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ENDOGENOUS MORTGAGE CHOICE, BORROWING CONSTRAINTS AND THE TENURE DECISION

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ABSTRACT

Earlier research has shown that lender income and wealth constraint ratios discourage homeownership. This empirical research has been based on home purchasers using an 80 percent loan-to-value (LTV) fixed-rate conventional loan. Employing the same assumption, we find that the constraints lowered the ownership rate of our 1919 young home purchasers by about 20 percentage points. However, households are not restricted to putting 20 percent down and choosing a fixed-rate loan. When we allow households to select the optimal LTV and mortgage type (adjustable or fixed-rate with Federal Housing Administration (FHA) or conventional insurance), the percentage of our sample that is credit constrained declines from 71 to 49. Moreover, the measured impact on the homeownership rate of the constraints falls to only 4 percentage points. Further, FHA loans are estimated to increase homeownership by only 0.1 to 0.2 percentage points.

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1. Introduction

Transactions costs and indivisibilities prevent households from adjusting housing consumption instantaneously in response to changing demand. These impediments include significant moving and transaction costs (including the illiquidity of owner housing) and the difficulties of incrementally changing consumption by remodeling one's current house. This fact combined with the uniqueness of individual housing units results in high search and information costs. Because of these impediments, households are forced to take a long-term view of their demand for housing when making a purchase. Models of housing reflect the long-term nature of this decision by making demand and tenure choice a function of permanent, rather than measured, income [Goodman and Muth, 1989].[1] Because lenders base borrowing capacity on observable/verifiable current income and wealth rather than total tangible wealth plus human capital, a household's demand for housing may be constrained by a borrowing limitation in addition to the usual budget constraint. This is most likely true in the case of

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[1] Killingsworth [1983, pp. 290-92] argues that collapsing the lifetime earnings profile into a single permanent income quantity is appropriate only if the number of hours of labor supplied over the individual's life cycle is fixed. Further, in order for consumption to be a function of permanent income and not transitory income, real prices must be expected to remain constant over the individual's lifetime.

a younger individual whose future earnings are often significantly greater than his or her current income and accumulated wealth. Such an individual would have a high demand for housing relative to current income and wealth, but would be unable to obtain a loan large enough to satisfy that demand. This individual would have two choices: either temporarily rent housing, planning to buy when income increases, or buy a smaller house.

Jones [1989] argues that the household's current stock of non-human wealth is the key factor in the transition to ownership, emphasizing the constraint imposed by a minimum downpayment (the wealth constraint). Linneman and Wachter [1989] estimate the impact of mortgage qualification requirements on the household's tenure choice, considering both wealth and income constraints (a minimum 20 percent downpayment and maximum payment/income ratio of 28 percent). The income constraint is evaluated on the basis of a nonamortizing loan; thus, the term of the loan is irrelevant. Two maximum house values are calculated for each household based on the two constraints. Optimum unconstrained house values are obtained from estimation based on buyers whose purchase is less than 85 percent of each of the two maximum values. The differences between the optimal value and the maximum income-constrained and wealth-constrained values are income and wealth "affordability gaps" that are hypothesized to affect the tenure decisions of

constrained households.

Zorn [1989] also considers both income and wealth constraints and expands the analysis by formally modelling the mobility and tenure-choice decisions subject to the two constraints. The maximum flow of housing that a household can purchase is computed assuming that the household issues a 25-year fixed-rate mortgage with the same downpayment and payment-to-income ratios assumed by Linneman and Wachter. The resulting maximum house value (the minimum of the maximums allowed by the income and wealth constraints) is compared to the house value that would be chosen in the absence of the constraints. Zorn determines this optimum implicitly by estimating a logit equation derived from the assumed utility function, including in the estimation only those buyers whose observed purchase is less than the maximum the underwriting critera allow.

In contrast to Linneman and Wachter and Jones, Zorn uses a direct utility function in his tenure-choice estimation for constrained households. Because borrowing constraints limit the quantity of housing that households are able to acquire as owners, the tenure-choice decision is driven not by the traditional ratio of the costs of owning and renting, but by an assessment of the level of utility attainable from the overall consumption bundle of housing and non-housing goods selected under each tenure alternative. In the presence of borrowing

constraints, the cost ratio is not sufficient to describe the tenure choice process.

Duca and Rosenthal [1994] analyze the impact of underwriting criteria using a data set (1983 Survey of Consumer Finances) in which they attempt to identify directly households whose tenure is unaffected by borrowing constraints and those whose tenure may be affected. Households who may be affected are those with positive responses to survey questions asking whether a lender either turned down or did not grant fully a loan request (home mortgage or other) or whether they had not applied for a loan because a turndown was expected. A tenure equation is estimated for unconstrained owners and renters. This equation is then used to predict the tenure of possibly constrained households, with the difference between actual and predicted being the impact of the constraints. Unlike the other studies, Duca and Rosenthal do not restrict themselves to recent movers.

