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THE DEMAND FOR HOME MORTGAGE DEBT AND THE INCOME TAX

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Abstract

The goal of this paper is to learn more about the demand for the *amount* of mortgage debt owed by United States home owners. Mortgage debt is defined to be the amount of outstanding household debt secured by the owner's principal residence; mortgages for second homes and other real estate are not considered, but second mortgages and home equity loans are. The analysis focuses on the behavior of individual households and examines variations in the their demand for mortgage debt with respect to a variety of characteristics such as household income, age, education, and other characteristics of the household. Of particular interest is the responsiveness of the demand for mortgage debt to the tax rate at which interest on mortgage and consumer debt can be deducted. The 1983 and 1989 Surveys of Consumer Finance are used to estimate the demand for mortgage debt. The analysis offers strong support for the hypothesis that the demand for mortgage debt is highly responsiveness to a change in the rate at which mortgage interest can be deducted. As such, the elimination of the mortgage interest deduction can be expected to lead some households to shift away from the financing of owner-occupied housing with mortgage debt and toward the use of their own assets (equity finance).

The Demand for Home Mortgage Debt and the Income Tax

Introduction

The primary purpose of this paper is to deepen our understanding of the demand for mortgage debt and, in particular, its response to variations in the federal income tax treatment of owner-occupied housing and mortgage interest. Mortgage debt for owner-occupied housing is the single largest component of household debt. It totals about $3.1 trillion, which is almost four times larger than the $.86 trillion of consumer credit (*Federal Reserve Bulletin* 1994). Mortgage debt also represents a large portion of the value of the housing stock. Over one-third of the value of the housing stock is secured by mortgage debt and about 60 percent of all household debt is related to the purchase of a home or its improvement. About 60 percent of owner households hold mortgages or home equity loans and the median value of this debt is $44,000 (*Federal Reserve Bulletin* 1994).

Although much has been written about the supply of mortgage debt and the household's choice of mortgage type, relatively little has been written about the demand for the *amount* of mortgage debt. It is typically assumed that the demand for the amount of mortgage debt, henceforth called the demand for mortgage debt, is largely driven by the demand for housing; as the demand for housing increases, so does the demand for mortgage debt. Nonetheless, changes in the demand for housing do not alone explain all or even most of the variation in the demand for mortgage debt. As noted above, almost 40 percent of owner households have no mortgage debt; also, the standard deviation of the loan-to-value (LTV) ratio among homeowners with one mortgage is nearly 30 percent (Ling and McGill 1993). The aggregate amount of mortgage debt outstanding relative to household income also varies considerably over time. One particularly stunning example of this is provided by Eugeni (1993). He reports that the ratio of mortgage debt to disposable personal income increased from 45 percent to nearly 65 percent between 1980 and 1992.

Learning more about the demand for mortgage debt is important for reasons other than the fact that it represents a large portion of household liabilities and is understudied relative to other aspects of mortgage choice. One particularly interesting issue relates to the effect of federal income tax policy on the demand for mortgage debt. A frequently touted reform proposal calls for the elimination or the reduction in the home mortgage interest deduction (MID). If the demand for mortgage debt is insensitive to such a tax policy change, then the revenue gains from such a policy change may be as high as $50 billion a year.

Follain, Ling, and McGill (1993) (FLM), Berkovec and Fullerton (1993), Green, Hendershott, and Capozza (1996), Weicher and Woodward (1989) argue that this estimate is almost surely an overestimate of the amount of revenue to be realized. Their reasoning is as follows. The elimination of the MID represents an increase in the after-tax cost of debt financed housing relative to the after-tax cost of financing owner-occupied housing with the households own financial assets (equity finance). For households who currently deduct mortgage interest, the cost of debt finance would increase from $(1- t_y)r_m$ to r_m, where t_y is the marginal tax rate of the household and r_m is the interest rate on mortgage debt. The cost of equity finance would remain equal to the opportunity cost of using one's own equity to finance the purchase of owner-occupied housing, which is $(1-t_y)r_e$, where r_e is the expected rate of return the household earns on its equity investments. The change in the relative cost of mortgage versus equity financed owner-occupied housing would be expected to reduce the demand for mortgage debt and, in turn, reduce the expected tax revenue gains brought about by the elimination of the MID.

The reduction in the demand for mortgage debt would be generated by two separate effects. First, some households would presumably substitute their use of mortgage debt with their own equity. Households would do this by using some of their holdings of taxable financial assets to pay off their mortgage debt; also, future purchases would be less reliant upon mortgage finance. In both cases, households would reduce their holdings of taxable financial assets and their income tax liabilities on

interest and dividend income. The reduced tax liabilities would offset some of the $50 billion expected tax revenue increase.

Second, the elimination of the MID would likely have a direct and negative impact upon the demand for owner-occupied housing, which would lead to an additional decrease in the demand for mortgage debt. The demand for owner-occupied housing would decline because the elimination of the MID would increase the cost of owner-occupied housing for households who require mortgage debt in order to purchase owner-occupied housing. Such an increase would presumably reduce the demand for owner-occupied housing by these households and their demand for mortgage debt. This second part of the household response to the elimination of the MID would further reduce the tax revenue gains likely to be obtained by its elimination.

