeownership and housing demand. (Also, the less revenue the government will gain by imposing the tax penalty.) Estimating the LTV response is the primary purpose of this paper.

During the last quarter century, the mortgage interest deduction in the UK has been limited in two ways. First, in 1974 the deduction was restricted to that on a £25,000 mortgage (and the deductibility of interest on other household debt was eliminated). In 1983, the limit was raised to £30,000; the median UK house price level had nearly tripled to £29,400 since 1974. Subsequently the limit was never again raised in spite of rising house prices (the median tripled again to £87,300 in 1999). As can be seen in Table 1A, by 1988-91 about half of the new mortgage originations were above the limit and by 1995-98 two-thirds were. Second, the maximum tax rate at which interest could be deducted was cut from the 40 percent maximum income tax rate to 25 percent in 1992, to 20 percent in 1994, to 10 percent in 1995, and finally to zero in 1999. Given that there were only two household income tax brackets during this period, 25 and 40 percent, after 1993 no household paying taxes could deduct mortgage interest at their full marginal income tax rate (see Table 1B).

Of the ceiling and tax rate maximums, the former has been far more important for new borrowers who have reasonably high initial loan-to-value ratios (the average of our sample is about 0.75). With a median house price in 1995-98 of £60,000 to £70,000 outside the London/Southeast area and £85,000 to £115,000 in London and the Southeast, most households had initial loans above the £30,000 mortgage limit and thus could not deduct interest at the margin.

Figure 1 illustrates how the debt tax penalty varies with loan size. Tax rates are on the vertical axis and loan amount on the horizontal. The top line is a household's marginal tax rate. Holding house value constant, the larger is the mortgage loan, the more interest is deductible (unless the loan is above the ceiling, Lc), but the larger are the household's taxable investments and thus the higher is its taxable interest income. As long as the ceiling isn't binding, taxable income is at least roughly independent of loan size. But when the loan exceeds the ceiling, the larger is the loan (and thus taxable investments), the higher is the household's taxable income. At some point the household could be pushed into a higher tax bracket, as the shift from t1 to t2 illustrates.

Figure 1: The Tax Penalty Variable



The dashed tt line in the figure indicates the lower maximum tax rate introduced in 1993 at which mortgage interest on the loan amount below the ceiling can be deducted. Of course, interest on the loan above the ceiling is deductible at a zero rate. To summarize then, the tax penalty on loans above the ceiling is the full tax rate, t; the penalty below the ceiling is the maximum of t-tt or zero (the latter for households with t < tt). Before 1993, there was no penalty on loans below the ceiling.

Thus two tax penalty variables are needed to reflect possible UK limitations on interest deductibility. The first captures the nondeductibility of interest on loans above the loan ceiling and is measured as the product of the tax rate and the market interest rate. The second captures the effect of the lower tax rate at which interest below the ceiling is deductible after 1992 and is measured as the product of max(t-tt, 0) and the market interest rate.

Estimation Strategy

To disentangle the characteristics of borrowers that have loans above the ceiling from characteristics that are caused by being above the ceiling, we first estimate a logit equation predicting whether or not the borrower's loan amount exceeds the ceiling and then use the predicted probability that the loan amount exceeds the ceiling, rather than whether it actually does, in computation of the tax penalty variables for use in the leverage estimation. This is an attempt to address the simultaneous determination of the tax penalty facing the borrower and his/her loan to value ratio. Although similar variables appear in both the LTV regression and the logit, we use different transformation of them in each. Combined with the non-linearity of the logit and the non-linear way in which the predicted probability enters the LTV regression, the incidence of multicolinearity between the tax variable and the other variables is minimized. The plausible signs and magnitudes of coefficients, the stability of the regressions and the high t-ratios confirm that multicolinearity is not a problem (Greene, 1993, p. 267).

The logit equation takes the form:

$$\text{CEIL}(0/1) = f(\text{income, ageDUMs, previous-owner, regionDUMs, yearDUMs}), \qquad (3)$$

where income and previous owner are both entered separately and interacted with the age dummies (<25, 25-34, 35-44, 45-54, >54). Income and age give us a prediction of housing demand by the household; the greater this demand, the more likely the loan is to exceed the ceiling. The impact of previous owner is unclear. On the one hand, a household with equity from a previous house can use this to make a larger down payment and thus would be less likely to have a loan above the ceiling. On the other hand, holding income, age, etc. constant, the more equity from a previous house, the larger can be the house one purchases. The regional dummies are introduced to reflect the impact of differences in regional house prices, and the year dummies are introduced to capture the variation in the level of house prices across the years of origination. The higher are house prices, the more likely is the ceiling to bind. Two equations are estimated, one for loan originations in "low" house price regions and another for those in "high" house price regions (see the data section).

The leverage estimation equation is:

$$\ln LTV = g[\text{basic determinants}] - \gamma \, tiprob - \beta \max(t\text{-}tt,0)i(1\text{-}prob) \qquad (4)$$

where prob is the predicted probability of having a loan above the ceiling. We allow for the tax penalty responses, γ and β, to vary with the borrower's age. We denote the first tax penalty variable by T_above and the second by T_below.

The household tax rate used in this estimation, t, must be independent of LTV. We compute the tax rate on the first dollar of housing finance (opportunity cost of own equity invested unless the house is 100 percent debt financed) by adding an estimate of the income the household would have earned on the equity invested in the house, i(HOUS-LOAN), to reported income. Given a progressive tax system, this is the highest possible estimated tax rate.[3]

Data Base

We use the Council of Mortgage Lenders (CML) 5% random sample of mortgage loan origination data, which has 20,000 to 40,000 loans per year. The underlying database contains all loans originated by commercial banks, building societies and others. The data have been collected annually since 1974. The key variables included in the CML data set are:

1. mortgage data: date, amount, type, initial rate, maturity, amortization pattern, and type of advance (whether new mortgage, re-mortgage, further advance, or top-up loan).
2. dwelling data: purchase price, location of house, and dwelling characteristics
3. borrower data: number, income and age of borrowers; previous tenure of main borrower.

A wide variety of mortgages exist in the UK, with product varying by repayment (standard, interest-only and endowment), term, and adjustment period. The major types of repayment are interest-only, fully amortizing, and endowment. The endowment mortgage is interest only, but the homeowner purchases a life insurance policy with a constant monthly premium that presumably will cover repayment at the end of the mortgage.[4] The adjustment periods are monthly or fixed for various lengths. We have much detail on the 1995-98 loans, but less for 1988-91. Between the periods, the mean mortgage term fell from 23.4 to 20.5 years. The percentage of loans that were fully amortizing rose from 17 to 40 percent and interest-only increased from less than 4 to 19 percent. Endowment loans, on the other hand, fell from 62 to 37 percent. In 1995-98, two thirds of the loans were fully variable, while few were fixed for as long as five years.

[3] The Institute for Fiscal Studies at Cambridge University has the UK tax rules back to 1973 posted on its web site (www.ifs.org.uk). This information is used to compute the t's for our households.
[4] See Devereux and Lanot (2001) for an analysis of household choice between endowment and other mortgages.

We analyze new mortgage data (mortgages to finance house purchases) from 1988-91 and 1995-98.[5] By dealing with house purchasers, we avoid the problems of controlling for or estimating how long it will take existing owners to adjust their leverage level in response to changes in interest deductibility (Ling and McGill, 1998). The two time periods differ both in levels of house price (percent of loans over £30,000) and in the debt tax penalty. During 1995-98, mortgage interest on loans below the £30,000 ceiling was deductible at the 10 percent rate (t*=0.1), rather than the marginal income tax rate of most households. Thus the tax rate penalty was either 0.3 or 0.15 for households with loans below the ceiling versus 0.4 or 0.25 for households above the ceiling. During the 1988-91 period, the tax penalty varied from zero for households with loan size less than the ceiling to the highest marginal tax rate of households with loan size greater than the ceiling. Given that the tax penalty was less dependent on whether one is above or below the ceiling in 1995-98 than in 1988-91, estimates from the latter period will be less dependent on the accuracy of the estimated logit than estimates from the earlier period.

Figure 2 plots constant-quality UK house prices for 10 regions over the period 1980 to 1998. Prices grew steadily (nearly 10 percent per annum) during the 1970s and 1980s and were relatively flat during the 1990s.[6] At all times prices in London and the Southeast are significantly greater than those in the rest of the UK, and during the late 1980s prices in the Southwest and East Angelica were also relatively high. Loans from these four areas are designated the high price group and loans from the other regions are labelled the low price group during the 1988-91 period. Only London and the Southeast are classified as high house price areas during the 1995-98 period. Because households in high house price areas are far more likely to have loans above the £30,000 ceiling, we estimate separate logit equations for data in the high and low price

[5] In 1988 the deductibility of interest on loans for renovation was eliminated, as was the ability of both members of an unmarried couple to deduct interest on loans of up to £30,000 (removing a then existing "marriage tax penalty" by increasing the tax on non-marrieds). Prior to 1988 it is difficult to determine whether a multiple-adult household faced a £30,000 or £60,000 fully deductible ceiling.

[6] The movement in real house prices is substantially different. In particular, real prices cycled sharply during the 1972-76 and 1985-93 periods and otherwise grew at a fairly steady 2.5 percent between 1970 and 1997. This 2.5 percent barely exceeds the two percent drift in the U.S. that Hendershott and Thibodeau (1990) attribute to new houses being of higher quality than old and old being renovated. That is, median house price inflation exceeds constant-quality house price inflation by two percent annually.

areas. Because we believe it especially important to analyze samples with wide variation in the debt tax penalty, we estimate a single equation for each period to explain household LTVs.

We restrict the data set in a number of ways. First, to exclude investment properties we delete loans to finance houses not occupied by the borrower. Second, we delete observations owing to missing values for some of the variables needed for the logit estimations. Third, we eliminate borrowers who are deemed likely to have had their borrowing decision dictated by lender borrowing limits (borrowers who are at/near the maximum allowable loan-to-value and/or loan-to-income ratios). Constrained borrowers are unlikely to be able to respond to the tax penalty.

The deletion of credit-constrained borrowers involves three steps. First, we identify a clearly unconstrained subset of borrowers. Second, we estimate housing demand functions for these households. Third, we predict housing demand for the rest of the sample (the *possibly* constrained borrowers). Borrowers with demand equal to or greater than that predicted are defined as unconstrained and added to the clearly unconstrained to form our total sample. Sample selection effects were captured using the Heckman estimation procedure. Here we discuss how the clearly unconstrained subset was identified. The housing demand estimation is contained in the Appendix.

