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DEBT USAGE AND MORTGAGE CHOICE: SENSITIVITY TO DEFAULT INSURANCE COSTS

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ABSTRACT

Purchase of a house requires three interrelated household financial decisions: what level of debt to obtain, whether to select an adjustable or fixed rate mortgage (ARM or FRM) and whether to choose an FHA or a conventional loan. While some have analyzed the mortgage debt decision and the ARM/FRM choice, virtually no one has studied the FHA/conventional mortgage choice or the interrelation among the mortgage debt and instrument decisions. In our sample of 819 young home purchasers, debt and mortgage choice is driven by a need to finesse the downpayment and payment constraint ratios and to lower mortgage insurance costs.

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Purchase of a house requires three interrelated household financial decisions: what level of debt to obtain, whether to select an adjustable or fixed rate mortgage (ARM or FRM) and whether to choose an FHA or a conventional loan. Jones (1993) recently offered a thorough analysis of the mortgage debt decision, and the ARM/FRM choice has been the subject of substantial empirical investigation.[1] However, no serious research has been published on the FHA/conventional mortgage choice or on the interrelation among the mortgage debt and instrument decisions.

Linneman and Wachter (1989) and Zorn (1989) have shown that households with insufficient wealth for a 20 percent downpayment or insufficient income to make payments on a 80 percent conventional FRM are less likely than other households to be homeowners. While this analysis is useful, 20 percent down is not an immutable minimum, and the conventional FRM is not the only financing choice.[2] Borrowers can put less down and pay default insurance fees to private insurers or FHA. Further, households can lower mortgage payments

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[1] The important early studies include Dhillon, Shilling, and Sirmans (1987) and Brueckner and Follain (1988, 1989). Follain (1990) provides a review of this and related literature. For an important subsequent study, see Capone and Cunningham (1992).

[2] In a more recent paper, Zorn (1993) concludes that the households do not behave as though underwriting constraints bind as much as the 80 percent LTV assumption implies.

by choosing ARMs. In order to measure the impact of borrowing constraints on homeownership accurately, one likely has to allow choice of both LTV and mortgage type.[3]

Although adjustable-rate FHA loans first appeared in 1984, the provisions of these mortgages were so unfavorable relative to those being offered in the conventional market that very few borrowers chose FHA ARMs until 1992.[4] Thus prior to this time, the choice among alternative mortgage types can be viewed in a nested framework: borrowers simultaneously chose between an ARM and an FRM (FHA or conventional), but take into account the fact that the choice of an ARM eliminates the opportunity to choose an FHA loan.

We estimate a nested logit mortgage choice model using data from the 1984 Metropolitan American Housing Survey in the eleven sampled metropolitan statistical areas (MSAs). We explain LTV selection and mortgage choice of households who moved into owner-occupied housing between March 1983 and November 1984 and

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[3] A companion paper uses the choice results of this paper to investigate the impact of underwriting standards on tenure choice (LaFayette, Haurin and Hendershott, 1995).

[4] Prior to 1986, the ARM share of FHA originations was less than 0.5 percent; between then and 1992 the share never exceeded five percent and was over two percent in only two years. In 1992 and 1993 ARMs accounted for 18 and 14 percent of FHA originations. These data are from Price Waterhouse (1994).

originated a conventional or FHA FRM from an institutional lender (assumptions and owner financing are excluded).[5] The ARM/FRM sample includes 819 homeowners, 29 percent of whom chose ARMs. The FHA/conventional sample is the 581 homeowners who originated a FRM in the purchase of their dwelling, 28 percent of whom chose FHAs. Table 1 indicates the sample by MSA and the fractions in each MSA that chose ARMs, FHA FRMs and conventional FRMs. The table also gives the breakdown by age. As can be seen, ARM usage rises with age, and FHA usage declines.

The LTV, FHA/conventional, and ARM/FRM choices are analyzed in Sections I, II, and III. In Section IV, the impact on mortgage choice of the 1983-91 changes in default insurance premia is simulated, and Section V concludes.

I. Borrowing Constraints and the Optimal LTV

For wealthier households, choice of the LTV ratio depends on a household's portfolio diversification desires and its aversion to risk, as well as the after-tax cost of mortgage financing relative to both the cost of other debt financing and the after-tax returns on financial assets (Jones,

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[5] We exclude 172 VA mortgages because we have no indication of which borrowers are eligible for VAs. We exclude 35 FHA GPMs and 14 FHA ARMs owing to the small sample sizes.

1993).[6] For less wealthy households facing binding mortgage qualification constraints, the choice is more straightforward: what LTV maximizes the value of the house they can purchase?

To compute the LTV that maximizes purchasable housing for constrained households, we begin by assuming a 20 percent downpayment on a fixed-rate conventional loan for all households. There are four possible situations: the wealth (downpayment) constraint binds but the income constraint does not, income binds but wealth does not, neither wealth nor income binds, or both constraints bind.[7] We employ an iterative procedure to select the LTV.[8] To illustrate, say that the wealth constraint is binding

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[6] Because our analysis is based on data prior to the 1986 tax act, the vast majority of individual households face similar after-tax costs of mortgage and other debt and after-tax returns on debt investments. For an analysis of how the 1986 tax act altered the relationships among these costs and returns, see Follain and Ling (1991).

[7] Lenders are assumed to require a liquid wealth reserve of one month's salary. Total liquid wealth (wealth less pensions and consumer durables) less this reserve, 0.011 of house value (closing costs), and average mortgage points (at market for the month preceding the move) is available for the downpayment.

[8] This procedure is performed assuming a conventional 30-year FRM. We cannot allow for mortgage choice in selection of the optimal LTV and then use this LTV to compute insurance costs to use in determining mortgage choice.

at the 80 percent LTV, but the income constraint is not. We increase the LTV ratio by 0.5 percent increments and recompute the wealth- and income-constrained house values at each step. This process stops when the wealth constraint no longer binds, when the income constraint binds more than the wealth constraint, or when the LTV reaches 95 percent. If we obtain a nonbinding wealth constraint, we continue to increase the LTV until the constraints become equally nonbinding, we hit an insurance break point (85, 90 or 95 percent), or the LTV reaches 95 percent. If an LTV increase produces an income constraint that binds more than the wealth constraint, the predicted LTV is this LTV less 0.5 percent.