FLM generate a variety of estimates of the net revenue gain from the elimination of the MID using a simulation model of household housing and mortgage demand. One of their estimates is based upon an elastic demand for mortgage debt; under this assumption the net revenue gain is less than $10 billion. Berkovec and Fullerton use a general equilibrium model to examine the elimination of the MID. Their reasoning and their conclusions are similar to FLM. Unfortunately, neither the FLM nor the Berkovec and Fullerton estimates are based upon firm econometric estimates of the elasticity of the demand for mortgages with respect to its after-tax price.

The Tax Reform Act of 1986 (TRA) provides an interesting opportunity in which to study this issue because TRA indirectly affected the relative price of debt versus equity financed housing investment. The indirect effect of TRA upon the relative cost of debt and equity financed housing investments is analyzed by Follain and Ling (1991). They argue that the increase in the standard deduction and the reduction of the number of nonhousing itemized deductions brought about by TRA introduced an anti-mortgage debt bias for some households. This contrasts with another commonly held view that TRA should increase the demand for mortgage debt because it eliminated the deduction for

consumer credit interest. According to commonly held view, TRA may lead some households to increase their demand for mortgage credit and reduce their demand for consumer credit. Households with large amounts of consumer credit, ample nonhousing itemized deductions, and arbitrage opportunities between mortgage debt and tax-exempt bonds are most likely to do this. Although Follain and Ling identify these dual effects, their measures and those of FLM of the potential impact of TRA are limited to simulation analysis based upon assumed responses of the demand for mortgage debt to TRA. Green, Hendershott, and Capozza pursue a similar approach in their analysis of two tax reform proposals.

The centerpiece of the analysis is an econometric model in which the demand for mortgage debt depends upon the after-tax cost of equity and debt financed housing. Several specifications of the demand for mortgage debt are estimated. Some are considered structural models in which the demand for mortgage debt and the demand for owner-occupied housing are simultaneously determined. Alternative reduced form specifications of the demand for mortgage debt are also estimated. In all cases, the demand for mortgage debt is also hypothesized to depend upon a variety of other variables such as its after-tax income and the age and education of the household. These equations are estimated for the entire sample of households and particular subsamples whose demand for debt may be more or less elastic than the average for the entire sample. Subgroups include those in the top half of the income distribution, those in the bottom, those in the middle 50 percent, and those thought to be either liquidity constrained or unconstrained.

Mortgage debt is defined to be the amount of outstanding household debt secured by the owner's principal residence; mortgages for second homes and other real estate are not considered but second mortgages and home equity loans are. Demand is not defined in terms of the number or volume of mortgage originations, which are better considered to be measures of changes in mortgage demand. The same basic model is estimated with two different data sets: the 1983 Survey of Consumer Finance

(SCF) and the 1989 SCF. Ordinary least squares and two types of Tobit estimators are used because many of the households in the sample have zero amounts of mortgage debt.

The focus in this paper is on the development and estimation of the model. Future work will use the estimates to develop a simulation model capable of analyzing the impacts of changes in the tax treatment of mortgage interest on the demand for mortgage debt. Nonetheless, insights about the impact of the elimination of the MID are obtained by the calculation of the elasticities of demand with respect to individual tax rates and a comparison of these elasticities in 1983 and 1989.

The next section of the paper surveys literature pertaining to the demand for mortgage debt. The model of household behavior underlying the econometric analysis is the subject of the third section. The following section discusses the data and the many steps and assumptions used to compute household tax rates and liabilities. The estimation results are presented in the fifth section. The final section summarizes the main conclusions of the paper and explains how the model will be used in future research to examine the likely effects of changing the tax treatment of mortgage interest.

Literature Survey

The theoretical basis of the model comes from the literature on household life-cycle choice models. Several recent papers explore this literature including Brueckner (1995), Follain and Wong (1995), and Jones (1994). The emphasis is this section is upon the limited number of empirical papers on the topic as well as a few recent empirical papers in the household savings literature that also shed light on the topic. Brueckner (1994) offers some important insights about these models and the role of liquidity constraints.

Empirical Literature

Although the literature on the mortgage market is voluminous, empirical studies of the *amount* of mortgage debt demanded by households is relatively sparse. Follain (1989) identifies only a few

papers on this topic in his survey of the literature on mortgage choice. These papers and recent contributions since his survey are discussed below.

Jones (1993, 1994, 1995) is among the first to produce estimates of the demand for mortgage debt. A key part of his approach is the notion of excess mortgage demand, which is defined to be the difference between actual mortgage demand and the minimum amount needed to purchase the preferred amount of housing. The minimum amount is the difference between the household's preferred amount of housing and its net worth. He is particularly interested in the measurement of excess mortgage demand and whether it is used to invest in other financial investments. His work analyzes the 1983 and 1986 SCF and a similar survey of Canadian households. He consistently finds a positive relationship between the amount of excess mortgage demand and certain types of nonhousing investments. In his 1994 paper, for example, he finds that United States household preferences for lumpy, liquid business and investment real estate assets are especially important as generators of the demand for home mortgage debt.

A more recent example is produced by Ling and McGill (1993). They use micro-data from the 1985 and 1989 American Housing Survey (AHS) to estimate a two equation model for owners under 60 years of age. The first equation explains the probability of having a mortgage and the second explains the loan-to-value ratio (LTV).[1] Demand equations include a variety of household characteristics and are estimated for all owners with debt, recent movers, and for those with only one mortgage. They also address the potential impact of TRA by including a "potential wasted interest" variable, which measures the "maximum amount of mortgage interest that may be deducted at the zero tax rate due to the difference between the household's standard deduction and other itemized personal deductions, including property taxes." TRA increased this variable for many households because the standard deduction increased; all else equal, an increase in potential wasted interest deductions ought to reduce the demand for mortgage debt and the LTV. Estimates of the coefficient of wasted deductions

are negative and significant for non-recent movers, but the variable does not perform as expected for recent movers.