Figures 3 and 4 contain the distributions of loans by LTV between zero and unity (the top half) and then between 0.8 and 1.0 (the bottom half) in our 1988-91 and 1995-98 samples (high and low priced regions are similar). The concentration of borrowers at the 90 and especially 95 and 100 percent values in the earlier period is obvious. This reflects both the increase in borrowing costs (required default insurance contracts) as those values are exceeded and, for the 100 percent concentration for sure, the maximum loan that lenders will make. The deregulation of financial institutions in the early 1980s had a major impact. In 1979, less than four percent of loans with LTVs above 80 percent had LTVs over 95 percent and only 20 percent had loans over 90 percent. In our full database, over a quarter of such loans had LTVs over 95 percent and two-thirds had them above 90 percent.

Figure 4 suggests a tightening of the LTV maximum in the middle 1990s; very few loans with LTV above 95 percent were originated in the 1995-98 period, while 15 percent of 1988-91 loans had LTVs of 100 percent. Nonetheless, in the later period 75 percent of loan originations had LTVs above 80%, versus only 57 percent in the 1988-91 period. That is, while there was a sharp reduction in 100% loans, credit was still amply available.

Figure 5 gives the distributions of the sample with ratios of loan size to income between 1.5 and 3.5 for single earner households in 1988-91 (top half) and 1995-98 (bottom half). The distributions for high and low house price areas are similar. As can be seen, the distribution falls off sharply after 3.0 in the first period but remains high until 3.25 in the second. It appears that lending standards were loosened between the two periods. Figure 6 gives the distributions for the loan-to-income ratio between 1.5 and 3.5 for multiple earner households in 1988-91 (top half) and 1995-98 (bottom half). In both periods the distribution drops off abruptly at 2.5, although significant numbers of borrowers obtain ratios up to 3.0 and some have ratios far above 3.0.

The "certainly unconstrained" borrowers in our sample are defined as those with LTVs below 0.89 and acceptable loan-to-income ratios. Based upon the above analysis, different loan-to-income constraints were applied for single and multiple earner households. In 1988-91 we restrict the sample to loan-to-income ratios below 2.75 (single earners) and 2.4 (multiple earners). In 1995-98 we increase the limit for single earners to 2.9, but maintain the 2.4 for multiple earners.

Table 2 presents summary data on our samples and how they have been produced. For each of the two house price groups for the two time periods we report both the number of loans we define as certainly unconstrained and the additional number we estimate to be unconstrained. As can be seen, we drop roughly 45 percent of the sample as we move from the logit estimation to the LTV estimation. For the unconstrained borrowers we list the percent (1) with loans above the £30,000 ceiling, (2) made to previous owners, and (3) made to multiple-earner households, as well as the percentage distribution by age class.

Not surprisingly, the percentage of loans exceeding the £30,000 ceiling is greater in high than low price areas and in 1995-98 (especially in low price areas) than in 1988-91. The age distribution of borrowers is similar in high and low price areas, but shifts significantly over time with the share of loans to under age 25 borrowers falling and that to ages 35-44 rising between 1988-91 and 1995-98. In both low and high house price regions, the share of loans to under age 25 borrowers was 12 percent in 1988-91. By 1995-98 this share was only nine (low price) and five (high price) percent. This shift at least partially reflects the ageing of the baby-boomers. The percentage of loans to previous owners in low price areas fell by five percentage points, while that in high price areas rose by four percentage points. The latter is consistent with the sharp drop in loans to those under age 25.

Estimation

1988-91

Table 3 reports the fit and the estimates of the logit predicting whether a borrower's loan is above or below the £30,000 limit. As can be seen, 78 and 82 percent of the sample, respectively, are predicted correctly in the low and high price areas. The distributions of the predicted probability of being over the ceiling and of the associated tax penalty variable are shown in Figure 7. The predicted probability distribution is flat through about 0.7 and then rises shapely. The rise reflects the high level of nominal house prices in the Southeast regions. The variation in the predicted tax penalty variable is large. While the variable is less than 0.03 for over two-thirds of the sample, it ranges from 0.045 to 0.06 for a quarter of the sample.

Table 4 reports the regressions of lnLTV. The adjusted R2 is 0.29. The key coefficient is, of course, that on the tax penalty variable, T_above. This coefficient is –6.4 with a t-ratio of 29. For high tax rate (40%) households with a loan over £30,000, and thus paying a tax penalty, lnLTV is reduced by –6.4(.12)(.4) = -0.294. For low tax rate (25%) households, the reduction is -6.4(.12)(.25) = -0.192. Assuming an LTV of 0.85 in the absence of the penalty, the LTV would be 0.63 to 0.70 with the penalty. If the LTV were 0.65 in the absence of the penalty, the LTV would be 0.48 to 0.54 with the penalty. That is, leverage would be reduced by 17 (low tax bracket borrowers) to 26 (high tax bracket borrowers) percent.

The elasticities of LTV with respect to primary income and secondary income (income is measured in thousands), respectively, are 0.275 and 0.068. Higher income households demand larger houses and choose to finance them with relatively greater leverage.[7] The lower leverage elasticity with respect to second incomes likely reflects the ability of households with second incomes to obtain down payment support from two families rather than one (we do not know if the individuals in the household are married). Previous ownership also reduces leverage, although much less for younger households. For households over age 34, the reduction in lnLTV is 0.28. For under age 25 households, the reduction is 0.09.

Table 5 reports some calculations indicating the predicted variation in LTVs across three age groups (25 to 34, 45 to 54, and 55 plus) with average single incomes for their age class, with and without a secondary earner with average income, and separately for first-time and previous owners. The calculations are for the dropped year (1991) and region (London) and assume no debt tax penalty. The first two rows give background data on mean incomes of first and second earners for the age groups. The next three (numbered) rows give the log of these mean incomes and mean LTVs. Incomes rise from ages 25-34 to ages 45-54 and then decline for those over age 55.

LTVs decline sharply with age, 30 to 35 percentage points as age increases from 25-34 to over 55. This is the type of decline commonly seen in developed economies, but note that this decline is for new purchases, not for homeowners generally. The predicted LTVs based on the mean income levels are four (over age 55) to ten (25 to 34) percentage points higher for multiple earner households than for single earner households. Finally, the LTV is about 10 percentage points lower for previous owners.

1995-98

The basic logits and lnLTV results are in Tables 6 and 7. Whether a borrower's loan is above or below the £30,000 ceiling is correctly predicted by the logit 83 to 86 percent of the time. Figures 8 and 9, respectively, plot the distributions of the predicted probability of being over the ceiling and of the associated tax penalty variables T_above and T_below. Owing to the rise in nominal house prices, the probability distribution is now strongly skewed to the right. Half of the sample has a probability greater than 0.8. The

[7] On the other hand, the existence of a second earner in the household reduces leverage (lnLTV is lowered by 0.48). The level of second income at which leverage is unaffected is obtained by solving 0.48 = ln(INCL)*0.068. The solution is £1095; for second incomes below this level, leverage declines.

tax penalty variables generally have lower values because the level of interest rates declined from 0.12 to 0.07. The right skewness of the probability of being over the ceiling results in a right skewness in T_above and a left skewness in T-below.

The adjusted R2 for the lnLTV regressions is 0.31. The previous owner results are similar to those for 1988-91, but the income variables have considerably smaller effects and age coefficients are smaller. This is illustrated by the calculations in Table 8, which assume no penalty and are based on London and 1998. The simulated declines from age 25-34 to 55+ are 23 percentage points for previous owners and 17 percentage points for nonowners, 10 to 15 points less than those in Table 5.

But the actual decline from age 25-34 to 55+ in the 1995-98 data was 0.32, greater than the 0.20 decline based on the 1988-91 data. This greater decline is due to the more widespread tax penalty on the use of home mortgage debt – a penalty that existed whether one's loan was above or below the £30,000 ceiling – and a larger estimated response to it. The two tax penalty coefficients in the first column of Table 7 are both statistically significant with the expected negative sign. The response to the penalty when above the ceiling, T_above, is more than double that in the 1988-91 period, -14.1 with t-ratio of 29, versus -6.4. The response when below the ceiling is much larger, -62.7 with a t-ratio of 41.

Because of the multiple tax-penalty coefficients, the interpretation of the tax penalty variables is more complicated. Above the ceiling, the penalty is t, below the ceiling it is t-0.1 (both times i = 0.07). For households in the 40 percent tax bracket, the lnLTV response to removal of interest deductibility is either -62.7(.07)(.3) – below the ceiling – or -14.1(.07)(.4) – above the ceiling, i.e., -1.62 or -0.39. For households in the 25 percent tax bracket, the estimated response is either –62.7(.07)(.15) or -14.1(.07)(.25), i.e., -0.66 or -0.25. That is, the response (reduction in lnLTV) is 2.5 to 4 times as great for those below the ceiling than those above. Given that loans below the ceiling are smaller (a half to a fifth on average), the percentage declines can be achieved with far smaller loan payoffs.

One possible reason for the larger responses to T_above in 1995-98 than in 1988-91 (-14.1 versus -6.4) is the decline in importance of under age 35 borrowers in the sample noted in Table 2 (from 54 to 48 percent of the sample in low price areas and from 53 to 42 percent in high price areas). If older households with greater wealth are more sensitive to the tax penalty, we would expect the average sample response to increase as the sample ages. To test the hypothesis that older households are more responsive, we run a regression with each tax penalty variable entered both by itself and times a dummy variable equaling one for households over age 34 and zero for younger households. The results are in Table 9. These interaction variables, as well as the tax penalty variables themselves are expected to have negative coefficients. The four coefficients are large, negative, and have t-ratios ranging from 7 to 29.[8]

Table 10 reports the impacts of removing the deductibility of mortgage interest for borrowers under age 35 and 35 and older and with loans above and below £30,000. The tax variable coefficients and t-ratios are in the first two rows of the table, and row 3 gives the cumulative coefficients ("all" for under age 35 and the sum of the "all" and "over 34" coefficients for over age 34). The first two columns are for loans over £30,000 and the third and fourth for under £30,000. Rows 4-7 report the distribution of households and average loan amounts for these household groups separately by low (largely 25 percent) and high (40 percent) tax brackets. Note that high tax bracket households are disproportionately older – they are almost twice as likely to be over age 34, while low tax bracket households are more likely to be under age 35 – and that the average loan size of high tax bracket households with loans over £30,000 is nearly twice that of low tax bracket households. Because high tax bracket and older households respond more than low tax bracket and younger households, this increases the aggregate response to removal of deductibility.