We extend Zorn's work in two major directions. First, rather than assuming that all households finance their purchase using an 80-percent FRM, households are allowed to select both the loan-to-value ratio and mortgage type (conventional FRM, conventional ARM, or FHA-insured FRM) that maximizes utility. A household with a reasonable level of income but little accumulated wealth is not necessarily forced to rent or to purchase a suboptimally small house. Rather, such a household

can respond by increasing the loan-to-value ratio above 80 percent. This will tighten the income constraint (because of both the higher loan balance and a possibly higher interest rate and/or mortgage insurance premium), but ease the wealth constraint, making a larger quantity of housing attainable. Conversely, a household with low income but high wealth can make a downpayment greater than 20 percent, easing the income constraint. Further, households with extremely tight wealth constraints can choose low downpayment FHA mortgages, and households with tight income constraints can choose low initial-coupon ARMs.

The second extension deals with estimation. Haurin, Hendershott, and Kim [1994] note that a number of the variables generally considered as exogenous determinants of a household's housing decisions, including marital status and income and wealth, are endogenous. Household formation and marriage are likely to be delayed if the cost of housing is high relative to an individual's earning potential, so that selection bias arises from limiting one's sample to those who have formed households and simultaneity bias results from entering marital status as a exogenous dummy variable. Real labor income is the product of the real wage earned and the quantity of labor supplied by the household; the latter is influenced by the household's demand for housing and its choice of tenure. Similarly, household wealth depends on saving out of income, and this, too, is influenced by the

household's desire to become a homeowner. Finally, the household's ability to supply more labor and accumulate more wealth as a way of overcoming affordability constraints implies that measures of these constraints are themselves also endogenous with respect to housing decisions.

To overcome these endogeneity problems, observed marital status, income, wealth, and the affordability constraint gap are replaced with predicted values, estimated as a function of exogenous characteristics. To address the sample selection bias, the two-stage correction procedure of Heckman [1976, 1979] is used. This procedure incorporates in the final estimation a variable derived from a first stage estimation of the probability that a given individual chooses an outcome that leads to their inclusion in the sample (e.g., choose to form a household or to be a recent mover).

The remainder of this paper is divided into five sections. Sections 2 and 3 present the model, and section 4 discusses the data. Sections 5 and 6 report the estimates and illustrate their economic importance. Section 6 summarizes and suggests future research. Background housing demand equations are discussed briefly in the appendix.

2. The Basic Utility Maximization Problem

The household determines its tenure state by comparing the utility available as an owner to the utility available as a renter. Our approach is to

develop a tenure-choice equation based on a direct utility function. The resulting equation is a function of quantities of housing and other goods that the household consumes under each tenure state.

It is assumed that household utility in a given tenure state depends on the quantities of housing and nonhousing goods consumed in that tenure state as well as on a vector of intangible preference shifters relevant to the household in that tenure state (see Haurin, Hendershott, and Ling [1988] for discussion of the role of preference shifters in utility). It is further assumed that individuals' utility functions are loglinear; this choice is made for computational reasons (Zorn, 1989). The household's utility in tenure state k is:

$$U_k^j = \beta_o + \beta_1 \ln H_k^j + \beta_2 \ln X_k^j + \beta_3 Z_k^j \qquad (1)$$

where U^j_k = utility of household j in tenure state k,

H^j_k = number of housing units consumed by household j in tenure state k,

X^j_k = number of units of the non-housing good consumed by household j in tenure state k,

Z^j_k = a vector of unobservable preference shifters relevant to household j in tenure state k,

Because utility can only be measured with error, the household's true level of utility in tenure state k is the sum of measured utility and a random error:

$$U_k^j = U^{*j}_k(H_k^j, X_k^j, Z_k^j) + \epsilon_k^j. \qquad (2)$$

Households determine their tenure state by comparing the utility available as an owner to the utility available as a renter and selecting that state in which utility is greater. In the absence of affordability constraints, the probability of ownership is:

$$Prob[[U_O^j(H_O^{Dj}, X_O^j, Z_O^j) + \epsilon_O^j] - [U_R^j(H_R^j, X_R^j, Z_R^j) + \epsilon_R^j]] > 0. \qquad (3)$$

where O and R refer to the states of owning and renting and the superscript D denotes desired housing in the absence of constraints. We define OWN^j as the probability of ownership and rewrite (3) as

$$OWN_j = Prob[U^{*j}_O - U^{*j}_R \geq \epsilon_R^j - \epsilon_O^j]. \qquad (4)$$

If the error terms in (3) are independently normally distributed with zero mean, a probit tenure-choice econometric model is approriate:

$$OWN^j = \beta_o + \beta_1(\ln H_O^{Dj} - \ln H_R^j) + \beta_2(\ln X_O^j - \ln X_R^j) + (\beta_{30} - \beta_{3R})\, Z^{*j} \qquad (5)$$

The estimation of (4′) requires the specification of proxies for the unobservable preference shifters. In their development of the tenure-choice equation,

Haurin, Hendershott, and Ling [1988] assume that the shifters applicable to a particular household are a function of observable demographic characteristics of that household. Also required are estimates of the owner housing that renters would demand as owners and the renter housing that owners would demand as renters. Equations from which these predicted values are computed are reported in the appendix.