A second possible outcome of evaluating the affordability constraints at an 80 percent LTV is that the income constraint binds but the wealth constraint does not. The household would in this case respond by decreasing the LTV below 80 percent. To obtain estimates of the optimal LTV for these households, the LTV is decreased by 0.5 percent increments. In this case, the iterations stop when the two constraints become equally nonbinding.

If both the income and wealth constraints bind at 80 percent, owning the optimal quantity of housing is not feasible for this household: a change in the LTV will ease one constraint but tighten the other. The assumed LTV for these households is that at which the income and wealth constraints bind equally, subject to the restriction that the LTV lies between 0 and 0.95.

Finally, if neither constraint binds for a household at an 80 percent LTV ratio, the household can satisfy its unconstrained demand. These households might not consider an 80 percent LTV optimal, however. If one of the constraints were much closer to binding than the other, the household might prefer a higher ratio (for portfolio diversification purposes) or a lower ratio (to remove the possibility of the income constraint binding in the future). To reflect these possibilities, the predicted LTV for unconstrained households is that at which the two constraints are equally nonbinding.

Figure 1 illustrates the model solution for two different values of V^*, unconstrained housing demand, and two wealth levels.[9] The right vertical axis is house value and the left is wealth; the horizontal axis is the LTV, ranging from 0 to 0.95. The two upward sloping lines indicate the maximum house value possible given initial wealth of W_L (low) or W_H (high). These curves are derived by solving $W_i/(1\text{-LTV})$ for different values of LTV.[10] The downward sloping line

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[9] We thank Don Haurin for suggesting the construction of this Figure.

[10] A house is financed with debt and equity (E); thus V = LTV*V + E. The maximum house purchase is one in which all available wealth (see note 8) is invested in the house (set E = W and solve for V_W).

indicates the maximum house value possible given the household's income (Y), market interest rates, and the underwriting criteria. This curve is obtained by solving $0.28*Y/\theta LTV$ for different LTV values; the breaks in the income constraint line at LTVs of 80, 85 and 90 reflect increases in PMI costs.[11] Increasing the LTV makes a given wealth amount go further but reduces the buying power of a given income level. The possibilities set for a household is the area under both the income and wealth constraint curves.

Consider a household with wealth W_L and income Y. Its possibilities set is the slashed area. If the optimal unconstrained house value is V^*_L (indicated on the right vertical axis), the household can achieve this value anywhere on the line segment AB, i.e., with an LTV between 0.87 and 0.95. We place the household at 0.9, where the jump in the cost of mortgage insurance occurs. On the other hand, an optimal unconstrained house value of V^*_H is unattainable. The best a low wealth household can do is to select a 95 percent LTV and reach point C (alternatively, of course, the household could rent).

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[11] The housing cost underwriting constraint is $\theta LTV*V = 0.28*Y$, where θ includes the mortgage constant, property taxes, and the hazard and the PMI (where relevant) annual insurance rates. For purposes of the diagram, we assume that the housing cost constraint is more binding than the total obligations constraint (the more binding constraint is the relevant one).

Next consider a household with wealth $W_H > W_L$. With a higher wealth curve, the possibilities set expands to include the dotted area. An LTV of 0.4 to 0.95 allows the household to reach V^*_L. We place the household at 0.83, where the two constraints are equally nonbinding. With V^*_H, the constrained household maximizes by choosing point C′ or an LTV of 0.83.

In these calculations, the unconstrained housing demand of constrained households is calculated from estimates of the observed demand of unconstrained households (those whose observed house value is greater than that which they are eligible to purchase based on their observed income and wealth). Constant quality demand is regressed on the age, education, gender, predicted marital status, and predicted number of children of the household head, the household's predicted income and predicted wealth, and the real price of housing services (see the appendix).

Table 2 examines the ability of this iterative technique to predict correctly the LTV ratio of the households in our sample. This table shows the number of households predicted to have LTVs of 80 percent or less, of 80 to 85 percent, of 85 to 90 percent, of 90 to 95 percent and of 95 percent or greater compared to the actual LTV of these households. As can be seen, we overpredict the number of households having very low and very high LTVs (80 percent or less and 95 percent or greater) and underpredict the number of households between these extremes. Nonetheless, at these extremes, the predictive ability of the technique is reasonably good: we correctly assign over 80 percent of the households with LTV of 80 percent or less (292 versus 357) and nearly 70 percent of those with LTV of 95 percent (122 of 176). Overall, we correctly predict the LTV category of 56 percent of our sample; 80 percent are assigned within one category higher or lower than the correct LTV class. Reasons for incorrect assignment include: the income constraint not being rigidly enforced by all lenders, the total obligation constraint binding more than the housing cost constraint, not allowing for other mortgage instruments (ARMs and FHAs) and data errors.

II. FHA or Conventional Fixed-Rate Loan

FHA financing can ease mortgage qualification constraints in two ways. First, the FHA uses a looser income qualification criterion from that employed by private mortgage insurers. Private insurers limit fixed-rate mortgage payments (including property taxes and hazard and default insurance) to 28 percent of gross income, and all fixed obligations (the mortgage payment plus other loan payments, alimony, child support, etc.) to 36 percent of gross income.[12] The

[12] MGIC has recently introduced (in some states) an affordable housing program with more expansive 33 and 38 percent limits. This program also allows a maximum LTV of 97%.

FHA mortgage payment limit is 38 percent of after-tax income (gross income less income and social security tax withholding); total fixed obligations cannot exceed 53 percent of after-tax income. Assuming an average income tax rate of 20 percent, these limits are equivalent to 30 and 44 percent of gross income.

Secondly, FHA mortgages permit a smaller downpayment than that allowed under a conventional loan. Private insurers ordinarily will not accept loans with a LTV greater than 95 percent. During the 1983-84 period, the maximum FHA ratio was 97 percent on the first $25,000 of borrowing and 95 percent on the remainder, and closing costs could be borrowed. Thus the LTV comparable to that of private insurers was roughly 98 percent. Borrowers who have sufficient income to increase the LTV above 95 percent, but do not have sufficient wealth to make a five percent downpayment, can relax the wealth constraint by choosing an FHA mortgage.