The impacts of removing deductibility are computed in two ways. First, we shift the probability of being over the £30,000 ceiling from zero to one, i.e., we use the coefficients from the first two columns. Second, we shift the probability of being under the ceiling from zero to one, using the much larger coefficients from the second two columns. The percentage reduction in leverage from removal of deductibility is $(1 - e^{pen})*100$, where pen is the product of the tax variable coefficient, the interest rate (0.07), and either the tax rate (loans over £30,000) or the tax rate less 0.1 (loans below £30,000). For those with loans above the £30,000 ceiling the reduction ranges from 19 to 29 percent for those under age 35 and from

[8] The age interaction tax penalty variable was tested with the 1988-91 subsample, but its coefficient was insignificantly different from zero. For 1995-98, an under age 25 interaction was tested in addition to the over age 34 interaction. The under age 25 coefficients were positive, as expected, but small.

23 to 34 percent for those 35 and older. These percentage declines are, on average, about the same as the 17 to 26 percent declines based on the 1988-91 sample, even though the level of interest rates was only 7 percent in 1995-98 versus the 12 percent in 1988-91 and thus the tax penalty was less.

The declines in leverage for those with loans less than the ceiling (columns three and four) are much larger, 40 to 65 percent for young households and 53 to 78 for older households. Given that we are dealing here with smaller volume loans, the percentage declines can be achieved with smaller loan payoffs. The larger responses are because the greater estimated response to the tax penalty outweighs the smaller penalty (the tax rate less 0.1, rather than the full tax rate). Of course the fact that these loans are small means that even these large responses are not very important to the aggregate response. In fact, the weighted average LTV response for the eight household groups is a 30 percent decline.

How much government tax revenue would be gained by elimination of tax deductibility depends on who (high or low tax rate payers) is repaying the debt, as well as how much is repaid. Say that the "static" (no behavioral responses) estimate of the revenue lost owing to deductibility is £10 billion and that mortgage debt declines by 30 percent in response to the removal of deductibility. The government revenue pickup will be significantly less than £7 billion because high tax bracket households would repay relatively more debt than low tax bracket households. Not only do higher tax bracket households respond about twice as much because their tax penalty is greater, but higher tax bracket households have loans that are almost twice as large. The response of older households with the same tax penalty is about 20 percent greater than that of younger households, probably owing to their having greater wealth relative to income.

Summary and Conclusion

We analyze over 117,000 UK loan originations split about equally between the 1988-91 and 1995-98 periods. Because the tax penalty to using debt varied during these periods with whether a borrower had a loan above or below £30,000, we first estimate logit equations explaining whether the loan exceeded £30,000 and then use the predicted probability of the borrower's loan exceeding this amount in computing our two tax penalty variables. The variables represent the penalty per unit of debt if the loan is above £30,000 – the product of the tax rate and the interest rate – or below – the product of the interest rate and the difference between one's marginal income tax rate and the rate at which mortgage interest is deductible.

We establish a major sensitivity of leverage to the debt tax penalty created for many households (for all during the 1995-98 period) by the partial deductibility of mortgage interest. This sensitivity exists for both time periods. Based on this, we can infer what the impact of removing the interest deduction would be relative to having the full deduction. Because estimates for the latter period are less sensitive to the accuracy of the logits used in computing the tax penalty variables, we view them as more credible. Our best estimate is that leverage of those with loans over £30,000 would decline by 19 to 34 percent, the larger percentage applying to older (over age 34) borrowers in the 40 percent tax bracket. For those with smaller loans (under the £30,000 ceiling), the estimates are far larger – a 40 to 78 percent decline. Because 80 percent of loans are above £30,000, the aggregate decline would be about 30 percent.

Our analysis is based on new loans for home purchase. Homeowners with existing loans will also pay down their loans. Because these households are older and many will have smaller loans, they are likely to be more sensitive to removal of the mortgage interest deduction (although effective prepayment penalties would make this response less/slower in the UK than in the U.S.). On the other hand, we have excluded 45 percent of new loans on the grounds that the borrowers may have been income or wealth constrained. These borrowers would be less sensitive to the tax penalty than unconstrained borrowers. Overall, our estimates of a reduction in the average UK leverage suggest a smaller – say 25 to 30 percent response than the 40 percent found in earlier studies of Australia and U.S. data.

The tax revenue gained by the government from removal of the home mortgage interest deduction will be less than the product of the average tax rate at which interest is deducted and the amount of debt not repaid for a variety of reasons. First, the average tax rate will decline because high tax bracket households will repay disproportionately larger fractions of their debt owing to their having a larger tax penalty and having greater relative wealth to repay debt. Second, removal of deductibility will lower the volume of single-family housing to be financed by raising the weighted average user cost of capital (WACC), although the debt response mitigates the rise in WACC, our concluding topic.

Initially assume full deductibility, a mortgage rate of 8 percent and an after-tax risk premium of one percent. Consider two households, one in the 40 percent tax bracket and the other in the 25 percent bracket. Their WACCs – (1-t)8 + 1 – are, respectively, 5.8 and 7 percent. Without deductibility, their WACCs rise to (1-t)8 + 1 + LTVt8. Table 11 gives the WACC for these households assuming alternative initial LTVs – 0.9 and 0.7 – and alternative percentage declines in leverage in response to the removal of interest deductibility – 20, 30 and 40.

Of course, with no decline in LTV, the increases are the largest, being greater the higher the initial LTV. The percentage decline in LTV acts as a direct offset to the percentage increase in WACC – if LTV declines by 30 percent, the increase in the WACC is only 70 percent of what it otherwise would have been. Consider the 0.9 LTV. With no change in leverage, removal of the deduction increases the WACC by 1.8 to 2.9 percentage points or 26 to 50 percent (the larger numbers for households in the 40 percent tax bracket). With a 30 percent decline in leverage, the increase in the WACC is reduced by 30 percent or a half to a full percentage point.

Changes in household leverage would significantly offset the negative impact of the removal of interest deductibility on house prices, housing consumption and home ownership. To illustrate, consider the extreme case where all of the increase in WACC causes a reduction in housing consumption. In the appendix we estimate that the elasticity of housing demand with respect to the WACC is –0.25 to –0.4. Thus if the WACC rises by 30 percent, the decline in housing consumption would be 7.5 to 12 percent. On the other hand, if leverage adjustments offset half of the rise in WACC, the decline in consumption would be only 4 to 6 percent.

At the other extreme, the rise in WACC could simply lower real house prices. In this case, a 30 percent rise in the WACC translates directly into a 30 percent price decline. Thus a halving of the increase in WACC would half the price decline. A mixture of consumption and price declines would be expected, but the declines would, according to our estimates, by reduced by about a third by the leverage response.

Appendix: Determining Credit Constrained Borrowers

The LTV functions were estimated using a five-step procedure applied separately to each time period. The last two steps were discussed in detail in the text and so it is the first three steps, relating to the treatment of rationed borrowers, that is our focus here. Before detailing each step, it is worth summarizing the overall strategy. The goal is to develop a methodology for identifying unrationed borrowers. We first specified a subsample of borrowers who we believe to be clearly unrationed given their loan-to-value and loan-to-income ratios. We then estimated a housing demand function for this group of borrowers and used this function to estimate the demand for each household in the rest of the sample and compared it to their actual demand. If actual demand equaled or exceeded predicted demand, the household was added to our unrationed sample, on which our final LTV function was estimated. Sample selection effects were captured using the Heckman estimation procedure. This method translates into a five step procedure.

Step 1: Estimate ψ_{bt}

ψ_{bt} is the predicted probability that the borrower's loan will be less than or equal to the £30,000 ceiling on tax deductibility. This probability is needed in the construction of the user cost of capital variable in the demand regressions estimated in step 2.

ψ_{bt} was estimated by running logits (dependent variable = whether or not the borrowers loan exceeded the £30,000 limit) on a subsample of clearly unrationed borrowers, selected as those borrowers in the 1988-91 (1995-98) period with a loan to value ratio less than or equal to 0.89 (0.89) and either a loan to primary earner income ratio less than or equal to 2.75 (2.9) or a loan to total income ratio less than or equal to 2.4 (2.4). This resulted in a basic sample of unrationed borrowers in 1988-91 (1995-98) of 44,506 (38,836). Separate logits were run for low and high house price regions.

Step 2: Estimate unconstrained housing consumption

The housing demand equation followed Hendershott and Pryce (2002),

$$lnHC_b = \beta_0 + \beta_1 lnMCH_b + \beta_2 lnY_b + \beta_3 AGE_b + \beta_4 AGE_b^2,$$

where lnHC is the log of housing consumption, lnMCH is the log of the marginal cost of housing, lnY_b is the log of total income, AGE is the age of the main borrower, lnY_b is the log of total income, the β_i are the estimated coefficients, and the subscript b refers to household b. We adopt Goodman and Kawai's (1982) method for calculating HC, defining it as the actual household house price (times a constant imputed rental rate that is absorbed in the constant term when logs are taken) divided by the constant-quality price. The latter is estimated using hedonic regressions of price on housing attributes and quarter dummies, run separately for each of the ten regions and each year.

The marginal cost of housing was calculated as, $MCH_t = UCC_t(\hat{P}_{rt}/\mathrm{RPI}_t)$, where RPI is monthly retail price index, and UCC is the user cost of capital, defined as the mortgage interest rate i, less the tax deductible component τ, plus the rate of depreciation (assumed to be 0.01 for all households), plus property taxes (0.02), and less expected capital gains, π^*_{rt}:

$$UCC = (1 - \tau_{bt})i_t + 0.03 - 0.3\pi^*_{rt}.$$

The expected rate of nominal house price change, π^*_{rt}, was estimated separately for each region using the backward-looking expectations approach of Ermisch, Findlay and Gibb (1996). That is, $\Delta\hat{P}_{rt}$ was regressed on $\Delta\hat{P}_{rt-1}$ from 1979 quarter one through to 1998 quarter four, where $\Delta\hat{P}_{rt}$ is the four quarter difference in the price index, $\Delta\hat{P}_{rt} = \hat{P}_{rt} - \hat{P}_{rt-4}$, and the estimated parameters used to forecast expected house price inflation for each region in each quarter).

The constant quality price house price index used for these calculations was constructed using the selling price and dwelling characteristics information in the CML Survey of Mortgage Lenders data. For each of the ten regions region, separate regressions were run on selling price for each year of the data since 1979 (explanatory variables = number of rooms, number of rooms squared, age of dwelling dummies, type of dwelling dummies, room-type interactive terms, and quarterly dummies on selling price) thus allowing marginal valuations of characteristics to change from year to year. These regressions (200 in total) had an average adjusted R^2 of 0.48 based on samples of around 1,500 depending on the region and the time period. We then predicted value of a constant quality dwelling (a five bedroom, semi-detached, post war dwelling) for each region in each quarter = $\hat{P}_{rt}$.