3. LTV and Mortgage Instrument Choice

Next, we need to allow for the impact of affordability constraints on tenure choice. Following Linneman and Wachter [1989], affordability constraints are measured in terms of "gaps," representing the difference between the value of the house that would be purchased in the absence of income and wealth constraints (the unconstrained house value) and the value to which the household is limited by the maximum payment-to-income and loan-to-value ratios. The unconstrained house value is estimated based on those households whose house purchase price is less than that which they are eligible to purchase based on their observed income and wealth (see the appendix). The procedure of Heckman [1976] is used to correct for the selectivity bias arising from estimation on a censored sample.

Because the impact on the ownership decision of a binding gap is probably less if the gap is small relative to unconstrained house value than if the gap

is relatively large, the constraints in the tenure-choice equation are measured relative to unconstrained house value:

$$RELGAP_j^Y = (V_j^* - V_j^Y)/V_j^* \qquad (5a)$$

$$RELGAP_j^W = (V_j^* - V_j^W)/V_j^* \qquad (5b)$$

where V^*_j is the household's unconstrained house value, and V^y_j and V^w_j are the income-constrained and wealth-constrained maximums. As recognized by Zorn [1989], only the more tightly binding of these two constraints affects the household's behavior. Accordingly, the gap measure included in the tenure-choice equation is the maximum of the income and wealth gaps, although in most instances households will adjust their LTVs to equalize the gaps. Because only binding gaps matter, the calculated value of maximum RELGAP is interacted with a dummy equal to 1 if the gap is positive and 0 otherwise.

The mortgage rate and qualification requirements used to calculate V^y_j and V^w_j depend on the household's choice of LTV and mortgage instrument. FHA mortgages allow smaller downpayments and higher payment-to-income ratios than conventional loans, so V^w_j and V^y_j are larger for FHAs than for conventionals. ARMs typically have smaller monthly payments than FRMs. Because most ARM contracts are evaluated using the

same 28 percent minimum payment-to-income ratio as FRMs, V^y_j is greater for ARMs than for FRMs. Of course, V^w_j rises with LTV and V^y_j declines. To incorporate the household's mortgage choice in the affordability measure, a nested logit model of mortgage choice is estimated in which households choose among conventional ARMs, conventional FRMs, and FHA-insured FRMs (Hendershott and LaFayette [1995]). Maximum house values for constrained homebuyers are calculated based on the LTV that allows maximum house purchase and the mortgage instrument predicted by this model.[2]

Figure 1 illustrates how a household with a conventional FRM would choose the optimal LTV. The model solution is illustrated for two wealth levels. The right vertical axis is house value, the left is wealth, and 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