On the other hand, FHA regulations set a maximum amount on the initial loan balance. This loan limit affects households desiring an expensive house, but without the wealth to make a significant downpayment. Households facing this constraint are more likely to choose conventional loans. The 1983-84 base loan limit was $67,500; higher limits were set for metropolitan areas in which the cost of housing was deemed to be relatively high.[13]

The final factor relevant to the choice between an FHA and a conventional loan is the difference between the cost of FHA mortgage insurance and that of private mortgage insurance (PMI). During the 1983-84 period, MGIC (the largest private insurer) quoted an annual premium rate of 0.25 percent of the outstanding loan balance, with a first-year premium varying between 0.3 percent and 1.0 percent depending on the initial loan-to-value ratio. Prior to September 1, 1983, the annual FHA premium was 0.50 percent, regardless of the LTV. On loans originated on or after that date, an up-front premium of 3.8 percent replaced the annual premium, with a portion of this premium being refunded if the loan is retired early.[14] (This premium could be borrowed and was not considered in calculating the initial LTV.) Given the variation in insurance premium with LTV, determination of a household's LTV is necessary to compute the cost

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[13] Of the eleven metropolitan areas in the sample, seven were "high-cost areas" for part or all of the sample period. These areas and their loan limits are: Cleveland ($75,000; $75,400 as of March 1983); Memphis ($75,000; $87,750 as of April 1984); Milwaukee ($73,500; $77,800 as of April 1984); Norfolk ($76,500; $78,500 as of April 1984); Oklahoma City ($68,000; $72,800 as of April 1984); Salt Lake City ($75,000 as of March 1983); and San Jose ($90,000).

[14] For the derivation of the 3.8 percent premium and the calculation of the refund, see Herzog (1984).

of insurance.

To summarize, the probability that a household will choose an FHA mortgage is:

$$\text{Prob(FHA)} = \theta(\overset{+}{CON_{IW}}, \overset{-}{CON_{LL}}, \overset{-}{DIFFCOST})$$

where CON_{IW} is the maximum of zero and the difference between an estimate of the household's unconstrained house value and the value obtainable under the more binding of the income and wealth constraints divided by unconstrained house value;

CON_{LL} is the maximum of zero and the difference between the household's unconstrained house value and the FHA local loan limit divided by unconstrained house value;

DIFFCOST is the difference between the annualized cost of FHA insurance and PMI at the chosen LTV.

As noted above, the unconstrained housing demand of constrained households is calculated from estimates obtained from an explanation of the observed demand of unconstrained households.

Because private insurance premiums were sensitive to the LTV during 1983-84 and FHA premiums were not, the cost difference between private and FHA insurance varies with the LTV. However, the observed LTV itself depends on the type of loan selected. We finesse this simultaneity problem by basing the PMI insurance cost on the predicted conventional LTV from the iterative procedure that minimizes the effect of the income and wealth constraints on house value selected.

The up-front FHA premium introduced in late 1983 made the annual cost of FHA insurance to households with equal LTVs sensitive to the length of time to expected loan payoff (just as is the cost of PMI): borrowers who pay off early are charged a higher annualized premium than those who hold their mortgages for a longer period. The lower two curves in Figure 2 show the borrower's annualized effective FHA premium net of refund as a function of time to payoff for two discount rates, the 12.6 percent mortgage rate of 1983-84 and the 8 percent rate of 1993-94 (the highest curve in Figure 2 will be discussed in Section IV). At then current interest rate levels, the new 3.8 percent up-front insurance premium was more expensive than the old 0.5 percent annual premium for all borrowers. With an eight percent discount rate, the new premium was more expensive for those who retired their loans prior to the thirteenth year.

The number of years that the household expects to hold the mortgage is the lesser of the expected length of stay in the house and the expected time until prepayment. Our data set does not contain actual lengths of stay that would allow estimation of expected lengths of stay. In the estimation reported below, we assume all borrowers assign a 50 percent probability to a 3-year holding period, 20 percent probabilities each to 7- and 12-year holding periods and 10 percent to an 18-year period.[15] The effective conventional rate assuming a 7-year life to amortize points is used as the discount rate. We experimented briefly with household-specific expected mortgage lives, but without much success.

The first column in Table 3 lists the proportion of the sample in different predicted LTV ranges: equal to or less than 80 percent, 80.1 to 85 percent, 85.1 to 90 percent and over 90 percent. Half of the sample selects an LTV of 80 percent or less; a third chooses an LTV over 90 percent.

The next four columns list the fractions of households in the different LTV ranges that are constrained by the FHA loan limit and that are constrained by the underwriting criteria. Just over a quarter of the sample is constrained by the FHA loan limit. In the first row, we indicate that 71 percent of the sample is constrained by the underwriting criteria when an 80 percent LTV is assumed; with endogenous LTV choice, only half are constrained (last row).[16] The percent constrained, especially by wealth, rises with LTV.

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[15] According to data from the Panel Study of Income Dynamics, 36 percent of recent movers during the 1969-81 period moved again within three years and 47 percent moved within five years. Greater percentages either moved or refinanced.

[16] The 71 percent is comparable to the 67 percent Zorn (1989) finds to be constrained.

The difference between the annualized cost of FHA and PMI default premia is listed for the different LTVs in the last two columns. Given a flat FHA cost and a rising (with LTV) PMI cost, this difference declines with LTV. Prior to September 1983, FHA insurance was cheaper than PMI for higher LTV loans. With the FHA shift to an upfront premium, FHA insurance became more expensive at all LTVs.

The model is estimated on data from the 1984 Metropolitan AHS for households who originated a conventional or FHA FRM from an institutional lender in the purchase of housing other than mobile homes. The survey was taken during the September-November 1984 period. We consider all households that moved within 18 months of the survey date.[17] Some observations are excluded because variable values are not available above a certain level: salary income (unavailable above $100,000) and house and mortgage values (each unavailable above $200,000). The final sample consists of 581 observations.

Table 4 reports estimated responses to two price variables: a zero-one dummy differentiating the periods before and after the 3.8 percent up-front premium was introduced and the difference in the cost of FHA and conventional insurance at the predicted LTV

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[17] The survey reports income components on the survey date. To obtain estimates as of the move date, we deflate nominal components back to that date using the MSA or regional CPIs net of shelter.

level. The up-front dummy is insignificant (t=0.3), while the DIFFCOST coefficient is negative with a t-ratio of 3.4. The insignificant up-front dummy suggests that the entire effect of the FHA premium change is captured by DIFFCOST, as one would expect.

The significantly negative coefficient of CON_{LL} (t=3.7) suggests that FHA loan limits deter borrowers with unconstrained demand greater than the limit from choosing an FHA, while the significantly positive coefficient of CON_{IW} (t=2.6) implies that the looser FHA underwriting standards are an incentive for borrowers constrained by conventional market criteria to choose FHAs.[18] The results imply that, all else equal, a borrower with a desired loan 20 percent greater than the limit is less than half as likely to choose an FHA loan than one unconstrained by the loan limit, while a borrower desiring a house 20 percent more expensive than that allowed by conventional loan underwriting criteria is 15 percent more likely to choose FHA than one not bound by income and wealth constraints.