Cho, Kim, and Megbolugbe (1995) develop and estimate an elaborate model of four interrelated decisions at the time of home purchase: tenure choice, the demand for housing services, the choice of mortgage instrument, and the LTV. The analysis produces numerous insights about these various decisions; however, they do not produce estimates of the effects of household tax treatment on these decisions. Their focus upon recent purchasers also reduces the applicability of their results to the MID.

Maki (1994) examines many of the same questions being addressed in this paper, but approaches it in a very different manner. He uses difference-in-difference techniques to compare changes in the debt portfolios of high income households before and after the 1986 TRA. Both pooled time-series and cross-section data from the Internal Revenue Service and the Consumer Expenditure Survey during the 1980s are used in the estimation. Among his findings is that a one percent increase in the tax price of consumer debt increases the demand for mortgage debt by 2 percent. This result offers strong confirmation that changes in the relative tax prices of various kinds of debt and equity financing produce portfolio shuffling or substitution by households toward the tax preferred form of finance. Our paper also examines the sensitivity of the demand for mortgage debt in 1989 to the after-tax price of consumer credit so an opportunity exists to confirm his specific findings regarding the elasticity of the demand for mortgage debt to the tax price of consumer credit.

Although the amount of research on this topic that makes use of micro data is small, a larger literature that focuses on national aggregate data does exist. This type of approach was popular in the 1960s and 1970s when large-scale econometric models of the United States economy were being developed and when disintermediation in the mortgage market was an important phenomenon. A recent example is conducted by Goodman in his study of the influence of adjustable-rate mortgages (ARMs) on the housing market in the 1980s (1992). He estimates a two-equation model that explains changes in

the amounts of ARM and FRM mortgage debt outstanding as functions of the average ARM and FRM rates and lagged values of mortgage debt outstanding. Although analysis of this type is essential to understand United States mortgage market activity prior to the 1980s and special types of questions, e.g., ARM-FRM choice, it probably sheds little light on the variation in mortgage demand among households and, in particular, changes in the tax treatment of mortgage interest.

Another variant of this approach makes use of mortgage data at the metropolitan area level; Megbolugbe, Cho, and Rubin (1993) are pursuing this approach. They estimate a multi-equation model of the housing and mortgage market that explains, among other things, the number of mortgage originations within each metropolitan area. This is a promising area of research because it has the potential to shed much light on the demand for mortgage debt; this is especially true if one believes that the supply of mortgage debt to individual metropolitan areas is very elastic. A problem with this approach is the difficulty of measuring the amount of debt outstanding or changes in it at the metropolitan area (versus the number of mortgage originations). Another data difficulty arises because the sources of the supply of mortgage debt to any metropolitan area are diverse and most likely to be from lenders or portions of the capital market outside the metropolitan area.

Household Savings Behavior

Most of the papers discussed above pertain to the analysis of housing; however, the analysis is similar in many ways to several recent analyses of the consumer savings behavior. Because both of these literatures are struggling with many common problems, consideration of the savings literature provides some insights regarding the demand for mortgage debt. This is especially true regarding empirical analysis because this literature makes use of similar data sets, e.g., SCF, and contains more empirical analysis. Papers in this category include those by Scholz (1994), Gale and Scholz (1992), Poterba (1993), Venti, and Wise (1993), and Skinner and Feenberg (1990).

The work in this paper is similar to recent work done by Scholz. His paper contains numerous tables comparing components of the household portfolios in 1983 and 1989 by various groupings of households, e.g., income class. The primary differences between this work and his is threefold. First, this paper places a greater focus on mortgage debt and its relationship to housing demand and consumer credit. Second, this paper focuses exclusively on home owners. Third, demand equations are estimated in this paper whereas his work consists of detailed cross-tabs of various types.

Gale and Scholz are interested in the impact of IRAs upon savings. They perform both analytical and empirical work. The analytical work employs a quadratic utility function that depends upon consumption and expected future income. The budget constraint takes account of the returns to savings and the special benefits and limitations associated with IRAs. Their empirical work uses the 1983 and 1986 SCF and includes simple cross-tabs and econometric results. They focus only on IRA savings and non-IRA savings.

Poterba et al. (1993) add a third form of savings, the 401(k) savings. They analyze three cross-sections using the 1984, 1987, and 1991 Survey of Income and Program Participation (SIPP). Their statistical analysis is quite simple and makes use of "natural experiments" provided by the "essentially exogenous determination of 401(k) eligibility, which is determined by employers. A regression model is estimated using the median values of the three savings variables and median incomes for a variety of subgroups based upon income and eligibility rules.

Skinner and Feenberg (1990) are primarily focused upon the impact of TRA upon household savings, but they do offer some interesting information regarding the interaction between the deductions for mortgage interest and consumer credit. Using a matched but nonrandom sample of itemizing households that straddles TRA, they estimate several simple but provocative regressions. One explains the change in the MID for a taxpayer as a function of a variety of variables including the change in the amount of personal interest deductions. The coefficient on this last variable is -.67, which they interpret

as the responsiveness of mortgage demand to a change in the treatment of consumer interest. They also estimate the change in the mortgage deduction as a function of the after-tax mortgage rate and find a significant negative relationship. Although specification and estimation procedure are relatively simple, the results do suggest that many itemizing households made adjustments to TRA and are worthy of serious consideration.