A weight of 0.3 was applied to π^*_{rt} following Ermisch, Findlay and Gibb (1996). The tax deductible component τ, was computed by multiplying the borrower's marginal income tax rate T_b by ψ_{bt}, the predicted probability that the borrower's loan would be less than or equal to the £30,000 ceiling on tax deductibility (computed in Step 1). As in the final LTV regressions, the household tax rate used in this estimation, T_b, was computed as the tax rate on the first pound of housing purchased by adding an estimate of the income the household would have earned on the equity invested in purchasing the house to reported income.

The housing demand regression was run on the subsample of easily identifiable unrationed borrowers and the estimated parameters (listed in Table A) were used to predict unrationed housing demand. Missing values reduced the basic unrationed sample in 1988-91 (1995-98) by 3,065 (7,933) observations to 41,441 (30,903) cases. The estimated income elasticity is about 0.6 and the price elasticity is –0.25 (1995-98) to –0.4 (1988-91).

Step 3: Compare actual and predicted demands for households in the remaining sample

If actual demand (as recorded in the data) equals or exceeds predicted demand (the antilog of the predicted values from the demand regressions in Table A), the household was added to our unrationed sample.

Step 4: Predict the probability of exceeding the ceiling

The logits were re-run on the enlarged sample and the estimated parameters used to predict the probability of exceeding the ceiling. This probability was used to construct the tax penalty variable in the LTV regression.

Step 5: Run the LTV regression

Finally, the LTV regression was run on the expanded unconstrained sample using the Heckman procedure to account for selection effects.

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Figure 2

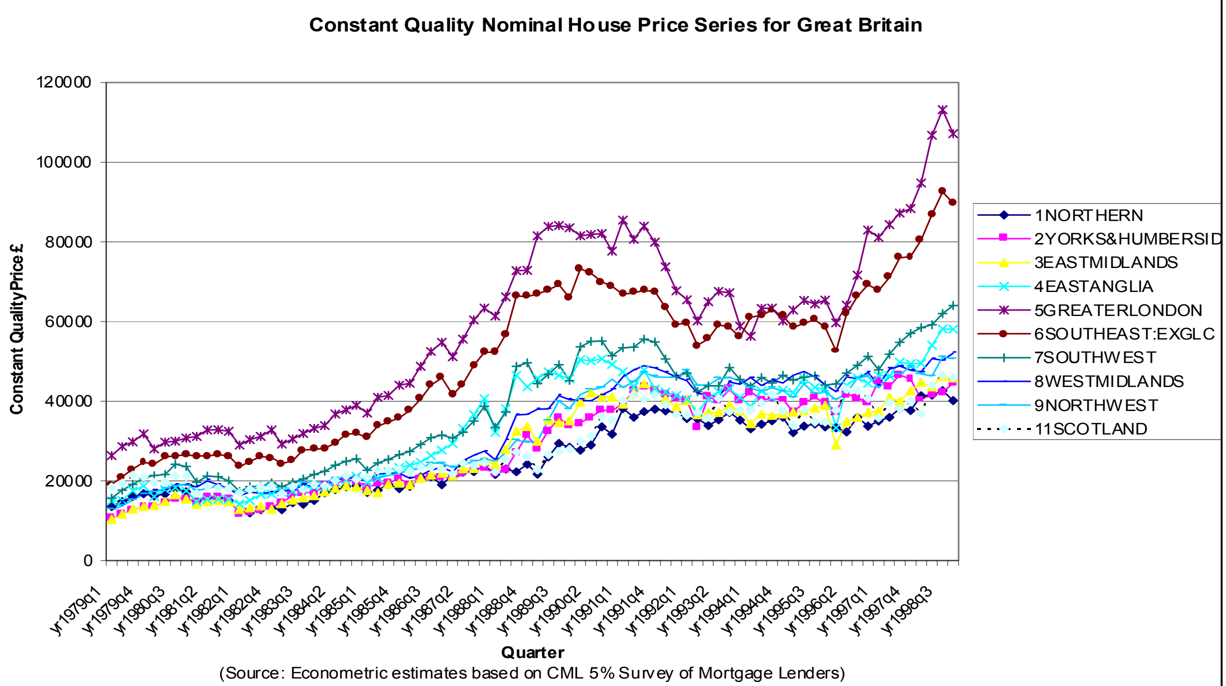
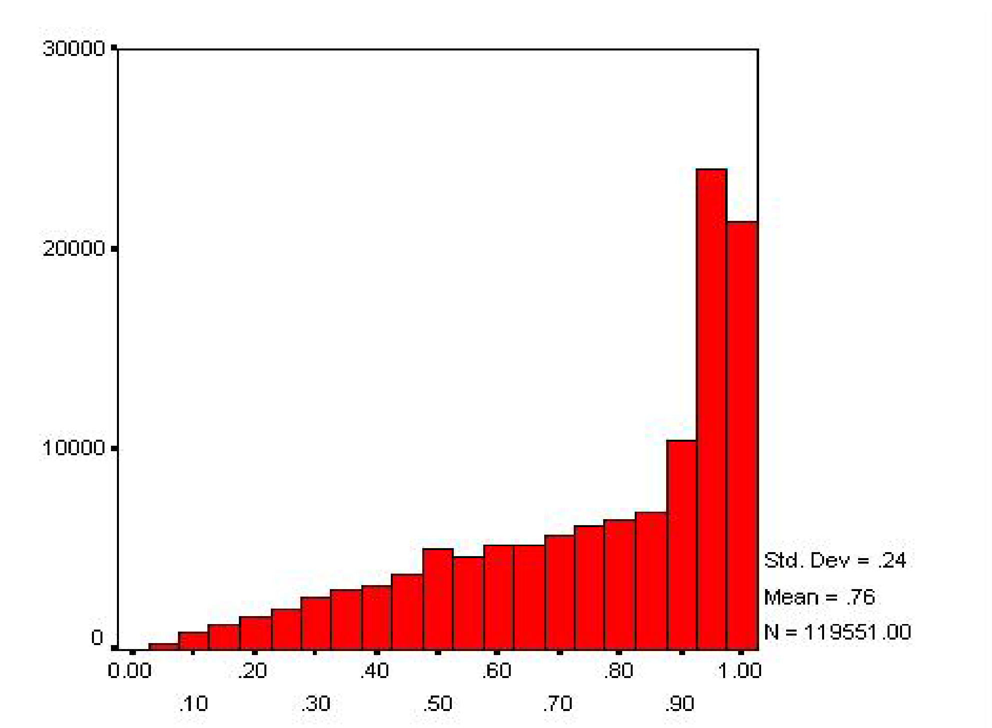


Figure 3 1988-91 Loan to Value Ratio

LTVs between 0 and 1



LTVs between 0.8 and 1

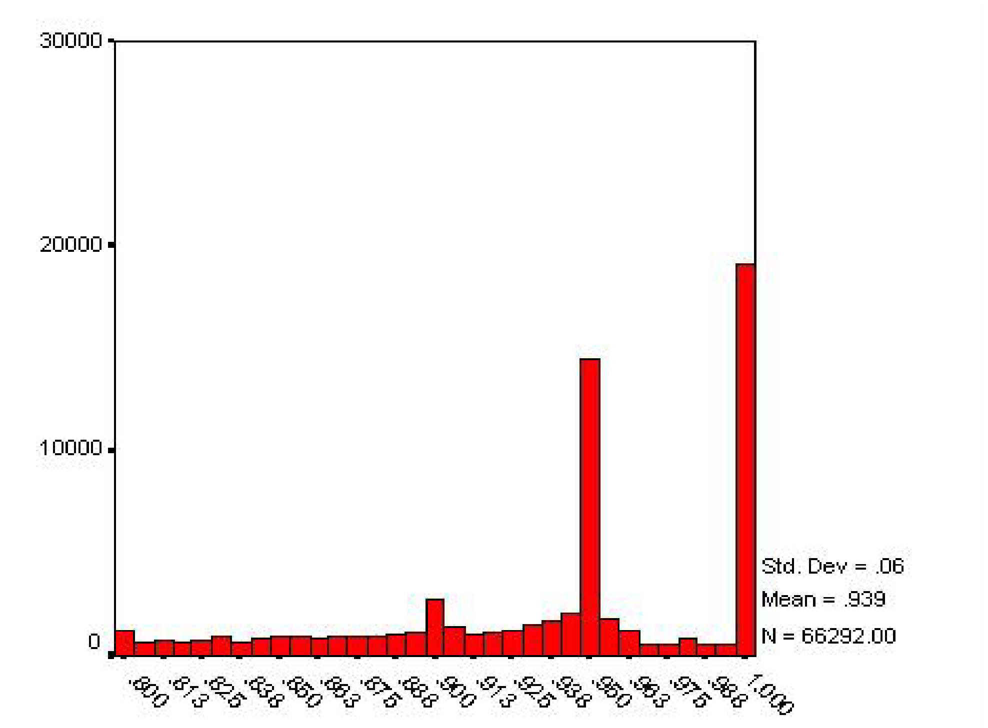
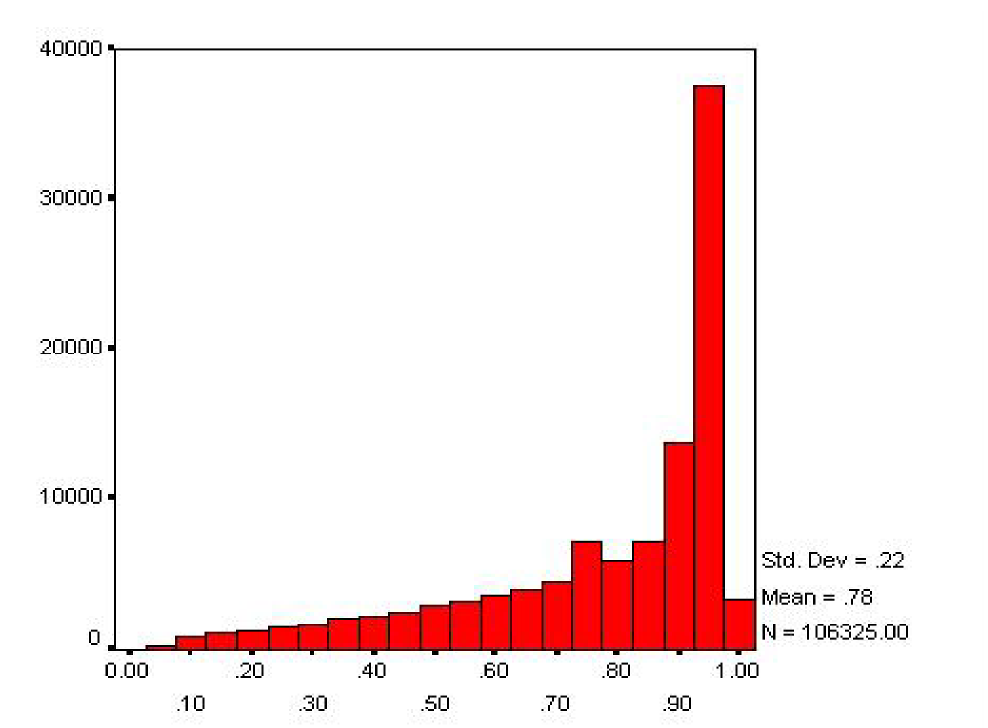