To indicate the economic significance of the insurance cost differential, we calculate the predicted number of FHA borrowers before and after the premium change. These numbers are calculated by

[18] We also tested specification of the gaps in dollar terms rather than as percentages. Results were virtually identical to those reported in Table 4.

summing the predicted probability of FHA choice across all households. Using this method, we (by construction) perfectly predict the number of FHA households (161) in our sample during the estimation period. The shift from the half point annual premium to the 3.8 percent upfront premium reduces FHA usage in our sample by 27 percent.

The statistic denoted "LRI" in Table 4 is the likelihood ratio index, a measure of the explanatory power of the equation. The LRI is calculated as one minus the ratio of the equation log-likelihood to the log-likelihood with all coefficients equal to zero. The LRI is a "pseudo R^2" because it is bounded by zero and one (although LRI is always strictly less than one) and because larger LRIs imply a better ability of the equation to explain variation in FHA usage.

Below the equation estimates we compare the equation predictions with a random assignment of households between the mortgage types. Using random assignment, 28 percent of households choosing FHAs and 72 percent choosing conventionals would be correctly identified (the mean values in the sample). Weighting these by their fractions of the sample, 60 percent of households would be correctly assigned. If we assume no errors, i.e., assume that all households with a greater than estimated 50 percent chance of choosing FHAs do so and that all with a less than 50 percent chance do not, our equation correctly identifies 72.5 percent of borrowers.

III. The Choice of an ARM or FRM

Three classes of borrowers tend to prefer ARMs to FRMs: those who are less averse to the risk of rising interest rates, those with short expected holding periods, and those facing affordability constraints. More mobile households are more likely to prefer ARMs because the long-term call option in a FRM is of little value to these households and because the teaser rates sometimes offered are a better deal for them.[19] Those with affordability constraints prefer ARMs because the initial rate upon which they qualify for a loan tends to be lower than that on a FRM for three reasons: the premium for the FRM call option is not built into the ARM coupon, ARM teaser rates are sometimes employed, and the term structure of interest rates is historically upward sloping.

Empirically, then, ARM choice will depend on both characteristics (or proxies for them) reflecting borrower aversion to rising interest rates, borrower expected mobility, and the relative ability of (and need for) ARMs to reduce affordability constraints. Numerous proxies have been employed in the literature. For mobility, proxies include age (the older are less

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[19] Capone and Cunningham (1992) estimate a nested-logit model of ARM choice and mortgage termination, i.e., they allow for the differences in household proclivities to prepay and default owing to differences in expected mobility and risk aversion to affect the ARM/FRM choice.

mobile), household structure (married couples are less mobile), whether the household had moved from another metropolitan area (movers are more mobile), and income or wealth (those with greater income and/or wealth tend to be more mobile). Households with potentially greater affordability problems are those who live in high house price areas and who have low wealth. The difference between the cost of FRMs and ARMs measures the ability of ARMs to address affordability problems and proxies for the price advantage of ARMs for mobile homebuyers; the level of the FRM rate is an indicator of how severe the affordability problem is generally. We also add a race variable.

Finally, because a rational borrower knows that the choice of an ARM eliminates the ability to choose an FHA, the borrower's "taste" for FHA should be incorporated in the ARM choice equation. In the nested logit framework, this is accomplished by means of the "inclusive value" (Maddala, 1983, pp. 68-70). The inclusive value for the ARM equation is calculated from the result of the FHA equation as follows:

$$IV = \log[(\beta_{FHA}X_{FHA}) + 1]$$

where β_{FHA} is the estimated coefficient vector from the FHA equation and X_{FHA} is the vector of regressors in the FHA equation.

Based on the preceding discussion, the ARM choice equation is:

$$\text{Prob(ARM)} = \rho(\overset{+}{\text{RATEDIF}}, \overset{+}{\text{FRMRATE}}, \overset{+}{\text{WEST}}, \overset{+}{\text{WEALTH}},$$
$$\overset{+}{\text{NEWMETRO}}, \overset{-}{\text{AGE55}}, \overset{-}{\text{MARR}}, \text{BLACK}, \text{IV})$$

where RATEDIF = the difference between the FRM and ARM coupon rates (national FHLBB closing rates for previous month);

FRMRATE = the market coupon rate on FRMs;

WEST = 1 is the house is located in the West census region;

WEALTH = household wealth;

NEWMETRO = 1 if the household's most recent move was from a different metropolitan area;

AGE = age of the household head;

MARR = 1 if a married couple is living in the household;

IV = the inclusive value reflecting the probability of FHA choice.

The national market FRM coupon rate is used for all observations because the FRM rate offered to households who chose ARMs is not reported.[20] Mortgage terms are those of the month preceding the

[20] Brueckner and Follain (1988, p. 96) note that individuals may have chosen a particular type of mortgage because the rate on that mortgage was particularly favorable; if this is true, then the rate obtained by households choosing FRMs is a biased measure of the FRM rate offered to ARM borrowers.

household's move to account for the time span between loan origination and closing. Because of the endogeneity of reported wealth with respect to housing decisions, we use the predicted value, estimated as discussed in the appendix.[21]

Results of the estimation of the ARM choice model are given in Table 5. As can be seen, the FRM-ARM rate spread is significant at the 0.05 level and has the expected positive sign. Older and black households are significantly less likely to choose ARMs, and households with greater predicted wealth and/or residing in the West are significantly more likely to do so.

Also included is a variable representing the expected difference between the annualized insurance premiums of ARMS and FRMs.[22] Because some FRM borrowers use FHA insurance while all ARM borrowers who insure their loans use PMI, the cost difference between FHA insurance and PMI will lead to a difference between the overall cost of FRMs and ARMs. The ARM insurance cost is the cost of PMI at the

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[21] See Haurin, Hendershott and Kim (1994) for a discussion of the need to treat income, wealth and other variables as endogenous to housing decisions.

[22] The same expected life assumptions used to compute the analyzed cost of PMI insurance on FRMs is used to compute that on ARMs. While ARM borrowers will have a shorter expected life in a house, they will have a lower expectation of terminating their mortgage by refinancing.

household's predicted LTV ratio. The insurance cost applicable to FRMs is a weighted average of the costs of PMI and FHA insurance at that LTV, using the total sample proportions as weights. The insurance premium difference has the expected negative sign, but is not significant.[23] The predictive ability of this equation outperforms random assignment (72 percent correct versus 59 percent with random assignment).