The last paper discussed in this section is by Berkovec and Fullerton (1992) and is quite relevant to the topic of this paper and deserves special attention. They develop a computable general equilibrium model in order to explore the likely consequences of altering the tax treatment of owner-occupied housing. The model allows households to invest in a variety of risky assets and to consume housing; the household can either rent or own its housing. Households may also borrow in order to finance their investment and consumption choices. The model is calibrated to the 1983 SCF. They do some estimation in order to parameterize their model, but this is not the primary focus on their exercise. They find that the elimination of the MID would have a modest impact upon housing demand, consumer welfare, and government tax revenue.

An important distinction exists between their model and the one estimated in this paper. They develop a general equilibrium model primarily designed to capture the interactions between the tax treatment of owner-occupied housing and other asset and liability markets within the economy. The general equilibrium approach allows for changes in the level of before-tax rates of return on the various assets and liabilities throughout the economy; for example, the mortgage interest rate is allowed to decline in response to a change in the tax treatment of mortgages. Our paper focuses on the estimation of elements of their model that are particularly relevant to the analysis of the MID. More specifically, our paper focuses on the demand for mortgage debt whereas their model makes no distinction among different kinds of debt.

Model Specification

The empirical specification of the econometric model of the demand for mortgage debt is the topic of this section. The discussion begins with the presentation of a general theoretical model of household choice underlying the empirical specification. The solution to the most general version of the model is also quite general and complex, but the essential elements of the empirical specification can be observed by examining the solution to special cases of the model. Several of these special cases are discussed. The final part of this section presents the empirical specification of the model.

Theoretical Basis[2]

Various theoretical models can and have been used to discuss mortgage choice and the demand for the amount of mortgage debt. All of these models share some common characteristics. The most important of these is the combination of a utility function that includes housing services, nonhousing consumption, and future wealth with a budget constraint that depends upon the returns to financial investments, initial wealth, and possible appreciation in the value of the price of the housing asset. The primary differences among these models pertain to the treatment of liquidity constraints and the manner in which uncertainty is introduced. The model presented in Alm and Follain (1987) is a useful summary of this class of housing finance models and serves as the starting point for the development of the empirical model of the demand for mortgage debt.

In this model, households choose c (nonhousing consumption), h (housing services), B_e (the risky financial asset), and M (mortgage debt) in order to maximize expected utility.[3] That is, households

$$Max \quad EU = U(c,h) + F[EW, \sigma^2(W)] \qquad \textbf{(1)}$$

subject to:

$$W_1 + I = P^c c + P^H H - M + B_e \qquad \textbf{(2)}$$

and

$$EW = (1 + r_p - \tau_p - d)P^H H - (1 + Er_m)M + (1 + Er_e)B_e + (1 + Er_I)I - t_y(I + Er_e B_e) + t_m(Er_m M + \tau_p P^H H) \quad \textbf{(3)}$$

and

$$\sigma^2(W) = E[(W - EW)^2] \quad \textbf{(4)}$$

where W_1 is wealth at the beginning of the first period; I is income in the first period; P^c is the price of nonhousing consumption in the first period; P^H is the price of one unit of housing stock at the beginning of the first period; r_p is the expected appreciation of housing; r_m is the mortgage interest rate; r_e is the expected return to the risky financial asset; r_I is the expected increase in salary income; d is the depreciation rate on housing; and, τ_P is the property tax rate. t_y is the marginal income tax rate faced by the household and t_m is the tax rate at which mortgage interest and the property tax can be deducted. t_m would typically equal t_y for households who itemize deductions and zero for those who take the standard deduction. W represents wealth at the end of the period and is a random variable; E is the expected value. $\sigma^2(W)$ represents the variance of household wealth; as such, it depends upon the variances and covariances of the returns to each component of the portfolio and the shares of the portfolio allocated to the various assets and liabilities. In principle, adding consumer credit to the model poses no serious problems. One simple way is to introduce a second liability, consumer credit, with its own interest rate, which can be fixed or variable.

Several types of restrictions are usually placed upon the solution to the model. Short selling of the assets is typically prohibited. Neither are households allowed to invest at the mortgage rate nor the consumer credit rate; that is, the minimum amounts of mortgage and consumer credit are zero. Three types of liquidity constraints are also usually part of a model of household mortgage choice because

they seem to be so prevalent in the market for housing and mortgages. The first is a nonnegative savings equation, which can be stated as $B_e \geq 0$, which implies that $I + W_1 + M - P^c c - P^H H > 0$. The second is a downpayment constraint, which limits the size of the mortgage to be less than some fraction of the value of the house, i.e., $M \leq \lambda P^H H$. The third limits mortgage payments to be some fraction of income, e.g., $r_m M \leq \alpha I$. These latter two constraints stem from commonly practiced mortgage underwriting criteria.

Solutions of the Model

Both analytical and numerical solutions have been offered for various versions of this model, e.g., Alm and Follain, Brueckner (1994), Henderson and Ionnides (1982), Jones (1995), Schwab (1982), and others. Brueckner's (1995) analysis is particularly helpful in formalizing the intuitive argument presented in the introduction; the following discussion relies heavily upon Bruckner's analysis.