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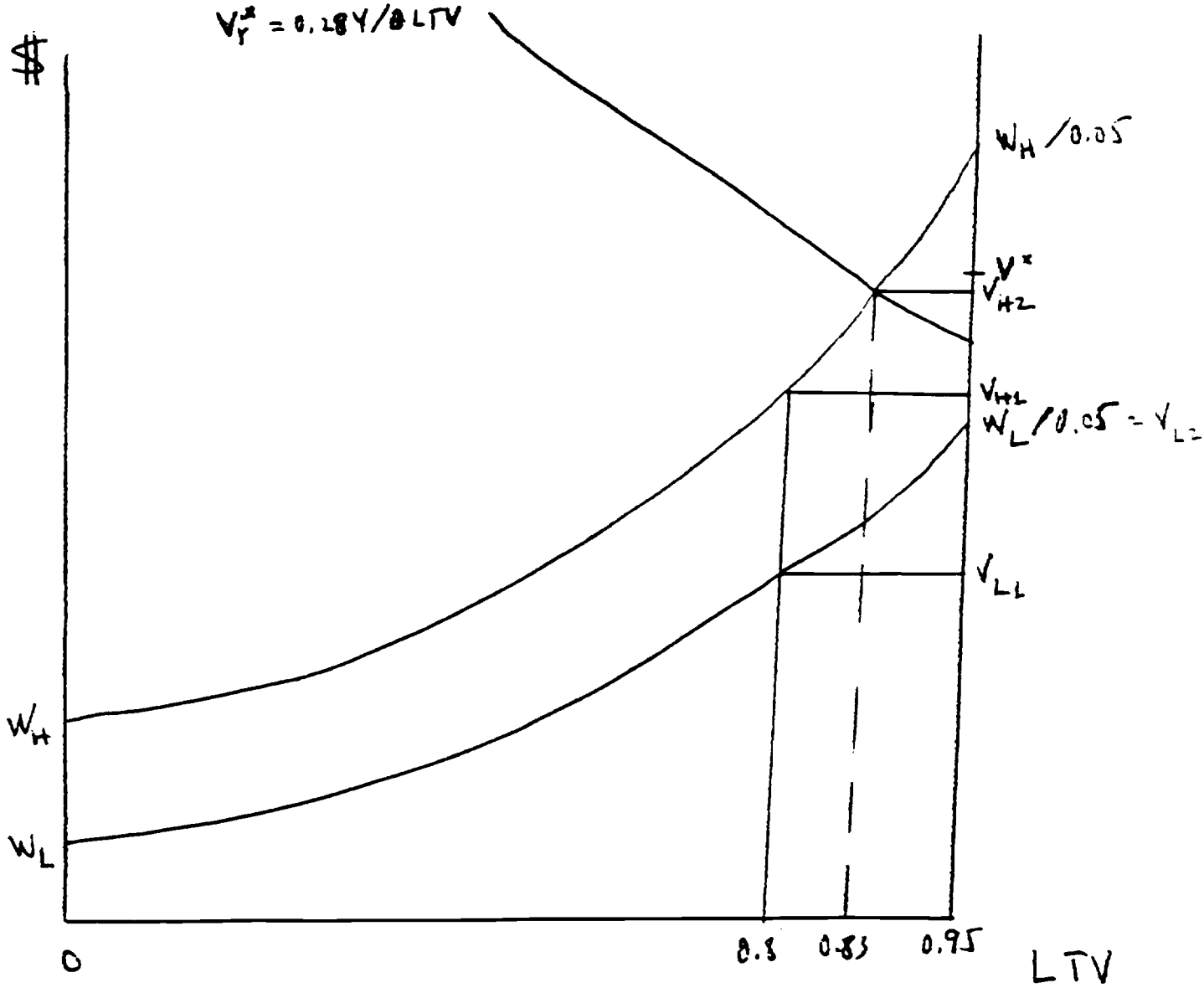
[2] Given the dominance of conventional FRMs in our sample, our equations underpredict the other two mortgage types when each household is assigned the mortgage they are predicted to be most likely to choose. To ensure that the model correctly predicts the number of households choosing each mortgage type, we have lowered the threshold probabilities for choosing ARMs and FHAs. In the absense of this adjustment, we would overstate the extent to which the constraints bind (the conventional FRM is least able to reduce affordability constraints) and thus the impact of removing the constraints.

FIGURE 1: Selecting the Optimal LTV



of W_L (low) or W_H (high). These curves are derived by computing $W_i/(1\text{-LTV})$ for different values of LTV.[3] The downward sloping line indicates the maximum house value possible given the household's income (Y), market interest rates, and the underwriting criteria. This curve is obtained by computing $0.28*Y/\theta LTV$ for different LTV values.[4] Kinks exist in the curve at the 80, 85, 90, and 95 percent PMI insurance break points. 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, income Y, and desired unconstrained house value V^*. With an

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[3] A house is financed with debt and equity (E): V = LTV*V + E. The maximum house purchase is one in which all "available" wealth (W_A) is invested in the house (set E = W_A and solve for V_W). We define available wealth as wealth other than pension investments and consumer durables less one month salary, closing costs (0.011 of house value), and mortgage points (dependent on size of mortgage and thus LTV).

[4] The housing cost underwriting constraint is $\theta LTV*V = 0.28*Y$, where θ includes the mortgage constant, tax and hazard insurance escrows, and the PMI (where relevant) annual insurance rate. 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).

imposed LTV of 80%, the household must select a house value of V_{L1}, far less than V^*. One would not be surprised if this household rented rather than owned. Even with endogeneous LTV choice, the optimal unconstrained house value of V^* is unattainable; the best a low wealth household can do is to select a 95 percent LTV and purchase V_{L2}. Next consider a household with wealth $W_H > W_L$. With a higher wealth curve, the household can demand V_{H1} with an 80 percent LTV or V_{H2} with the optimal LTV of 83 percent. At the latter LTV, the wealth and income constraints are equally binding.

Mortgage instrument choice improves matters further. The low wealth household would opt for a high LTV FHA loan; the wealth-constrained housing demand curve is effectively extended beyond the 0.95 LTV, allowing a larger house to be purchased. The high wealth household would likely select an ARM; the income-constrained house line rises owing to the lower interest rate on the ARM, likely permitting the household to achieve its desired housing.

Table 1 indicates the proportions of owners and renters in our sample that would be constrained by insufficient income, wealth, and either, assuming they selected a conventional FRM with an 80 percent LTV or the optimal LTV and preferred mortgage instrument. The top part of the table is the "high" interest rate period of our sample (roughly 12 percent rates); the bottom part is for the low interest rate environment

prevailing in 1993 (8 percent FRM rate and 6 percent ARM rate).

The ability of LTV and mortgage choice to finesse constraints of owners is obvious. With high interest rates and the forced usage of conventional FRMs, 71 percent of recently moving owners are constrained by underwriting constraints (this is close to Zorn's result of 67 percent).[5] With LTV and mortgage choice, the percent constrained declines to 49 percent. At the lower interest rates, 58 percent are constrained when an 80 percent LTV conventional FRM is assumed; only 40 percent are constrained when choice is allowed.