Figure 4 1995-98 Loan to value Ratio

LTVs between 0 and 1



LTVs between 0.8 and 1

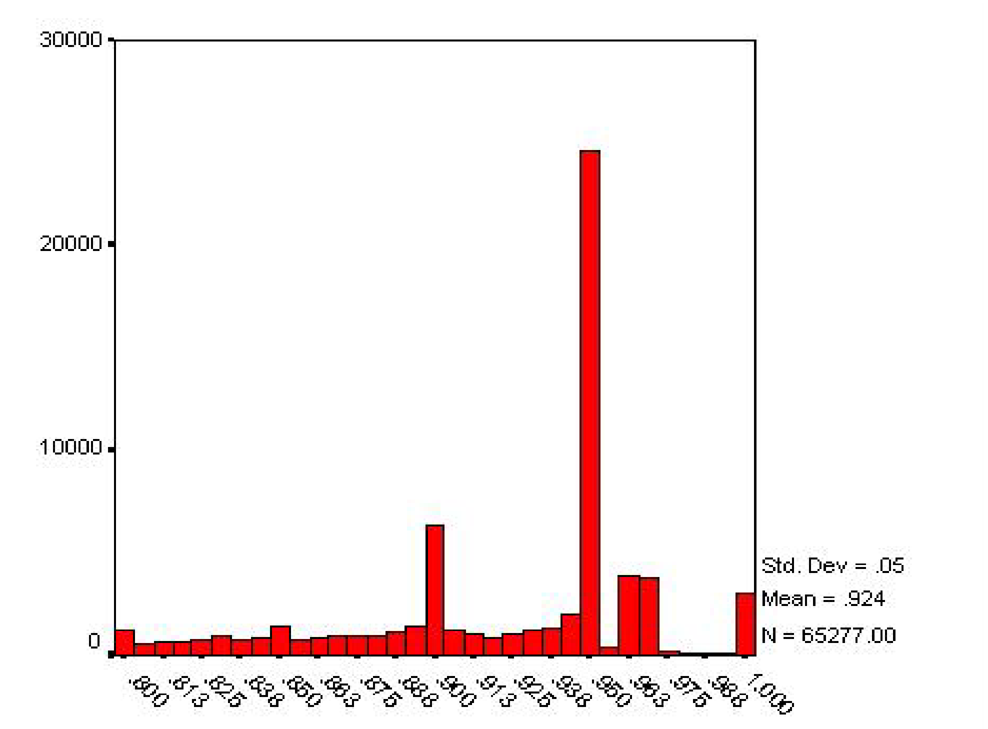
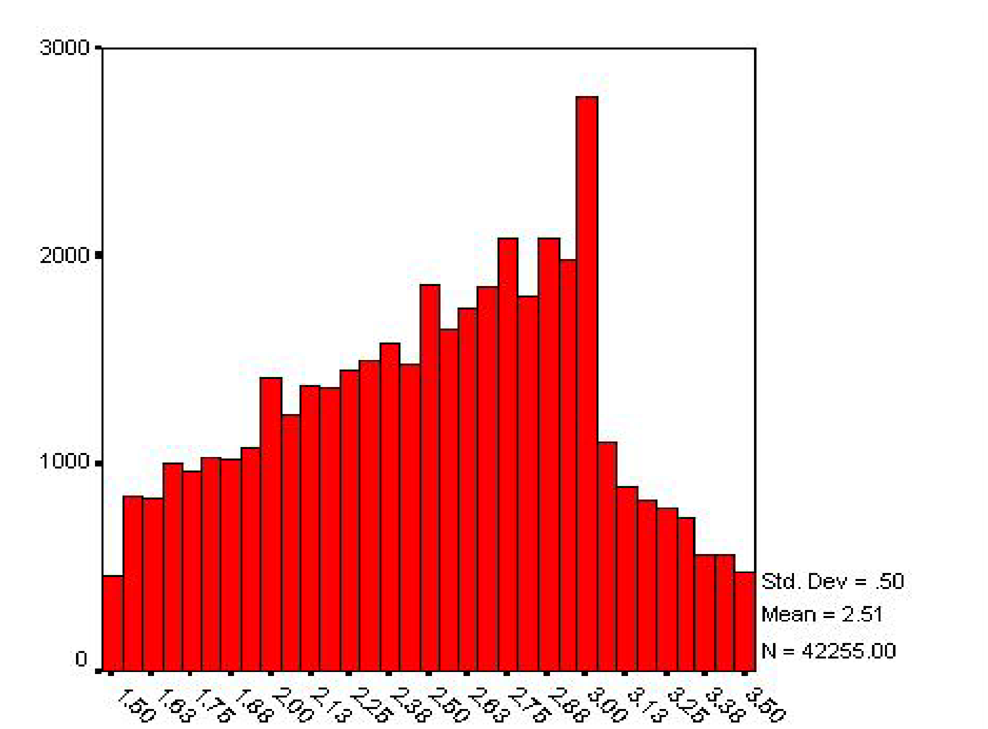


Figure 5 Loan to Income Ratios for Single Earners

1988-91



1995-98

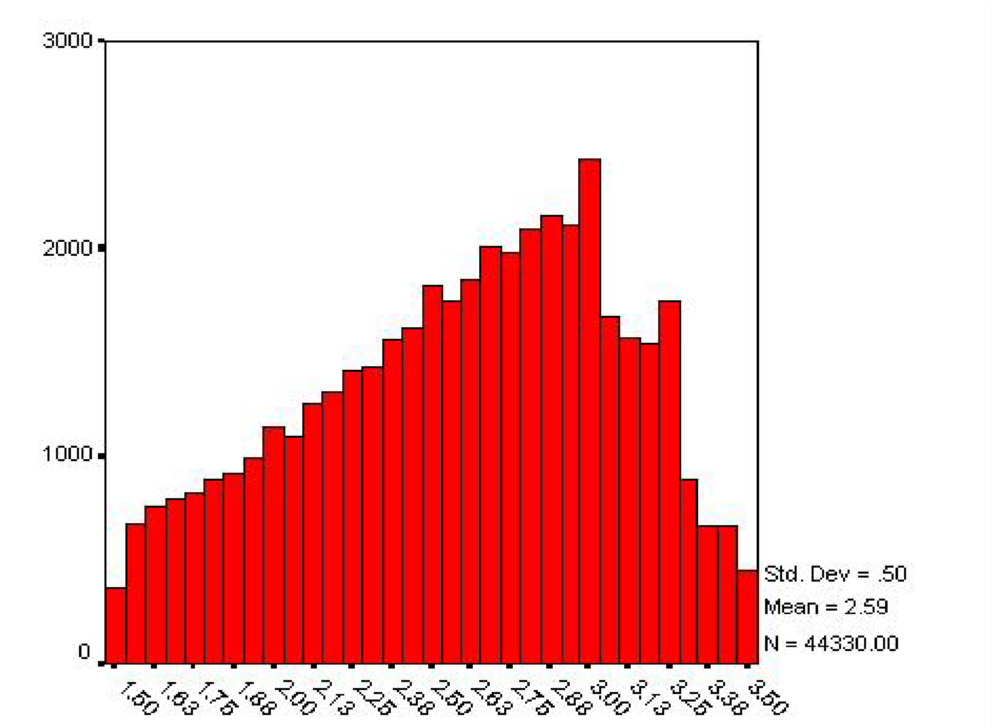
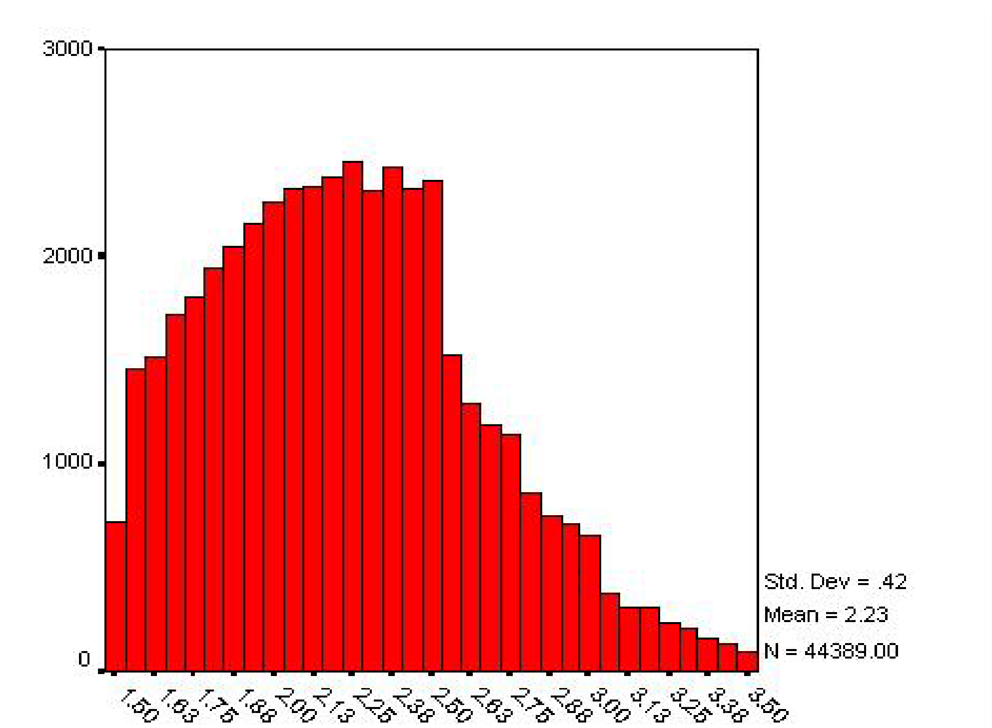