Consider a simpler version of the model in which the third liquidity constraint is ignored and the returns to the investments and the cost of the various types of debt are also known with certainty. Short-selling of the risky asset and negative balances for mortgages and consumer credit are prohibited. In this case, the solution is obtained by a two-step process. Households first analyze the budget constraint to identify the cheapest form of financing. If debt is used, then only the cheapest form of debt is used; furthermore, debt is used only if its cost is less than the return on equity. Given the optimal form of financing, a unique and least cost budget set is defined.

In step two, households solve the revised utility maximization problem, which yields solutions for c, H, and, possibly, the amount of debt to be used. Implicit in the solution is the amount of equity to be used as a downpayment, i.e., $E = P^H H - M$. The values of the endogenous variables (c, H, and M) depend upon the preferences of the household and the exogenous variables in the model: initial wealth, income, and the prices of housing and nonhousing consumption, respectively. Mortgage demand equals

the maximum amount if its cost is less than the cost of consumer credit and cheaper than the cost of equity finance (i.e., the return to the financial asset B_r). Mortgage demand equals zero otherwise. According to this model, the demand for mortgage debt is highly elastic with respect to a change in the cost of debt if the cost of debt and equity are similar; otherwise, the elasticity is quite small.

Adding income tax considerations does not change the basic logic of this solution, but does introduce insights into the ways in which tax policy affects the relative cost of debt and equity. If the household has enough nonhousing expenses to itemize regardless of whether it uses mortgage debt and if mortgage interest and consumer credit are deductible, then the after-tax cost of mortgage debt is simply $(1-t_y)r_m$, the after-tax cost of consumer credit (r_c) is $(1-t_y)r_c$, and the cost of equity finance is $(1-t_y)r_e$. This produces a situation exactly as stated above; the household uses the maximum amount of the cheapest form of financing.

The introduction of income tax considerations becomes more interesting if variations in the tax rate at which debt and equity can be deducted. First, consider the case in which all forms of debt are deductible, the pre-tax cost of debt and equity are the same, but the household has the opportunity to invest at the tax-exempt interest rate, which is usually assumed to depend upon the marginal tax rate of the marginal investor in tax-exempt debt. If the household has a tax rate above the tax rate of the marginal investor in tax-exempt bonds, then the solution tilts toward the usage of mortgage financing, all else equal. In this case, the borrower would presumably borrow the maximum allowable mortgage amount (the value of the house or some fraction of it). In fact, the borrower would probably purchase a larger house than in the previous case in order to take advantage of the arbitrage opportunity.[4] This case probably applied to many households in 1983 because of the progressivity of the tax rate schedule and the prevalence of tax-exempt bonds. The case probably applies to a lesser number in 1989 because of the reduction in the tax rates on the top income brackets and the provisions of TRA that tightened the restrictions needed to issue tax-exempt debt. Second, if the cost of consumer credit is not

deductible but the cost of mortgage debt is deductible, the solution tilts in favor of the use of mortgage debt. This has been the case since the provisions of the 1986 TRA were became fully effective (1989).

The third case applies if nonhousing expenses are insufficient to allow the household to itemize expenses. If the household cannot itemize, then the MID does not apply. As such, the solution tilts toward the use of equity finance. In this case the after-tax cost of mortgage debt equals r_m and the after-tax cost of equity finance remains $(1-t_y)r_e$. As FLM and others point out, this situation likely applies to many households after TRA because the standard deduction increased and the number of nonhousing expenses allowable as deductions decreased.

Adding liquidity constraints can alter the solution. If a household is liquidity constrained, then the marginal cost of another dollar of debt is the after-tax cost of debt minus the shadow price associated with the liquidity constraint. This may apply to the case of a first-time borrower who has a strong preference for owner-occupied housing and expects future income growth. All else equal, the solution tilts in favor of the use of debt for the liquidity constrained borrower. This makes for an interesting situation if the borrower is the young, prospective homebuyer with limited equity and nonhousing deductions. Namely, tax considerations alone may favor the use of equity finance; however, the addition of a binding liquidity constraint tilts the solution toward the use of debt.

Adding uncertainty regarding the returns to the risky investment alters the situation considerably. Alm and Follain analyze a case numerically in which utility is given by an isoelastic utility function. In this case, many of the basic results in the certainty case seem to hold up; however, the answers were quite sensitive to the parameterization of the problem, especially the assumed values of the cost of debt and the expected returns to the risky assets. Brueckner also analyzes the demand for mortgage debt in the more general case with uncertainty and liquidity constraints. The analytical solution depends upon the preferences for risk and the nature of the distribution of returns.

Unfortunately, the clear cut relationships between the demand for mortgage debt and the after-tax cost of mortgage debt are not as apparent in the more general case.

Empirical Specification

Ideally, the demand for mortgage debt would be specified as one of a system of demand equations that stem from the models just discussed. The system would include a demand for housing, a demand for nonhousing consumption, asset demand equations, as well as equations to explain the demand for mortgage and consumer debt. The exogenous variables in the system would include the wealth of the household in the initial period, income, the price of housing and nonhousing consumption, as well as the after-tax prices of mortgage and consumer debt, and the after-tax returns to various types of financial assets.