IV. Insurance Premia Changes Mortgage Choice

Table 6 indicates the sensitivity of mortgage choice to changes in FHA and PMI insurance premia. The table contains the simulated number of ARM, FHA, and conventional borrowers. To obtain these estimates, we use the results of the two estimated mortgage choice equations to calculate the estimated mortgage selection probability for each household in the sample given the values of the variables and then sum the calculated probabilities. The result is the predicted number of households selecting each type of loan.

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[23] Two additional variables were tested. First, because the cost differential should matter especially for households who are income constrained, we included the product of the differential and a dummy for income-constrained households. Similarly, the product of the relative differential in points charged [(FRM-ARM)/ARM] and a dummy for wealth-constrained households was also included as a regressor. Neither coefficient was statistically different from zero.

The first row of Table 6 assumes the actual mortgage cost and affordability conditions experienced by the sampled households just prior to the FHA shift from the flat half percent annual premium to the 3.8 percent up-front premium in 1983. The FRM rate is the 1983-84 average of 12.61 percent, and the FRM-ARM rate spread equals the sample average of 80 basis points. In the second row, the result of the 1983 change in the FHA insurance premium is reported assuming the same discount rate and rate spread. FHA usage falls by 29 percent (slightly more than the 27 percent implied by the FHA equation alone). In the third row, we show the additional effect of the rise in PMI insurance rates. During 1984-86, the renewal fee for FRMs was raised from a quarter percentage point to 0.34 (LTVs under 95 percent) and 0.49 (LTV of 95 percent); the initial fee was also increased 0.25-0.50 percentage points for certain LTVs. ARM renewal fees were set 0.05 to 0.1 percent higher. The result is a 16 percent increase in the FHA share.

The last row indicates the impact of the 1991 reintroduction of a 0.5 percent annual premium in addition to the 3.8 percent up-front premium. The 0.5 percent is paid for 5, 8, and 10 years for borrowers with LTVs under 90 percent, between 90 and 95 percent, and over 95 percent. (The highest curve in Figure 2 plots the annualized premium for borrowers with initial LTVs between 90 and 95 percent and different expected loan payoff periods.) The increased premium lowers FHA usage by a quarter.

V. Summary

We model the simultaneous decisions of house purchasers regarding LTV and mortgage instrument. The model is tested using a sample of 819 purchasers from the 1984 Metropolitan American Housing Survey. Regarding LTV, we find that a simulation model in which constrained households maximize house purchase assigns 56 percent of our sample to their correct LTV range and 80 percent to within an adjoining range. Allowing LTV choice reduces the portion of our sample that are either income or wealth constrained at an 80 percent LTV from 71 percent to 49 percent.

We find a statistically and economically significant sensitivity of mortgage choice to differences in FHA and PMI insurance premia. To illustrate, the 1983 change in the FHA insurance premium from 0.5 percent annually to 3.8 percent up-front reduced FHA demand in our sample by 29 percent and the 1991 increase in the FHA premium is predicted to have lowered FHA demand by 24 percent. Further, a binding FHA loan limit significantly reduces choice of FHAs, while binding conventional underwriting standards significantly increase usage of FHAs.

While the current results are promising, investigation of more recent and more geographically dispersed data is called for. More specifically, data from AHS surveys in 1991-93, when FHA insurance premia and interest rates changed markedly and substantial usage of FHA ARMs developed is in order. Further, the analysis should be applied to refinances, as well as new purchases. Such sensitivity should be taken into account in future analyses of the impact of insurance changes on the solvency of the FHA MMI Fund.[24]

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[24] This impact is important owing to the National Affordable Housing Act of 1990, which requires that the MMI Fund achieve a capital ratio of 2 percent by the year 2000. The ability to reach this ratio depends both on new business being profitable and on a sufficient volume of such business being generated. Without knowing the sensitivity of mortgage choice to the mandated increases in the FHA premium schedule, it is impossible to forecast the volume of business.

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APPENDIX

As discussed in the text, computing a household's affordability gaps requires an estimate of the value of the house that would be purchased in the absence of qualification constraints. The unconstrained housing demand of constrained households is inferred from a selectivity-corrected regression of the observed housing quantity of unconstrained owner households on a set of cost, income, and demographic variables. The base sample for the estimation is all 1,883 households who moved into an owned dwelling in the sample period, whether or not the household originated one of the three types of loans in this study. Households are classified as unconstrained if they buy a less expensive house than is available given the household's observed LTV and mortgage type; 949 households were classified as unconstrained and used in the estimation. Because the estimation is performed on a non-random sample, the procedure of Heckman (1976) is used to correct for selectivity bias.

The equation to be estimated is:

$$UNITS = f(AGE, EDUC, MALE, MARR^*, CHILD^*, INC^*, WLTH^*, BLACK, UC, \lambda_{SMPL}),$$

where UC = the household's user cost of owner-occupied housing;

λ_{SMPL} = the Heckman selection correction variable;

and asterisks denote predicted values.

We estimate a hedonic equation for the owner-occupied dwelling units in one of the MSAs to obtain house prices in that MSA.[25] The price of a unit of housing in this MSA is set at one dollar so that the number of units in a dwelling equals its price. To obtain housing quantities for an individual dwelling unit in a different MSA, the characteristics of the subject dwelling are entered in the hedonic. The result is the price of the subject dwelling if it were located in the reference MSA, which is equal by definition to the number of units of housing that the unit contains. Units of housing are converted to local prices by multiplying units by the price of a unit of housing in the household's MSA relative to that in the reference MSA. Relative unit prices are obtained by calculating the hedonic value of a standard house in each of the MSAs; the conversion factor is the local price of the standard house divided by its price in the reference MSA.

The only direct wealth information available in the AHS is a variable indicating whether or not the total value of the individual's investments is greater than $20,000. Total nonlabor income, including investment income (interest, dividends, and net income from rental properties), is reported, as is a series of dummy variables indicating whether each particular

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[25] We select Cleveland as the reference MSA because of that MSA's moderate level of house prices and the relatively high R^2 and small coefficient standard errors of the hedonic.

type of investment income is included in this total. The share of nonlabor income that is investment income is given by adjusted gross income level in the IRS's Statistics of Income: Individual Returns. Nonhousing investment wealth is estimated by capitalizing total investment income by an investment return during the twelve months to which the income applies.