The second part of the table repeats these calculations for renters. Not surprisingly, they are far more constrained and allowing choice doesn't help much. With no choice, 97 percent are constrained (versus Zorn's 90 percent); with choice, 92 percent are constrained at high interest rates and 90 percent at low interest rates.

4. The Data

The model is estimated on data from the 1984 Metropolitan American Housing Survey (AHS). This data

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[5] Linneman and Wachter [1989] report binding income and wealth constraints separately. They find for their 1981-83 sample that 40 percent of recently moving homeowners were wealth constrained, compared to our 43 percent. Because they do not take tax and insurance escrows into account, they find that only 27 percent are income constrained versus our 46 percent.

set contains an extensive survey of the characteristics and costs of approximately 4,250 housing units within eleven geographically diverse metropolitan statistical areas (MSAs). We exclude unoccupied units, mobile homes, rooms in rooming houses, non-traditional dwellings (such as boats, tents, caves) and units occupied by individuals who neither own the dwelling unit nor pay cash rent because of the difficulty of determining the level of housing consumption or cost that they entail. Households with especially large income, wealth, or house value are also excluded because the AHS does not report the values of a number of key variables above a certain level. These truncated variables include salary income of individual household members and household investment income (each unavailable above $100,000), house value (unavailable above $200,000), and monthly mortgage payment (unavailable above $2,000 on each loan).

The sample is also limited to white and black households, excluding members of other racial or ethnic groups (e.g., Hispanics, Asians, Native Americans, etc.) It is hypothesized that the behavior of individuals differs on the basis of their ethnic or racial background, so race is used as an explanatory variable in the model. Members of these other ethnic or racial groups may exhibit economic and social behavior that differs from both blacks and whites; thus, it would be incorrect to include these

individuals in those groups. Because of the small representation of other groups in the sample, they are deleted.

This study also excludes owner households who are not recent movers; specifically, those households whose most recent move occurred prior to March 1983, eighteen months before the modal date of the survey. This exclusion is necessary because the AHS does not contain sufficient information to obtain reliable measures of the downpayment and income constraints that non-mover households faced when they acquired their current unit. (In particular, income and wealth data for prior years are not available.) Because one cannot determine whether the quantity of housing purchased by non-mover households was affordability constrained, unconstrained house values cannot be estimated for a sample of owners including non-movers. Finally, we exclude households who financed with assumptions, owner financing, or VA or GPM mortgages. That is, the mortgage instrument choices are limited to conventional or FHA long-term (15 years plus) FRMs or conventional ARMs.

The final sample, by MSA and tenure state, with breakdown by various demographic characteristics, is shown in Table 2. The diversity of the surveyed MSAs in terms of location, housing costs, and local characteristics, as well as the inclusion of households of different types in different race and age groups, enhances the generality of the model,

while the limitation to eleven MSAs makes the collection and processing of supplementary local data needed to estimate the model a manageable task.

Because the search, transaction, and moving costs applicable to renter housing are low relative to those faced by owners, the changes in optimal demand and tenure choice triggering a move by a renter household are lower than those inducing a move by an owner. This implies that the decision of a household to rent a dwelling of a given size and to rent rather than own is likely made on the basis of the household's present income, wealth, and affordability constraints. Because the unavailability of data needed to calculate retrospective affordability gaps poses no problem for non-moving renters, these households need not be excluded from the estimation. The renter sample analyzed is a randomly-selected sample of approximately eleven percent of all renter households not excluded for other reasons.

5. Estimation Results

The tenure-choice equation estimated is:

$$OWN = b_o + b_1(\ln H\frac{D}{O} - \ln H_R) + b_2(lnX_O - \ln X_R) + b_3 AGE$$
$$+ b_4 AGE^2 + b_5 BLACK + b_6 MARR* + b_7 CHILD* + b_8 RELGAP$$
$$+ b_9 \lambda MOVE + b_{10}\lambda ALONE + b_{11}\lambda OUTPARENT, \qquad (4'')$$

where the first two variables are the estimated

differences between the logs of desired housing and other goods as an owner and renter; *RELGAP* is the maximum of the relative wealth and income gaps if they are positive or 0 otherwise; and the lambdas are selectivity correction variables reflecting the omission of those living with parents, those living in a group, and owner households who have not moved recently.[6] Demographic preference shifters include age and age squared and whether the household is *BLACK*, is married *MARR*, or has at least one *CHILD*.[7] Because b_1 and b_2 are coefficients on consumption quantities in the utility function in (1), these coefficients are expected to be positive; the hypothesized negative impact of affordability constraints on the probability of ownership implies that b_8 should be negative. The coefficients of the demographic variables, b_3 to b_7, are interpreted

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[6] There may be a degree of simultaneity among these selection-correction variables because the underlying decisions may be interdependent rather than sequential. This implies that the variables should be estimated as a joint system. The problem with this procedure is technical: as Greene notes [1990, p. 689], "existing results [on joint probit equations] are not sufficient to allow accurate and efficient evaluation for more than two variables in a sample of even moderate size." Consequently, at least some of the jointness among the decisions underlying this model must be ignored.