Figure 6 Loan to Income Ratio for Multiple Earners

1988-91



1995-98

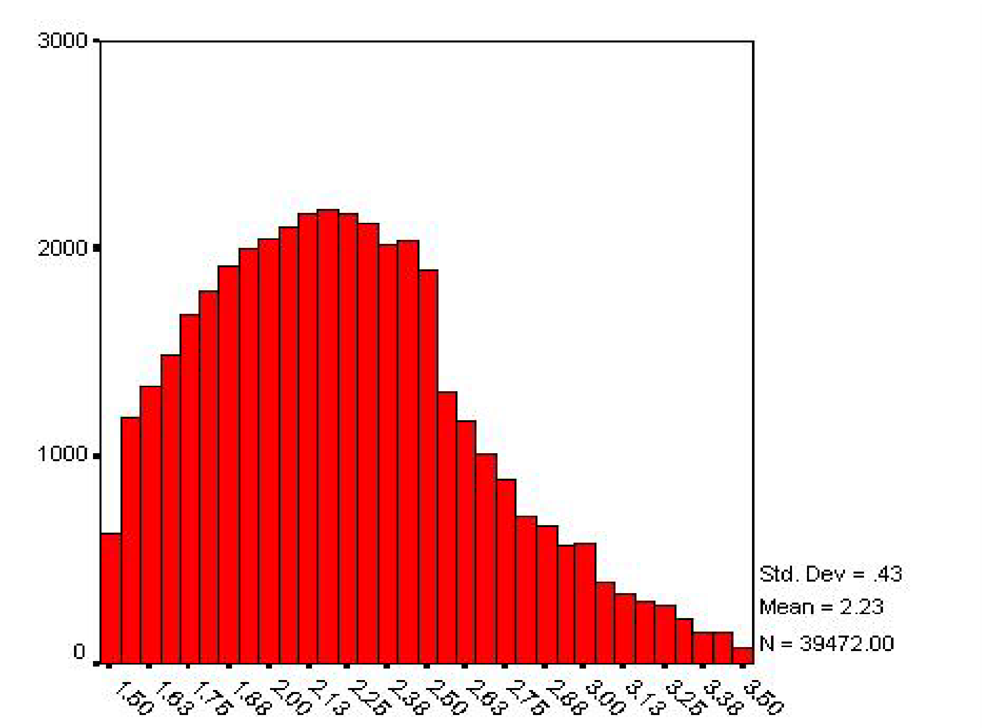
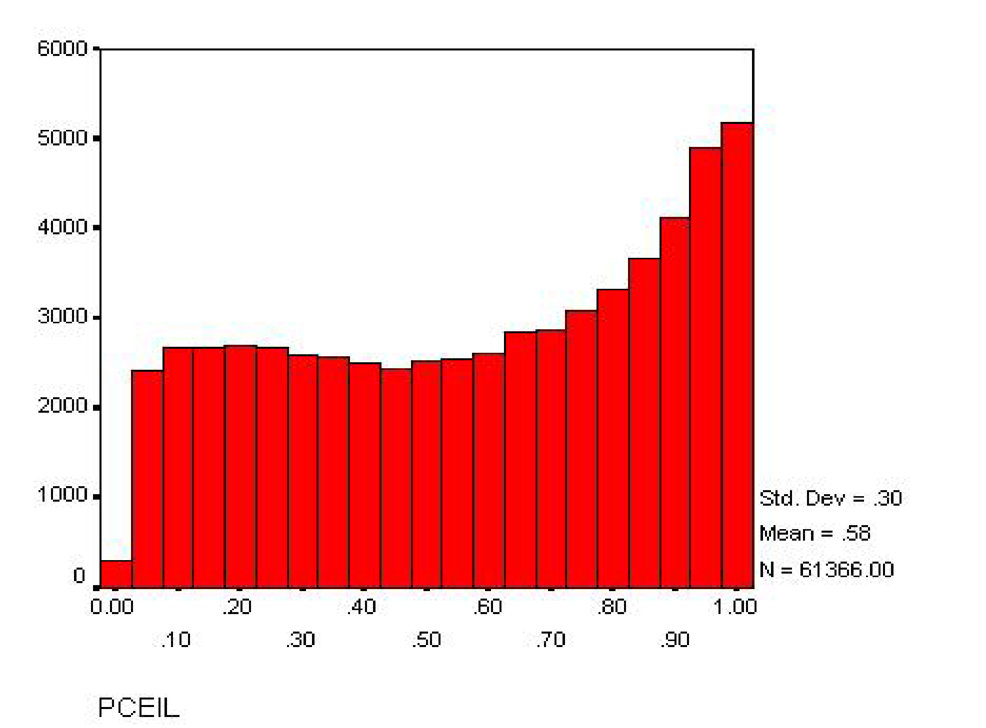


Figure 7 1988-91

Predicted Probability of Being over the Ceiling



Distribution of T_Above

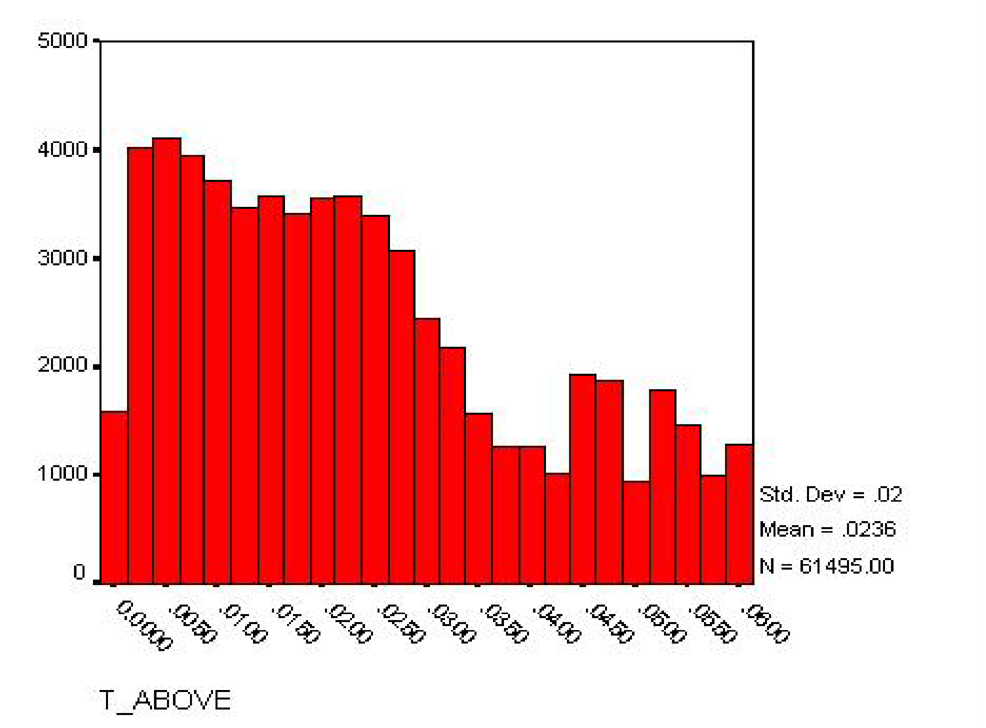


Figure 8 1995-98

Predicted Probability of Being over the Ceiling

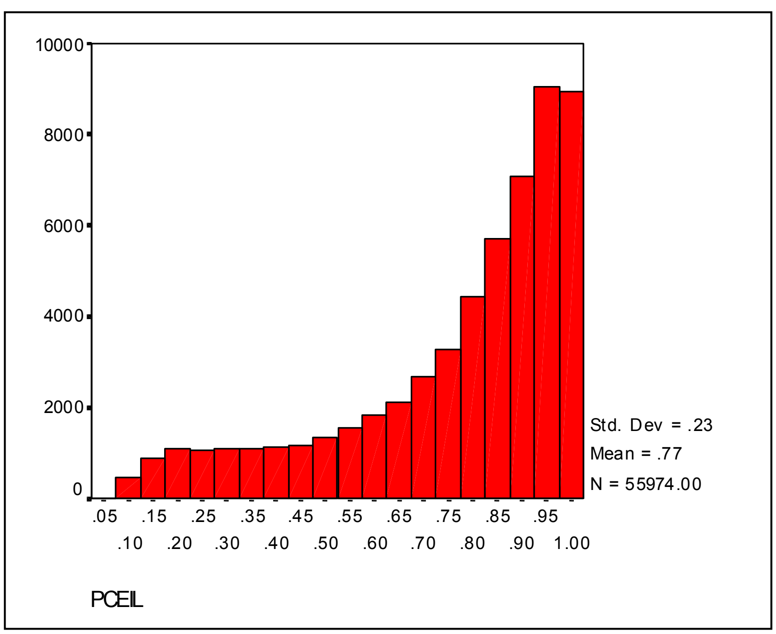
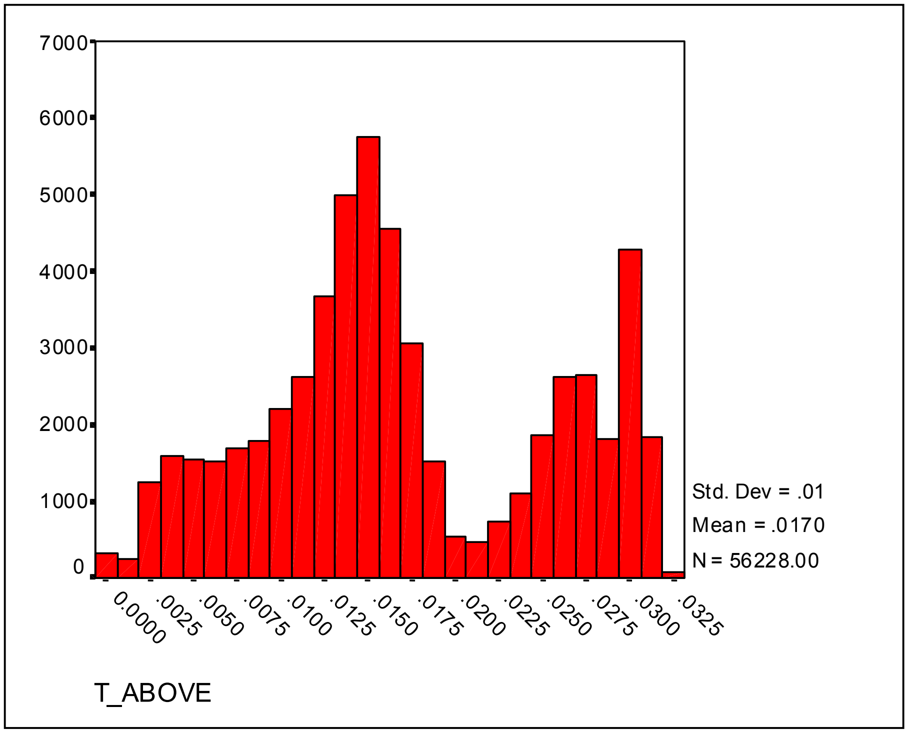