This is an extremely challenging problem for a variety of reasons and, to our knowledge, no attempt to estimate this system appears in the literature. The primary reason is the absence of data on household choices, especially nonhousing consumption, and data regarding the after-tax returns to the various assets and liabilities. The system of equations would also be expected to be highly nonlinear in the more general cases. Another problem is that the solution to the maximization problem is often a corner solution if the price of one liability is less than another or if an arbitrage opportunity exists. The problem is even more complex in the presence of liquidity constraints. Because of these problems, empirical work must choose to estimate a portion of the overall set of first-order conditions.

Our approach takes a simpler and more tractable route and focuses on one equation in this system: the demand for mortgage debt. Two versions are examined. The first is simply the reduced form equation for the demand for mortgage debt. The critical exogenous variables are the after-tax cost of equity financed housing investments, mortgage debt financed housing investments, and the after-tax cost of consumer credit. In addition, the demand for mortgage debt depends upon wasted deductions, after-tax household income, and other variables that may capture household preferences.

The effects of the various tax prices are captured as differences between the various tax prices. One variable measures the difference between the tax price of equity investments and the tax price of mortgage debt; the other measures the difference between the tax price of consumer credit and the tax price of mortgage debt. The distribution of these two variables in provided in Table A-1. About one-third of households have nonzero differences in the first measure in 1983 and about one-quarter in 1989. The tax price of mortgage debt and consumer credit were the same in 1983, but over two-thirds of the 1989 sample had nonzero differences in these two tax prices.

The reduced form equation is:

$$\ln M = \alpha_0 + \alpha_1[(1 - t_y)r_e - (1 - t_m)r_m] + \alpha_2[(1 - t_c)r_c - (1 - t_m)r_m] + \alpha_3 WASTDED + \alpha_4 \ln Y_T + \alpha_5 Z \quad \textbf{(5)}$$

where *WASTDED* is the difference between the standard deduction and the amount of nonhousing itemized expenses available to the household; Y_T is household after-tax income; and Z is a vector of other exogenous variables that may affect the demand for mortgage debt. Net worth is excluded from this version of the reduced form because, strictly speaking, it is an endogenous variable; however, results are presented with and without net worth to highlight the impact of its treatment on the results of primary interest, i.e., α_1 and α_2.

The coefficients of both tax price variables (α_1 and α_2) are expected to be positive; an increase in the cost of equity finance and the cost of consumer credit increases the demand for mortgage debt, all else equal. The sum of the two coefficients ($\alpha_1 + \alpha_2$) measures the impact of an increase in the cost of mortgage debt on the demand for mortgage debt; an increase in the tax price of mortgage debt (a decrease in the $t_{m)}$ reduces the demand for mortgage debt by $(\alpha_1 + \alpha_2)dt_{m.}$

The second approach estimates what may be considered a structural equation in which the demand equation for mortgage debt is allowed to depend upon the demand for housing. According to

this model, the demand for mortgage debt equation is modified to include the value of the house purchased. A separate reduced form equation for the value of the house is also specified in which housing demand is specified similarly to the reduced form for the mortgage demand equation. That is,

$$\begin{aligned} \ln M &= \alpha_o + \alpha_1\left[(1-t_y)r_e - (1-t_m)r_m\right] + \alpha_2[(1-t_c)r_c] \\ &\quad + \alpha_3 WASTDED + \alpha_4 \ln Y_T + \alpha_5 Z + \alpha_6 \ln H \qquad \textbf{(6)} \\ \ln H &= \beta_o + \beta_1 UCOWN + \beta_2 WASTDED + \beta_3 \ln Y_T \end{aligned}$$

where H is the value of the house owned by the household; all other variables have been defined previously. The only difference between the reduced form equations for H and M is the specification of the tax price terms. *UCOWN* is used the measure of the user cost of owner-occupied housing in the housing equation and is specified to be a fixed and simple average of the after-tax cost of equity and mortgage financing. The critical coefficients in the second approach are α_1, α_2, and α_6. β_1 should shed light on the price elasticity of the demand for housing; as such, it should be negative and near minus unity as is often the case in empirical studies of the price elasticity of housing demand.

Liquidity Constrained

As discussed above, the specification of the model applies best to those who are not liquidity constrained, i.e., are unconstrained. The demand for mortgage debt by those who are liquidity constrained is influenced by the nature of the constraints and the extent to which they are binding. To consider the differences between the demand for mortgage debt between these two groups, the demand for mortgage debt is estimated for all households, those defined to be unconstrained, those defined to be constrained, and some other subgroups of the population.

The definition of liquidity constrained follows Duca and Rosenthal (1994) and several other authors. The definition makes use of the answers to several questions asked of households in both the 1983 and 1989 SCF. In brief, a household is defined to be constrained if it has been denied credit and did not reapply or the household believed it would be denied. Follain and Wong (1995) use the same definition to replicate the original Duce-Rosenthal results for the 1983 SCF and to study the 1989 SCF. They also compare the Duca-Rosenthal approach to the approach used by Linneman and Wachter (1989) in their study of the 1983 SCF. Linneman and Wachter focus upon payment to income ratios and the net worth of households to define the liquidity constrained. The Duca-Rosenthal definition is used for two reasons over the Linneman-Wachter definition. First and foremost, the lack of geographical information in the 1989 SCF preclude the possibility of using the Linneman-Wachter definition. Second, Follain and Wong find that the Linneman-Wachter definition probably overstates the number of liquidity constrained, especially the portion of the definition associated with high payment to income ratios.