[7] Asterisks on *MARR* and *CHILD* denote predicted rather than actual values of these variables.

following equations (1) and (4'). That is, a positive coefficient implies the shift in utility related to this variable is greater for ownership than renting.

The estimation results for the tenure-choice equation are presented in Table 3. Column 1 contains the results for equation (4"). As shown in the lower panel of the table, the equation predicts 74.4 percent of the sample correctly versus 54.8 percent predicted correctly using random assignment.

The coefficient of the housing consumption quantity difference has the expected positive sign and a t-ratio of 12. The coefficient of the nonhousing consumption quantity is unexpectedly negative, but not statistically different from zero. Also as expected, binding qualification constraints have a significant negative effect on the probability of ownership; the *RELGAP* coefficient has a t-ratio of 10.[8] Of the demographic variables, the predicted probability of marriage and *BLACK* have coefficients statistically different from zero, the former positive and the latter negative. All three selectivity correction variables have statistically significant coefficients.

Column 2 gives results if the affordability gap is calculated assuming an 80 percent LTV on a conventional FRM, as in previous studies. Not only

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[8] We report in the appendix that the quantity of owner housing demanded by constrained households is negatively related to the affordability gap, but the t-ratio is only 1.5.

does the size of the gap variable increase substantially (the mean value nearly doubles), the magnitude of the *RELGAP* coefficient rises by ten percent. That is, the negative impact of qualification constraints is estimated to be far greater (offsetting this variable is a larger constant term).[9] The statistical significance of the coefficient declines slightly, and the log-likelihood of the equation worsens somewhat, suggesting that allowing borrowers to select the optimal LTV and mortgage instrument improves the measurement of affordability. Column 3 omits the selectivity-correction variables, resulting in a marginally inferior fit; more important, the *RELGAP* coefficient increases by 30 percent. That is, our (relatively young) sample of recent movers is more responsive to binding underwriting constraints than the population as a whole. Correcting for this sample selection allows us to make more accurate statements regarding the population as a whole.

In the final column, the consumption quantities of the previous equations are replaced with predicted income and the relative cost of owning and renting, as in Linneman and Wachter [1989], with the gaps once

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[9] Similarly, not correcting for endogeneity in the gap yields a far larger estimated impact; the gap coefficient nearly doubles in absolute value and has a t-ratio of 24. The larger gap coefficient likely reflects simultaneous equations bias.

again measured with endogenous mortgage choice and LTV as in column 1. Consistent with previous research, greater income significantly increases the propensity to own (t-ratio of 4.6), while an increase in the relative cost of owning significantly decreases that propensity (t-ratio of 9.9). The ability of this equation to classify household tenure correctly is slightly inferior to the quantity-based equation. The *RELGAP* coefficient is 15 percent lower than in column 1.

6. Simulations

The estimated model can be used to quantify the impact on tenure choice of market and constraint changes that affect affordability. We simulate three changes: an interest rate-induced increase in affordability, the disappearance of underwriting ratio constraints, and the unavailability of FHA.

To conduct the interest rate simulation, we lower the FRM interest rate to 8 percent from the 12.6 percent prevalent in 1983-84 and the ARM rate from 11.9 percent to 6 percent. These lower rates prevailed in 1993. Affordability improves with lower rates. In addition, an interest rate decline would raise demand and tenure choice through changes in user costs to the extent that the nominal interest rate reduction is a decline in the real after-tax rate. To focus on affordability effects, we assume the real after-tax interest rate, and thus the real user cost

of ownership, is unchanged from its prior level.[10] We further assume that real rents are unchanged.

To determine the effect of the affordability change on tenure choice, we first recompute mortgage choice and then obtain new income and wealth gap values based on the mortgages chosen and interest rates associated with them. The change in the maximum gap is then calculated and used to adjust the predicted gaps in both the owner housing demand and tenure choice equations. The ownership probabilities based on both the adjusted gap and demand variables are summed to find the predicted number of owners in the sample. The number of owners increases from 54.8 percent of the sample to 56.1 percent, an increase of 1.3 percentage points.

Next, we eliminate the underwriting ratio constraints (set the relative gap variables equal to zero in both the owner demand and tenure choice equations). Recomputing the predicted number of owners, we obtain as increase from 54.8 percent to 58.6 percent, a 3.8 percentage point increase.[11]

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[10] Real after-tax interest rates change for households in tax brackets higher and lower than average; the real after-tax rate rises for those in relatively low brackets, while those in relatively high brackets experience a decrease.