The rate of return used to capitalize income should vary among households, with age of the household being an important exogenous cause of that variation. The estimation of capitalization rates by age requires data on portfolio composition by age class and the cash return realized by those investment categories in 1984. The median value of holdings of various categories of investment assets by age group is given in the Census Bureau report Household Wealth and Asset Ownership, 1984 (Current Population Reports, Series P-70, Number 7). The asset categories that are relevant to the capitalization of household wealth income are interest-earning assets at financial institutions (a weighted average of the rates on savings accounts, money market deposit accounts, and small-denomination certificates of deposit),[26] other interest-earning assets, regular checking accounts,

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[26] The weights in the average are the proportional holdings of each type of deposit in commercial banks and in thrifts. Information on balances as of June 1984 is from The Treasury Bulletin.

stock, equity in personal businesses, savings bonds, and rental property.

The 1984 average rates on commercial bank deposits are from the Federal Reserve Board's 1984 Functional Cost Analysis for Commercial Banks. A corresponding functional cost analysis for thrifts, which generally offers higher deposit rates than banks, was available for 1985, but not for 1984. To approximate the 1984 rate for thrifts, the spread between deposit rates of banks and thrifts was calculated for 1985, and the spread for each deposit category was added to the corresponding 1984 commercial bank rate.[27] The return from other interest-bearing assets is a weighted average of 1984 average rates on Federal and local government bonds, corporate bonds, and commercial paper.[28]

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[27] The Federal Reserve functional cost data are not ideal: they are based on a small sample of relatively small banks in the Eastern US. Because smaller banks tend to underprice the market, the interest rates reported are biased downward. However, these are the only categorical deposit interest rates available; the only alternative is an overall rate earned on all deposits. Because a significant factor in this overall rate is large institutional deposits which earn higher rates than are generally available to individuals, using the overall rate would certainly give an upward-biased estimate of individuals' return on bank deposits.

[28] Average rates for each type of security for 1984 were obtained from The Federal Reserve Bulletin; households' holdings by category are averages of the

The relevant return from stock is the 1984 average dividend yield, reported in The Federal Reserve Bulletin. The return on personal business equity is estimated as the ratio of median self-employment income from the 1984 Consumer Expenditure Survey to the median value of individuals' personal business equity from Household Wealth and Asset Ownership. The return on savings bonds is 6.00 percent (reported in the Annual Report of the Secretary of the Treasury). The income from rental property included in the AHS measure of wealth income is gross rent receipts; the relevant return is thus the ratio of rent to current property value. The estimation of this ratio is based on the operation of five large diversified real estate investment trusts covered in the November 15, 1985 issue of The Value Line Investment Survey. Rent revenue, the value of land holdings, and the depreciated value of buildings were obtained from the 1984 10-K reports of these trusts. These historical cost asset values are inflated to current cost by multiplying them by the ratio of current cost to historical cost for land and for buildings for the non-corporate business sector in Balance Sheets for the US Economy.[29] The ratio of

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holdings at year-end 1983 and 1984 from Balance Sheets for the US Economy.

[29] The current cost and historical cost values for buildings in Balance Sheets for the US Economy are both net of straight-line depreciation.

rent revenue to current-cost asset value is computed for each of the five trusts. The rate used for returns on rental property is the value-weighted average of these five rent-to-value ratios.

The income capitalization rate applicable to a given household age class is the weighted-average return from the up-to-eight investment categories, where the weights are based on the median holdings of that investment category by that age class. The resulting capitalization rates for each household-head age class are: under 35, 9.14 percent; 35-44, 9.54 percent; 45-54, 10.16 percent; 55-64, 9.22 percent; 65-69, 8.54 percent; 70-74, 8.63 percent; and over 74, 8.55 percent. The capitalization rates for the intermediate age classes are assumed to be applicable to the midpoint age of the class; the rate for ages other than the midpoint age is found by interpolating between these midpoints. For individual households not holding specific assets, the weights for assets not held are distributed proportionately across the weights for assets held.

The estimated total value of the household's investment wealth is added to the value of housing equity to give total household wealth. The amount of housing equity (if any) is estimated based on the original terms of the mortgage and the owner's estimate of current house value; this estimate assumes no unscheduled prepayments.

Predicted income and wealth are used in place of observed income and wealth because of the endogeneity of labor supply and saving with respect to housing decisions; predicted marital status and number of children replace their observed values because of the endogeneity of household formation and composition. Predicted income is estimated separately for each of the eleven MSAs by regressing observed household income on the age, education level, gender, and race of the head and spouse (if present), and a series of dummy variables reflecting the AHS-defined zone within the MSA in which the household resides. Predicted marital status and number of children of the household head are estimated as functions of the head's age, education, gender, race, and predicted income. These regressors plus predicted marital status and number of children are used to estimate predicted wealth. Finally, the household's user cost is calculated using the formulation of Hendershott and Shilling (1982), plus a term reflecting expenditures on utilities.

The selection correction variable λ is derived from the results of a probit estimation of the probability of being an unconstrained owner, and thus included in the estimation sample for unconstrained demand. The estimated probit is:

$$Z_{SMPL} = \pi(AGE, EDUC, MALE, MARR^*, CHILD^*, BLACK, INC^*, WLTH^*, OWNCOST)$$

where OWNCOST is a measure of real total annual expenditures before tax for a standard size owned dwelling in the households zone of residence. (This crude measure of housing cost is used because the sample includes renters, for whom owner house value is unobserved.) Results of the estimation are given in Table A.

Table B reports the results of the estimation of unconstrained housing demand. The R^2, adjusted both for degrees of freedom and for use of the two-stage Heckman technique, is 42 percent. The effects of the individual variables must be interpreted with caution because the predicted demographic and income variables are functions of the remaining variables in the equation. However, we find that housing consumption increases with increases in education (at a decreasing rate), household income, number of children, and decreases with increases in user cost.