Data Description and Variable Definitions

The data sets employed in this analysis are the 1983 and 1989 SCFs. Each survey collects substantial information about the assets and liabilities of a sample of United States households. Both surveys have been the subjects of numerous papers, some of which are cited above, e.g., Jones, Scholz, and Berkovec and Fullerton. Complete descriptions of the data sets and the survey methodologies used are provided in several places; one recent paper by Kennickel and Shack-Marquez (1992) provides a comparison of the 1983 and 1989 SCF and discusses some of the differences in sample design. Because so much has been written about these surveys in other places, the discussion in this section focuses on the manner in which the SCF data sets are employed in this particular study, the construction of several key variables, and the analysis of some simple statistics.

Sample

Unlike much of the work done with the SCF, our analysis is restricted to home owners. There are 2,794 owners in the 1983 survey and 2,176 in the 1989 survey. A variety of statistics based upon the full sample are presented in Tables 1 through 3. The samples used in estimation are restricted to observations with net worth and after tax income greater than zero and which contain a reported level of education for the head and spouse (if married). Thirteen observations were dropped in 1983 owing to these restriction and 83 observations were lost in the 1989. A variety of statistics about the actual sample are presented in Tables A-2 and A-3.

Two other aspects of the specific sample used in this paper deserve mention. First, unlike the 1983 SCF, the 1989 public use tape provides virtually no information about the location of the household or the county in which it lives. The lack of locational information is a potentially important limitation in a study of housing demand since housing prices vary among housing markets. This issue is addressed by estimating the various equations of the model with and without certain locational

information in 1983 to obtain some insights about the likely sensitivity of the 1989 results to the omission of location information. Three measures of the county in which the household resides are used to capture the influence of housing prices; these are the median income, median house value, and the number of households of the county.

Second, the 1989 SCF includes five observations per household. Each observation contains a different set of measures of the variables for which values are imputed. For example, an equation is used to predict the value of a particular asset for those households in which information on this asset is missing; five different estimates are generated using five different random error terms. This has certain statistical advantages over the traditional practices used to impute values for missing observations and to develop estimates of certain population characteristics, e.g., net worth. Since the focus in this paper is on estimation of an econometric model, only one observation per household is used. For those observations in which a some information is imputed, a simple average over the five observations is employed. Only financial variables are affected by the imputation.

Variable Definitions

Most of the variable definitions are self-explanatory, but several do require some explanation. Consider first the definition of mortgages. The book value of all mortgages associated with the primary residence of the household is reported along with the book value of the first mortgage. Consumer credit includes installment credit, automobile loans, and credit card debt; it is designed to measure short-term credit available to the borrower that was deductible in 1983 and is not deductible after TRA is fully phased in. Net worth is computed with and without pensions. The 1983 SCF reports both values; unfortunately, accurate estimates of pension wealth are more difficult to obtain in the 1989 SCF because less information is provided. The estimate of pension wealth in 1989 are surely understated. At a minimum it excludes the present value of Social Security payments, which is included in the 1983 SCF. For this reason the estimation results use only net worth without pensions.

The SCF provides information about each household's adjusted gross income (AGI) in 1982 and 1988, but not enough information is available to compute the tax liability of each household. Therefore, it is necessary to compute and assign tax information to each household using a variety of assumptions in order to define tax liability and the appropriate marginal tax rates. The specification employed in this paper takes account of the filing status of the household, whether it itemizes or not, and the progressivity of the income tax schedules. Household taxable income (Y_T) equals adjusted gross income (AGI) less exemptions and deductions; deductions equal either the amount of itemized deductions or the standard deduction, which ever is greater. The household's tax liability (TAX) is constructed as follows:

$$TAX = \sum_{i=1}^{TB-1} t_{yi} \, (YB_{i+1} - YB_i) + t_{yTB}(Y_T - YB_{TB}) \qquad \textbf{(7)}$$

where YB_i is the income level associated with the top portion of the ith tax bracket of the household and t_{yi} is the marginal tax rate associated with the ith bracket. TB is the tax bracket of the household.

An important issue is the computation of itemized deductions. This is done using the same approach and information used in Ling and McGill. They estimate equations for each major category of itemized deductions with the 1985 Treasury tax file. These regressions explain the amount of each category of deductions as a function of adjusted gross income and the number of dependents in the family. Some of the equations use information about the state in which the household resides and is used in the 1983 estimates. The lack of geographical information in the 1989 SCF precludes the use of this geographical information in 1989. The same equations are used to predict itemized deductions in both 1983 and 1989.

Once an estimate of the amount of itemized deductions is computed, the remaining tax calculations are relatively straightforward. First, information from the SCF about the size of the household and the age of the household members is used to identify the filing status of the household,

e.g., filing separately, married filing jointly, or single taxpayer. Second, the household's tax liability is computed for both the standard deduction and itemization; the treatment that minimizes tax liability is chosen. Third, all mortgage and consumer credit interest payments could be claimed as itemized deductions in 1982; only 40 percent of consumer credit interest was deductible in 1988. Information about the property tax payments of each household is not provided and is not included in the analysis.