[11] Duca and Rosenthal compute a substantially larger 8.4 percentage point increase. Their estimate is based upon removal of "past credit histories," as well as underwriting constraints. Further, their

This increase is relevant to all households, not just recent movers. If we base the analysis on all households choosing an 80% conventional FRM (set the relative gap variables equal to zero in the equation based on the estimates from column 2), the predicted increase in ownership is an enormous 20.7 percentage points. As noted earlier, the gap variable binds far more tightly when an 80% conventional FRM is assumed, and the estimated coefficient in the tenure choice equation is ten percent greater. Thus, approaches that do not account for the endogeneity of LTV and mortgage choice will tend to overestimate the impact of eliminating mortgage constraints.

Last, we compute how much lower homeownership would have been had FHA not been available to those who chose it. We estimate an ARM/FRM choice equation for the 658 households in our sample with conventional mortgages (238 ARMs) quite similar to that reported in Hendershott and LaFayette [1995] and assign the FHA borrowers in our sample to an ARM or an FRM. As in the earlier simulations, we then recompute the income and wealth gap variables for these households and adjust the predicted maximum gap by the calculated change in the maximum gap predicted. The aggregate ownership rate declines by only 0.11 of a percentage

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sample covers a period of higher interest rates (1981-83 versus 1982-84) when ARMs were less available.

point.[12]

7. Conclusion

We analyze the tenure decision of 3439 recently moving households in 1983-84 from eleven MSAs (those in the 1984 Metropolitan AHS) in order to determine the impact of affordability constraints. In contrast to earlier research, we allow both LTV and mortgage choice, which reduces the proportion of the owners in the sample that are affordability constrained from 71 percent to 49 percent. We also allow for the endogeneity of income, wealth and the affordability constraint variable itself and correct for sample selection (recent movers and those living as separate households).

Binding affordability constraints significantly reduce homeownership, by 4 percentage points in the 1982-84 interest rate environment and 2.5 percentage

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[12] A possible reason for the small impact is that we may be understating the ability of FHAs to allow households to circumvent the income constraint. To allow for looser enforcement of the FHA guidelines relative to conventional guidelines, we raised the FHA housing cost constraint ratio by three percentage points, reestimated the original mortgage choice equations, respecified the mortgage choice thresholds to assign accurately the correct numbers of ARMs and FHAs, and repeated the simulation exercise. The impact on the ownership rate rose from 0.11 to 0.20 of a percentage point.

points at the lower 1993 interest rates. This impact is only a fifth of that obtained when calculations are made assuming that only an 80% conventional FRM is available. Given the relatively small impact of totally removing constraints, the availability of FHA is estimated to do little to mitigate the affordability problem. Disappearance of FHA would lower the ownership rate by only 0.1 to 0.2 percentage points.

The FHA estimate may understate FHA's impact today. We did not analyze the impact of FHA graduated payment mortgages, which increased affordability in the early 1980s (the program has since been cancelled), and low cost VAs were available to a larger fraction of the FHA's young borrower population in 1984 than in 1994. Also, FHA ARMs have been selected in significant numbers in the early 1990s vis-a-vis negligible usage in the first half of the 1980s. An analysis of data from the 1991-93 period, where VA usage was down, FHA ARM usage was up, and FHA insurance rates were altered, is likely to yield an accurate assessment of the current FHA impact on homeownership.

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APPENDIX

Demand for owner and renter housing are estimated as functions of household income, the real price of housing services, and demographic variables. The simultaneous-equations bias arising from the endogeneity of household formation and labor supply decisions is addressed by replacing reported income, marital status, and number of children with predicted values of these variables. The procedure of Heckman [1976] is used to correct for the selectivity bias caused by estimating the equation on a non-random sample.

The real price of owner housing is estimated as in Hendershott and Shilling [1982], but including the cost of utilities and using predicted rather than actual marginal income tax rates. Renter user cost is the median annual rent to hedonic value ratio of the household's zone of residence plus a charge for utilities and renter's insurance.

The demand equations are subject to three types of selection bias: the limitation of the sample to those who live away from their parents, those who live separately from unrelated adults, and those in one tenure state rather than the other. A further source of bias in the owner demand equation is the limitation of the sample to recent movers. (The bias corrections for ownership and recent-mover status are combined in recognization of the jointness of these decisions.)

The owner demand equation also incorporates the effect of affordability constraints. The quantity of housing consumed by an owner household is the quantity of housing desired in the absence of constraints less the impact of the constraints. As in the tenure choice equation, these constraints are represented by the maximum of binding income and wealth gaps. Unlike the maximum gaps from equations (5a) and (5b), the measurement is absolute rather than relative (no division by the unconstrained house value).

Coefficient estimates for the owner housing demand equation are in column 1 of Table A; estimates for the renter equation are in column 2. As expected, the effect of predicted income on owner and renter demand is significantly positive (t-ratios of 8 and 9, respectively) and the effect of user cost is significantly negative (t-ratios of 23 and 5). Further, the coefficient of *CONGAP* in the owner demand equation is negative with a t-ratio of 1.5, hinting that constrained households demand less housing than unconstrained households.