TABLE 1

Number of Households in the Sample and the Fractions Choosing Different Mortgages

	Sample	CONVARM	FHAFRM	CONVFRM
Birmingham	42	0.310	0.142	0.548
Buffalo	66	0.364	0.151	0.485
Cleveland	84	0.214	0.143	0.643
Indianapolis	79	0.228	0.278	0.494
Memphis	65	0.185	0.369	0.446
Milwaukee	81	0.383	0.185	0.432
Norfolk	81	0.235	0.284	0.481
Oklahoma City	88	0.329	0.182	0.489
Providence	77	0.338	0.013	0.649
Salt Lake City	92	0.174	0.319	0.511
San Jose	64	0.500	0.047	0.453
Total	819	0.291	0.197	0.513
Age of head:				
>30	289	0.232	0.253	0.516
30-39	335	0.313	0.185	0.501
40-59	178	0.331	0.135	0.534
>59	17	0.412	0.118	0.470

TABLE 2

Predicted vs. Actual Loan-to-Value Ratio

		PREDICTED					
		≤80	80.1-85	85.1-90	90.1-94.9	95	Total
A	≤80	292	37	16	6	6	357
C	80.1-85	26	12	9	5	3	55
T	85.1-90	24	11	17	17	26	95
U	90.1-94.9	29	6	8	18	75	136
A	≤95	37	3	3	11	122	176
L	Total	408	69	53	57	232	819

TABLE 3

Percent of Sample Constrained by FHA Loan Limits and Underwriting Standards and FHA-PMI Insurance Cost Differential, by Predicted Loan-to-Value Ratio

Predicted Loan-to-Value	Percent of Sample	Percent Constrained by: FHA Loan Limit	Income	Wealth	Income or Wealth	FHA-PMI Cost Difference preSept 1983	postAug 1983
80% LTV:		28	40	48	71		
Endogenous LTV:							
≤80%	50	39	24	6	24	0.46	0.90
80.5-85%	8	30	32	32	32	-0.01	0.43
85.5-90%	6	28	49	49	49	-0.08	0.36
>90%	35	12	52	89	89	-0.20	0.24
Total	100	28	36	40	49		

Sample size: 819.

TABLE 4

Logit Estimation of FHA Choice
(standard errors are in parentheses)

Constant	-0.343 (0.159)
Dummy for Post Aug 1983 Period	-0.094 (0.270)
FHA-PMI Annual Insurance Cost	-1.102 (0.326)
CON_{LL}	-6.898 (1.892)
CON_{IW}	0.965 (0.367)
Ln(L)	-316.40
LRI	0.214
Proportion Predicted Correctly (Random = 0.599)	0.725

Sample size = 581 (161 FHAs)

TABLE 5
Logit Estimation of ARM Choice
(standard errors are in parentheses)

Constant	-8.467 (5.314)
FRMRATE	0.452 (0.428)
FRM-ARM Rate	1.546 (0.336)
WEST	0.935 (0.302)
WEALTH(10^{-5})	1.067 (0.359)
NEWMETRO	0.403 (0.246)
AGE>54	-1.018 (0.475)
MARR	-0.366 (0.212)
BLACK	-1.076 (0.498)
ARM-FRM Annual Insurance Cost	-0.889 (0.831)
IV	-0.600 (0.357)
ln(L)	-442.8
LRI	0.220
Proportion Predicted Correctly (Random = 0.588)	0.717

Sample size = 819 (238 ARMs)

TABLE 6

Response of Mortgage Choice to FHA and PMI Premia Changes

	ARM	FHA	Conv.	%Change in FHA Usage
1. 0.5% annual FHA premium	132	285	402	
2. 3.8% up-front FHA premium	157	201	461	-29
3. Increase in PMI premium (1986-87)	152	233	435	16
4. 3.8% up-front plus 0.5% annual	171	176	472	-24