Figure 9 1995-98

Distribution of T_Above



Distribution of T_Below

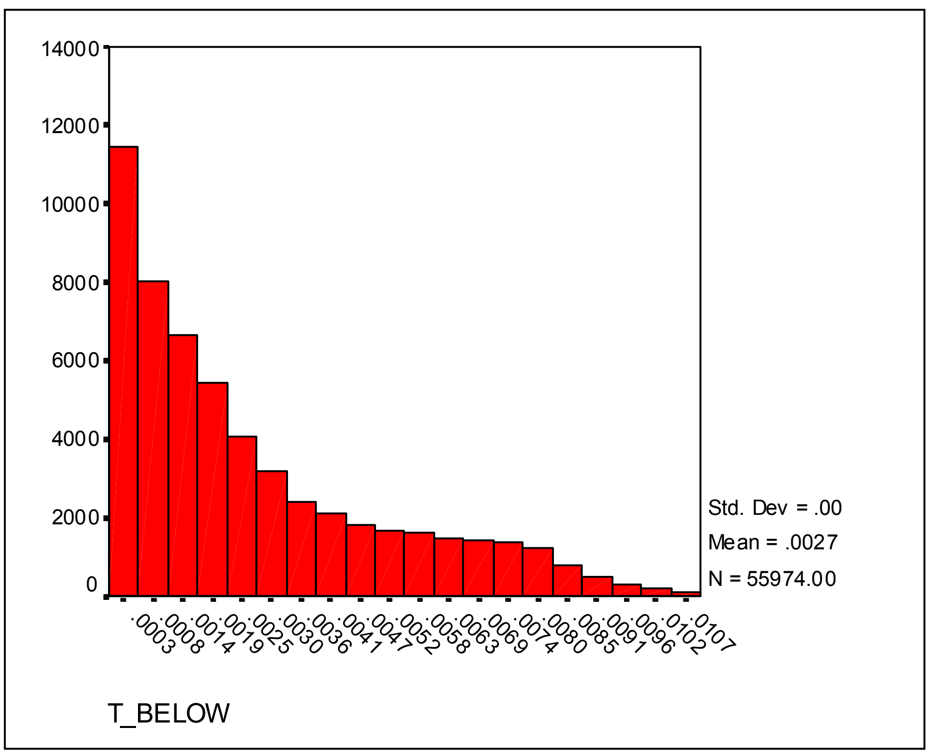


Table 1: Limitations of Mortgage Interest Deductibility

A: Limits on The Amounts Deductible

Year	Limit (£)	Median House Price (£)	% of Mortgages above Limit
1974	25000	10800	0
1983	30000	29400	5.4
1988-91	30000	63000	48.4
1995-98	30000	73800	67.4

B: Limits on Rate Deductibility

Year	Tax Rate	Max Deductible %	% of Mortgages above Max
1988-91	25, 40	25, 40	-----
1992-93	25, 40	25	26
1994	25, 40	20	100
1995-98	25, 40	10	100
1999	23, 40	0	100

Table 2: Descriptive Statistics **A: 1988-91**	Low Price Regions	High Price Regions
Total Number of mortgages (cases with missing values excluded)	**62,522**	**49,349**
Certainly unconstrained	24,762	17,293
Estimated unconstrained	9,827	9,484
Total unconstrained (= Certainly + Estimated = logit sample)	**34,589**	**26,777**
% of Total number of mortgages that are unconstrained	55.32	54.26
Characteristics of Unconstrained Borrowers:		
% of Total unconstrained with loans over £30,000	47.08	71.86
% of Total unconstrained who are previous owners	70.93	71.23
% of Total unconstrained who are multiple earners	45.70	48.96
% of Total unconstrained aged under 25	12.06	12.27
% of Total unconstrained aged 25 to 34	41.91	40.71
% of Total unconstrained aged 35 to 44	25.40	26.02
% of Total unconstrained aged 45 to 54	12.34	12.92
% of Total unconstrained aged over 54	8.01	7.79

Table 2: Descriptive Statistics **B: 1995-98**	Low Price Regions	High Price Regions
Total Number of mortgages (cases with missing values excluded)	**64,058**	**39,830**
Certainly unconstrained	23,175	14,277
Estimated unconstrained	14,034	4,488
Total unconstrained (= Certainly + Estimated = logit sample)	**37209**	**18765**
% of Total number of mortgages that are unconstrained	58.09	47.11
Characteristics of Unconstrained Borrowers:		
% of Total unconstrained with loans over £30,000	74.44	81.20
% of Total unconstrained who are previous owners	65.92	75.18
% of Total unconstrained who are multiple earners	48.34	45.60
% of Total unconstrained aged under 25	8.60	5.05
% of Total unconstrained aged 25 to 34	39.33	37.14
% of Total unconstrained aged 35 to 44	27.60	30.25
% of Total unconstrained aged 45 to 54	15.31	17.14
% of Total unconstrained aged over 54	9.17	10.42

Table 3. 1988-91

Logistic Regression, Probability of being over the ceiling - Low Price Regions

Classification Table for low price regions

		Predicted		
				Percentage Correct
Observed		.00	1.00	
	.00	15035	3268	82.1
	1.00	4361	11925	73.2
Overall Percentage				77.9

Variables in the Equation

	B	S.E.	Wald	Sig.
Previous Owner	.190	.057	11.3	.001
Basic Income	.123	.008	253.0	.000
Other Income	.000	.000	760.9	.000
Other Income Dummy	.016	.043	0.1	.713
AGE < 25	-.020	.191	0.0	.915
AGE 25-34	.476	.149	10.2	.001
AGE 35-44	.787	.146	29.0	.000
AGE 45-54	.453	.159	8.1	.004
Income Age < 25	.232	.016	215.9	.000
Income Age 25-34	.145	.010	227.0	.000
Income Age35-44	.057	.009	38.6	.000
Income Age 45-54	.017	.010	2.9	.087
Prev Owner*Age < 25	-.277	.095	8.4	.004
Prev Owner*Age 25-34	-.160	.072	4.9	.026
Yorks&Humber	.138	.049	7.8	.005
East Midlands	.488	.052	88.1	.000
North West	.226	.049	21.4	.000
Scotland	.042	.053	0.6	.421
West Midlands	.556	.051	119.3	.000
1988	-.362	.038	89.7	.000
1989	-.097	.040	5.8	.016
1990	.007	.041	0.0	.867
Constant	-4.164	.137	921.0	.000

1988-91

Logistic Regression, Probability of being over the ceiling - High Price Regions

Classification Table for high price regions

		Predicted		
				Percentage Correct
Observed		.00	1.00	
	.00	4073	3463	54.0
	1.00	1422	17819	92.6
Overall Percentage				81.8

Variables in the Equation

	B	S.E.	Wald	Sig.
Previous Owner	.203	.057	12.5	.000
Basic Income	.092	.006	236.8	.000
Other Income	.000	.000	340.4	.000
Other Income Dummy	.201	.051	15.3	.000
AGE < 25	1.585	.190	69.4	.000
AGE 25-34	1.004	.145	48.0	.000
AGE 35-44	.626	.134	21.9	.000
AGE 45-54	.378	.140	7.3	.007
Income Age < 25	.115	.016	54.6	.000
Income Age 25-34	.116	.009	161.7	.000
Income Age35-44	.066	.008	67.5	.000
Income Age 45-54	.024	.008	8.9	.003
Prev Owner*Age < 25	-.047	.124	0.1	.705
Prev Owner*Age 25-34	-.114	.083	1.9	.168
South East	-.061	.053	1.4	.245
South West	-.142	.056	6.3	.012
East Anglia	-.302	.067	20.2	.000
1988	.076	.044	2.9	.085
1989	.237	.052	20.8	.000
1990	.195	.050	15.1	.000
Constant	-2.909	.120	585.9	.000

Table 4. 1988-91 ln LTV Regression

Diagnostic Statistics

No. of Observations	61110
Parameters	25
Degrees of Freedom	61085
Adjusted R-squared	0.294
Model F Test = 1063.20	F Prob value = 0.000
Log Amemiya PrCrt = -1.758	Akaike Info Crt = 1.080
Correlation of regression disturbance and selection criterion (Rho) = 0.36886	

Variables in Model

	Coeff	Std Error	t-Stat	P-value
Constant	-3.562	0.053	-67.5	0.000
Previous Owner	-0.284	0.007	-40.3	0.000
Basic Income	0.275	0.006	49.8	0.000
Other Income	0.068	0.003	23.1	0.000
Other Income Dummy	-0.476	0.025	-18.8	0.000
Age < 25	0.575	0.010	54.9	0.000
Age 25-34	0.501	0.009	55.7	0.000
Age 35-44	0.429	0.007	58.6	0.000
Age 45-54	0.188	0.008	23.8	0.000
Prev Owner*Age < 25	0.195	0.012	16.1	0.000
Prev Owner*Age35-44	0.152	0.009	17.3	0.000
Yorks&Humber	0.136	0.008	16.1	0.000
East Midlands	0.125	0.009	14.1	0.000
North West	0.149	0.008	17.8	0.000
Scotland	0.201	0.009	22.7	0.000
West Midlands	0.095	0.009	11.0	0.000
North	0.184	0.009	19.2	0.000
South East	0.004	0.007	0.5	0.626
South West	0.069	0.008	8.4	0.000
East Anglia	0.070	0.010	6.8	0.000
1988	0.009	0.005	1.9	0.053
1989	-0.009	0.005	-1.7	0.079
1990	0.025	0.005	4.7	0.000
T_ABOVE	-6.383	0.221	-28.8	0.000
LAMBDA	0.159	0.014	11.6	0.000

Table 5: 1988-91 Predicted Variation in LTV by Age, Number of Earners, and whether Previous Owner	25-34	45-54	55+
Mean Single Income	14629	16392	10310
Mean Secondary Income (for those with it)	8332	7255	5863
(1) Mean Log Single Income	9.591	9.705	9.241
(2) Mean log Secondary Income (for those with it)	9.028	8.890	8.677
(3) Mean LTV	0.799	0.641	0.599
Base Case single: lnLTV = -3.56 + (1)*0.275 + Age coefficient	0.501	0.188	0
(4) lnLTV	-0.422	-0.703	-1.019
LTV	0.656	0.495	0.361
Previous Owner: lnLTV = (4) + Previous Owner coefficient	-0.132	-0.284	-0.284
(5) lnLTV	-0.554	-0.987	-1.303
LTV	0.575	0.373	0.272
Base Case multiple: lnLTV = (4) - .176 + (2)*0.068	0.501	0.188	0
(6) lnLTV	-0.284	-0.575	-0.905
LTV	0.753	0.563	0.405
Previous Owner: lnLTV = (6) + Previous Owner coefficient	-0.132	-0.284	-0.284
lnLTV	-0.416	-0.859	-1.189
LTV	0.660	0.424	0.305