TABLE 1: Percentage Affordability Constrained

A. Homeowners

	Percent of Sample	Income	Wealth	Either
High Interest Rates (12.6% 11.9%)				
80% LTV-Conv. FRM		46	43	71
Endog LTV + mortgage choice				
≤ 80%	57	26	6	26
80.5-90%	11	47	47	47
> 90%	32	60	92	92
Total	100	39	38	49
Low Interest Rates (8%/6%)				
80% LTV-Conv FRM		21	43	58
Endog LTV + mortgage choice				
≤ 80%	57	18	3	18
80.5-90%	11	15	15	15
> 90%	32	23	85	85
Total	100	19	32	40

B. Renters

	Percent of Sample	Income	Wealth	Either
High Interest Rates (12.6%, 11.9%)				
80% LTV-Conv FRM		82	83	97
Endog LTV + mort choice				
≤ 80%	38	81	57	81
80.5-90%	2	79	79	79
>90%	60	84	89	99
Total	100	83	82	92
Low Interest Rates (8/6%)				
80% LTV-Conv FRM		75	83	95
Endog LTV + mort choice				
≤ 80%	38	80	57	80
80.5-90%	2	43	43	43
>90%	60	67	98	98
Total	100	71	81	90

TABLE 2

Sample Size and Means of Demographic Variables by MSA

	Sample	Owner	Age	Marr	Black
Birmingham	254	0.488	40.5	0.547	0.343
Buffalo	234	0.504	40.4	0.538	0.111
Cleveland	286	0.462	41.3	0.531	0.199
Indianapolis	315	0.581	38.8	0.613	0.111
Memphis	344	0.526	39.2	0.523	0.349
Milwaukee	297	0.424	39.2	0.505	0.162
Norfolk	417	0.616	36.2	0.616	0.221
Oklahoma City	362	0.674	37.6	0.613	0.075
Providence	333	0.508	40.9	0.571	0.030
Salt Lake City	358	0.595	34.8	0.609	0.008
San Jose	239	0.569	37.0	0.519	0.054
Total	3439	0.548	38.5	0.567	0.151

TABLE 3: Tenure Choice Estimates
(standard errors in parentheses)

	(1) Equ (4")	(2) 80% FRM	(3) No Lambdas	(4) Pred. Income Relative Cost
Constant	0.398(0.587)	0.717(0.588)	1.198(0.523)	1.339(0.593)
$Ln(Q_{OWN})-Ln(Q_{RNT})$	2.220(0.178)	2.239(0.179)	2.364(0.176)	-
$Ln(X_{OWN})-Ln(X_{RNT})$	-0.102(0.205)	0.101(0.224)	0.167(0.203)	-
AGE (10^{-1})	-0.622(0.227)	-0.346(0.224)	-0.642(0.211)	-0.587(0.225)
$AGE^2(10^{-2})$	0.039(0.023)	0.018(0.023)	0.058(0.023)	0.066(0.022)
BLACK	-0.374(0.114)	-0.458(0.114)	-0.261(0.098)	-0.366(0.112)
MARR*	0.816(0.377)	0.243(0.371)	-0.082(0.347)	0.449(0.365)
CHILD*	0.115(0.107)	-0.048(0.102)	0.110(0.103)	0.333(0.091)
λMOVE	0.938(0.151)	0.515(0.179)	-	0.026(0.247)
λALONE	-0.157(0.074)	-0.187(0.075)	-	-0.072(0.072)
λOUTPARENT	0.300(0.115)	0.334(0.116)	-	0.338(0.116)
RELGAP	-0.709(0.070)	-0.791(0.089)	-0.924(0.062)	-0.596(0.076)
$INC*(10^{-4})$	-	-	-	0.327(0.072)
P_o/P_R	-	-	-	-1.167(0.117)
Ln(L)	-1823.4	-1834.7	-1853.6	-1844.1
LRI	0.230	0.225	0.217	0.221
Pred correctly (Random = 0.548)	0.744	0.742	0.739	0.735

TABLE A

OLS Estimation of the Log of Housing Demand

	Owner	Renter
Constant	6.720(0.461)	8.103(0.290)
Ln(INC*)	0.274(0.036)	0.230(0.025)
Ln(User Cost)	-0.637(0.028)	-0.125(0.024)
AGE (10^{-1})	-0.217(0.069)	-0.079(0.050)
$AGE^2(10^{-2})$	0.027(0.674)	0.009(0.005)
MARR*	0.140(0.110)	0.106(0.079)
CHILD*	0.127(0.029)	0.006(0.023)
BLACK	-0.192(0.041)	-0.588(0.170)
GAP(10^{-5})	-0.086(0.056)	-
λ_{SMPL}	0.087(0.059)	0.053(0.025)
λ_{ALONE}	0.018(0.030)	0.013(0.010)
λ_{OUTPAR}	-0.080(0.036)	-0.028(0.029)
Adjusted R^2	0.435	0.313
Sample size	1883	1556