FIGURE 1

Mortgage Qualification Constraints and the Optimal LTV

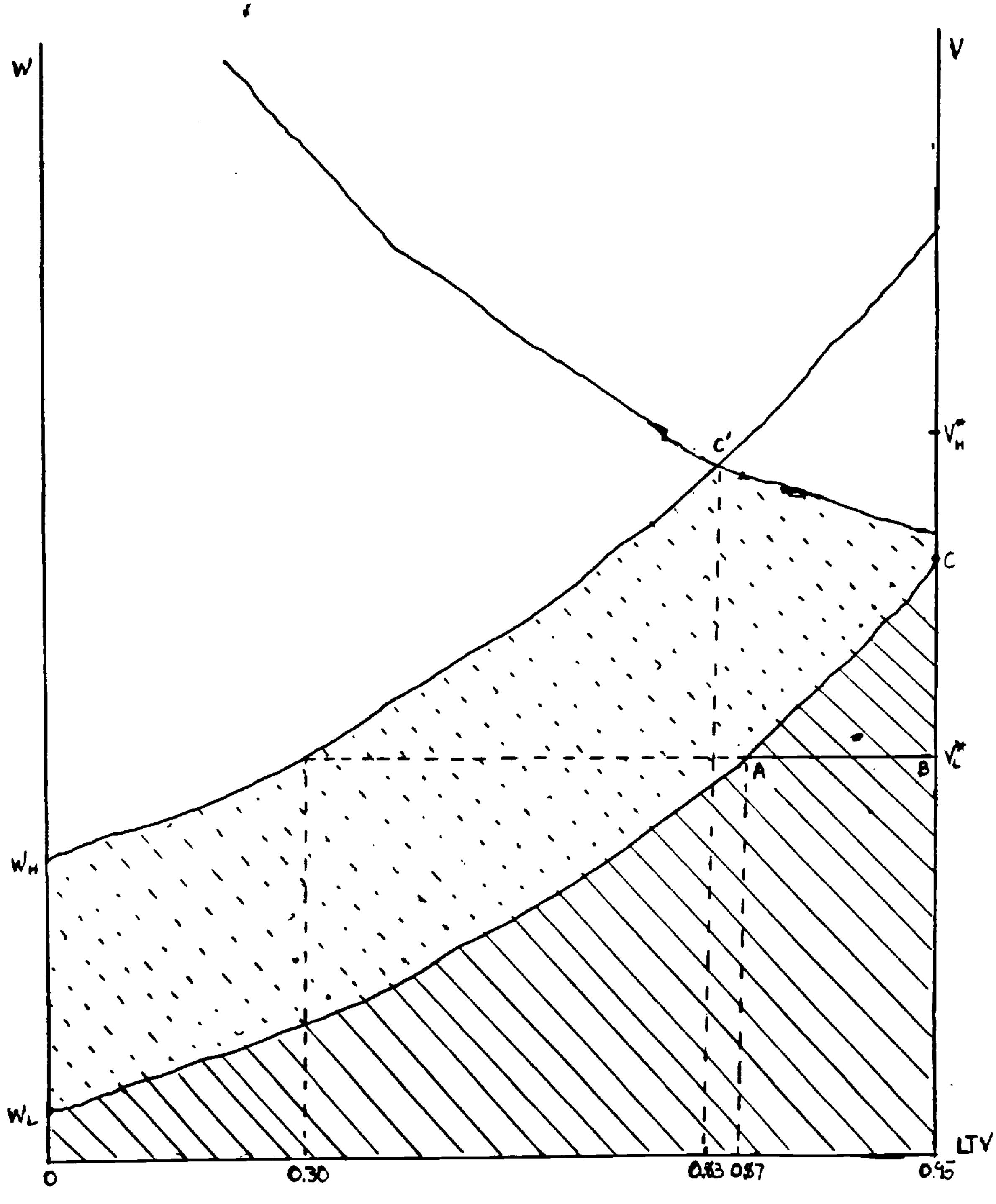

FIGURE 2

Effective Annual Cost of FHA Insurance

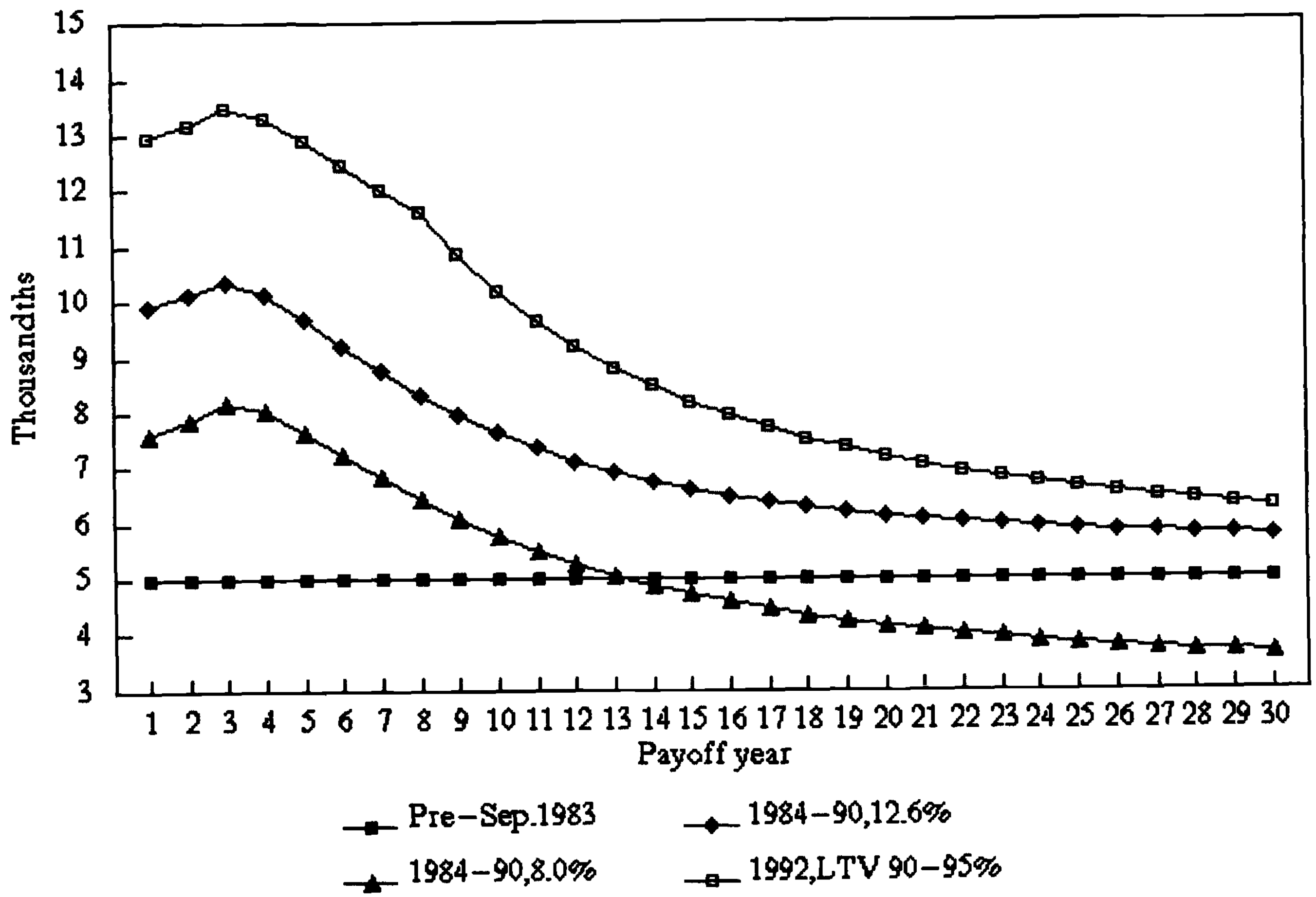

TABLE A

Probability of Being Unconstrained Owner

Constant	-0.019 (0.759)
AGE (10^{-1})	-0.318 (0.219)
$AGE^2(10^{-3})$	0.399 (0.230)
EDUC	0.007 (0.053)
$EDUC^2(10^{-2})$	0.037 (0.205)
MALE	0.009 (0.099)
MARR*	-0.768 (0.376)
CHILD*	-0.120 (0.102)
BLACK	-0.064 (0.105)
$INC^*(10^{-4})$	0.203 (0.063)
$WLTH^*(10^{-5})$	0.061 (0.178)
OWNCOST/INC*	-0.550 (0.140)
Log-likelihood	-1841.2
LRI	0.091
Proportion predicted Correctly (random=0.600)	0.732

Sample size = 3439

TABLE B

Estimation of Unconstrained Housing Demand
(standard errors are in parentheses)

Constant	5.573 (2.371)
AGE	-0.029 (0.057)
$AGE^2(10^{-2})$	0.068 (0.058)
EDUC	0.354 (0.152)
$EDUC^2(10^{-2})$	-1.151 (0.552)
MALE	-0.235 (0.276)
$MARR^*$	1.294 (1.262)
$CHILD^*$	0.661 (0.287)
$INC^*(10^{-4})$	0.594 (0.203)
$WLTH^*(10^{-5})$	-0.021 (0.424)
BLACK	0.992 (1.832)
BLACK·AGE	-0.034 (0.027)
$UC(10^{-2})$	-0.392 (0.036)
λ_{SMPL}	-0.634 (1.059)
Adjusted R^2	0.421

Sample size = 949