Table 6. 1995-98

Logistic Regression, Probability of being over the ceiling - Low Price Regions

Classification Table for low price areas

		Predicted		
				Percentage Correct
Observed		.00	1.00	
	.00	4821	4689	50.7
	1.00	1786	25913	93.6
Overall Percentage				82.6

Variables in the Equation

	B	S.E.	Wald	Sig.
Previous Owner	-0.250	0.044	32.5	0.000
Basic Income	0.129	0.004	973.8	0.000
Other Income	0.000	0.000	364.9	0.000
Other Income Dummy	0.160	0.045	12.4	0.000
AGE < 25	0.306	0.210	2.1	0.145
AGE 25-34	1.317	0.119	121.5	0.000
AGE 35-44	1.492	0.108	191.9	0.000
AGE 45-54	1.056	0.107	97.6	0.000
Income Age < 25	0.171	0.018	90.5	0.000
Income Age 25-34	0.062	0.008	66.4	0.000
Income Age35-44	-0.002	0.006	0.1	0.801
Income Age 45-54	-0.037	0.006	42.2	0.000
Prev Owner*Age < 25	-0.235	0.151	2.4	0.120
Prev Owner*Age 25-34	0.042	0.071	0.4	0.554
Yorks&Humber	0.243	0.062	15.4	0.000
East Midlands	0.127	0.062	4.3	0.039
North West	0.235	0.061	14.8	0.000
Scotland	0.144	0.065	5.0	0.026
West Midlands	0.236	0.062	14.3	0.000
South West	0.326	0.060	29.1	0.000
East Anglia	0.120	0.073	2.7	0.099
1996	-0.080	0.041	3.9	0.050
1997	-0.064	0.040	2.5	0.112
1998	-0.125	0.043	8.4	0.004
Constant	-2.761	0.093	881.5	0.000

1995-98

Logistic Regression, Probability of being over the ceiling - High Price Regions

Classification Table for high price areas

		Predicted		
				Percentage Correct
Observed		.00	1.00	
	.00	1469	2059	41.6
	1.00	563	14674	96.3
Overall Percentage				86.0

Variables in the Equation

	B	S.E.	Wald	Sig.
Previous Owner	-0.382	0.066	33.2	0.000
Basic Income	0.114	0.005	591.6	0.000
Other Income	0.000	0.000	98.1	0.000
Other Income Dummy	0.116	0.068	2.9	0.087
AGE < 25	0.479	0.400	1.4	0.231
AGE 25-34	1.811	0.172	111.1	0.000
AGE 35-44	2.110	0.148	204.4	0.000
AGE 45-54	0.877	0.147	35.4	0.000
Income Age < 25	0.120	0.030	16.2	0.000
Income Age 25-34	-0.012	0.008	2.1	0.144
Income Age35-44	-0.045	0.007	45.6	0.000
Income Age 45-54	-0.030	0.007	18.9	0.000
Prev Owner*Age < 25	-0.933	0.241	15.0	0.000
Prev Owner*Age 25-34	0.047	0.119	0.2	0.695
South East	-0.145	0.050	8.5	0.004
1996	-0.225	0.064	12.5	0.000
1997	-0.331	0.063	27.8	0.000
1998	-0.311	0.068	20.7	0.000
Constant	-1.441	0.115	157.2	0.000

Table 7. 1995-98 ln LTV Regression

Diagnostic Statistics

No. of Observations	55974
Parameters	26
Degrees of Freedom	55948
Adjusted R-squared	0.328
Model F Test = 1095.59	F Prob value = 0.000
Log Amemiya PrCrt = -1.754	Akaike Info Crt = 1.084
Correlation of regression disturbance and selection criterion (Rho) = 0.17774	

Variables in Model

	Coeff	Std Error	t-Stat	P-value
Constant	-2.015	0.076	-26.5	0.000
Previous Owner	-0.335	0.006	-54.1	0.000
Basic Income	0.196	0.007	26.5	0.000
Other Income	0.022	0.003	6.8	0.000
Other Income Dummy	-0.189	0.029	-6.6	0.000
AGE < 25	0.226	0.012	18.5	0.000
AGE 25-34	0.157	0.010	15.4	0.000
AGE 35-44	0.189	0.008	24.9	0.000
AGE 45-54	0.070	0.007	10.5	0.000
Prev Owner*Age < 25	0.112	0.018	6.1	0.000
Prev Owner*Age 25-34	0.160	0.008	19.0	0.000
Yorks&Humber	0.167	0.008	20.4	0.000
East Midlands	0.168	0.008	20.5	0.000
North West	0.159	0.008	20.0	0.000
Scotland	0.174	0.008	20.5	0.000
West Midlands	0.117	0.008	14.4	0.000
North	0.084	0.008	10.8	0.000
South East	0.120	0.010	12.2	0.000
South West	0.191	0.010	19.9	0.000
East Anglia	0.026	0.007	4.0	0.000
1988	-0.108	0.005	-19.7	0.000
1989	-0.126	0.005	-24.3	0.000
1990	-0.149	0.005	-27.7	0.000
T_ABOVE	-14.051	0.481	-29.2	0.000
T_BELOW	-62.669	1.543	-40.6	0.000
LAMBDA	0.075	0.013	5.9	0.000

Table 8: 1995-98 Predicted Variation in LTV by Age, Number of Earners and whether Previous Owner	25-34	45-54	55+
Mean Single Income	19965	25396	17363
Mean Secondary Income (for those with it)	12028	11811	8233
(1) Mean Log Single Income	9.902	10.142	9.762
(2) Mean Log Secondary Income (for those with it)	9.395	9.377	9.016
(3) Mean LTV	0.858	0.652	0.535
(4) Base Case, single (lnLTV=-0.829+(1)*0.062)	0.097	0.184	0
lnLTV	-0.118	-0.016	-0.224
LTV	0.889	0.984	0.800
(5) Previous Owner (lnLTV=(4)+	-0.178	-0.347	-0.347
lnLTV	-0.296	-0.363	-0.571
LTV	0.744	0.695	0.565
(6) Base Case, multiple (lnLTV=-0.829-0.152+(2)*0.019+(1)*0.062)	0.097	0.184	0
lnLTV	-0.092	0.010	-0.204
LTV	0.912	1.010	0.815
(7) Previous Owner (lnLTV=(6)+	-0.178	-0.347	-0.347
lnLTV	-0.270	-0.337	-0.551
LTV	0.764	0.714	0.576

Table 9. 1995-98 ln LTV Regression including Interactions of the Tax penalty Variables with over age 34 Dummies

Diagnostic Statistics

No. of Observations	55974
Parameters	28
Degrees of Freedom	55946
Adjusted R-squared	0.334
Model F Test = 1040.62	F Prob value = 0.000
Log Amemiya PrCrt = -1.762	Akaike Info Crt = 1.076
Correlation of regression disturbance and selection criterion (Rho) = 0.18709	

Variables in Model

	Coeff	Std Error	t-Stat	P-value
Constant	-2.027	0.076	-26.8	0.000
Previous Owner	-0.321	0.006	-51.6	0.000
Basic Income	0.191	0.007	25.9	0.000
Other Income	0.018	0.003	5.7	0.000
Other Income Dummy	-0.147	0.029	-5.1	0.000
AGE < 25	0.219	0.012	17.7	0.000
AGE 25-34	0.153	0.011	14.5	0.000
AGE 35-44	0.266	0.009	29.5	0.000
AGE 45-54	0.165	0.008	19.9	0.000
Prev Owner*Age < 25	0.092	0.018	5.0	0.000
Prev Owner*Age 25-34	0.145	0.008	17.1	0.000
Yorks&Humber	0.169	0.008	20.8	0.000
East Midlands	0.172	0.008	21.0	0.000
North West	0.162	0.008	20.5	0.000
Scotland	0.179	0.008	21.2	0.000
West Midlands	0.120	0.008	14.9	0.000
North	0.194	0.009	20.3	0.000
South East	0.030	0.007	4.6	0.000
South West	0.092	0.008	11.8	0.000
East Anglia	0.126	0.010	12.8	0.000
1996	-0.105	0.005	-19.3	0.000
1997	-0.124	0.005	-23.9	0.000
1998	-0.149	0.005	-27.7	0.000
T_ABOVE	-12.047	0.532	-22.6	0.000
T_BELOW	-49.397	1.676	-29.5	0.000
T_ABOVE&AGE34	-2.998	0.419	-7.2	0.000
T_BELOW&AGE34	-23.429	1.182	-19.8	0.000
LAMBDA	0.078	0.013	6.2	0.000

Table 10: Predicted Leverage Responses to Removal of Interest Deductibility					
		over £30000		under £30000	
		T_above	T_above	T_below	T_below
Coefficients		-12.05	-3	-49.4	-23.47
t-ratio		-22.6	-7.2	-29.5	-19.8
Cumulative Coeff		-12.05	-15.05	-49.4	-72.87
	tax rate	Under 35	Over 34	Under 35	Over 34
household share	0.25	0.3	0.11	0.05	0.12
	0.4	0.19	0.2	0.01	0.02
average loan	0.25	51818	49360	21696	17987
	0.4	96440	90478	18185	19304
%decline	0.25	19.0	23.2	40.5	53.5
%decline	0.4	28.6	34.4	64.6	78.4

Table 11: The Impact on the WACC of Removing Mortgage Interest Deductibility										
	Full Deductibility		No Decline in v		20% Decline		30% Decline		40% Decline	
Tax Rate	0.4	0.25	0.4	0.25	0.4	0.25	0.4	0.25	0.4	0.25
Initial v										
0.9	0.058	0.070	0.087	0.088	0.081	0.084	0.078	0.083	0.075	0.081
0.7	0.058	0.070	0.080	0.084	0.076	0.081	0.074	0.080	0.071	0.078
					Percentage Increase in WACC					
Initial v										
0.9			50	26	40	21	35	18	30	15
0.7			39	20	31	16	27	14	23	12

Table A: Demand Regressions
Used to Predict Unconstrained Housing Consumption

	Demand Regression 1988-91	Demand Regression 1995-98
Intercept	-3.368	-4.221
	(-74.9)	(-56.4)
Log of total income	0.646	0.594
	(152.7)	(138.3)
Log of marginal cost of housing	-0.396	-0.252
	(-83.3)	(-30.8)
Age of main or first-named borrower	0.034	0.026
	(32.4)	(19.0)
Age^2	-0.0004	-0.0002
	(-29.4)	(-15.0)
	41,441	30,903
N		
Adjusted R^2	0.406	0.419

Dependent variable is log of housing consumption (see text). Figures in parentheses are t-ratios.