Because the model is estimated using two separate cross-section samples, the expected before-tax costs of new mortgage debt, consumer credit, and the return to equity are presumably constant among all households in the samples. As a consequence, variations in the after-tax costs of mortgage debt, consumer credit, and the return to equity are determined solely by the tax rates at which the two forms of debt are deducted and the tax rate on equity income. The various tax rates are computed as follows. The marginal tax rate on equity is defined as the marginal tax rate on income before any interest deductions are made. This "first marginal tax rate" is done to avoid the possible simultaneity bias introduced by defining the marginal tax rate as a function of actual deductions. These rates reflect the income tax rate schedules in 1982 and 1988. The tax rate at which mortgage debt is deducted equals the first marginal tax rate if the household itemizes and zero if the household takes the standard deduction. The tax rate at which consumer credit is deductible equals the tax rate at which mortgage debt is deductible in 1983. In the 1989 results, t_c equals 1-.4t_m if the household itemizes and zero otherwise.[5]

Statistical Summary

Tables 1 and 2 summarize the information about the full samples of home owners in both 1983 and 1989. The mean and median are presented for each variable. In addition, both weighted and unweighted statistics are presented in order to demonstrate the sensitivity of the population estimates to the presence of the high income sample. Several aspects of the data particularly relevant to this study are identified and discussed.

Consider, first, the characteristics of housing and mortgage debt. Median nominal house value was $53,000 in 1983 and $75,000 in 1989. The consumer price index increased by about 25 percent between these two years, which indicates that the real value of housing demand increased by 16 percent. Housing was a larger portion of total household assets in 1983 than in 1989, falling from the mid-sixties to about 50 percent. House values seem to have risen much less rapidly than the values of nonhousing assets, yet the ratio of house value to total assets remains above 50 percent for most households.

Home mortgage debt consists primarily of the first mortgage and averages about $7,000 in 1983. Forty percent of owner households have no mortgage debt in 1983 and 36 percent have no mortgage debt in 1989. A small portion of households have a second mortgage, about 6 percent. An even smaller group has a third mortgage. Home equity lines of credit are included in 1989, but not in 1983; even these were relatively rare in 1989. Although outstanding balances of consumer credit are typically smaller than the amount of outstanding mortgage debt, more people have some consumer credit than some mortgage credit.

Forty four percent of households are estimated to have itemized in 1983 and about forty six percent in 1989. Median after-tax income increased by nearly 30 percent between 1983 and 1989 and the median tax liability actually declined among this sample. The first marginal tax rate and the final marginal tax rate (the rate after deductions are included) are similar and average about 22 percent in 1983 and 15 to 16 percent in 1989. This decline presumably reflects the lower marginal tax rates schedule associated with TRA. The median wasted deduction rose from $1,671 to over $2,800 between 1983 and 1989, which is also consistent with the increase in the standard deduction associated with TRA.

More detailed information about the characteristics of household debt is provided in Table 3. The information is divided among four income quartiles and the itemization status of the household.

Unweighted numbers are used to provide a sense of the distribution of the actual data used to estimate the model.

Several patterns are apparent. First, the relationship between income and the demand for mortgage debt is modestly positive. The average amount of all mortgage debt is higher in the highest income category than the lowest income category, but the averages among the first three income groups do not reveal a strong positive relationship. In fact, the fraction of the sample that holds any type of home mortgage declines among the itemizes as income increases; a modest positive relationship holds among those who do not itemize.

Second, itemizers uniformly hold more of all types of debt than those who do not. The average amount of home mortgage debt among itemizers is about ten times the average amount held by those who take the standard deduction in 1983; the ratio of these averages is nearly twenty to one in 1989. The holdings of consumer and automobile loans among itemizers exceed those among non-itemizers, although the differences are not as stark as among the holdings of mortgage debt.

Third, increases in the average holdings of mortgage debt between 1983 and 1989 were greater among itemizers than among non-itemizers. The changes in the average holdings of mortgage debt among the non-itemizers are roughly in line with the change in the consumer price index over this period. Such is not the case among itemizers. The average holdings of mortgage debt increased by a substantially larger amount. The increase in total mortgage debt was large relative to the increase in first mortgage debt.

Fourth, although average mortgage balances tended to increase, the number of households with some type of mortgage tended to decline. This is especially true among the itemizers. For example, the percentage of itemizers with some type of mortgage debt declined from 94 percent to 69 percent.

Fifth, LTVs for home purchase declined among most groups. LTVs among the non-itemizers changed very little, but they did decline. They averaged about 12 percent in 1983 and 11 percent in

1989. The decline among the lowest income group of non-itemizers is two percentage points from 11 to 9 percent. The major exception is the top income quartile group of itemizers. Their average increased from 22 to 26 percent.

A sixth and related pattern pertains to the use of consumer credit. The average amount of consumer credit and the proportion of households with some consumer debt declined substantially between 1983 and 1989. Again, this is especially true among itemizers. The decline in the average amount of consumer debt is especially clear; it declined from $44,249 to $1,316. Some of this is no doubt due to outliers among the highest income class in 1983; nonetheless, the pattern seems significant. A similar pattern appears with respect to the use of automobile loans to purchase automobiles. The average ratio of car loans to the value of vehicles declined among all groups. The average among itemizers declined from 41 to 31 percent. These results are consistent with the hypothesis that home owners decreased their use of consumer credit to finance automobile purchases and placed more reliance upon home equity loans and automobile leasing.

In sum, much of the evidence seems consistent with the hypothesis that TRA had a substantial impact on the use of debt among households. The decline in consumer debt among itemizers and the rise in their average holdings of mortgage debt seem especially consistent. The low holdings of mortgages among non-itemizers is consistent with their tax treatment, although it seems that little changed between 1983 and 1989. Despite these broad patterns, the information in Table 3 suggests that the variation in the usage of mortgage and consumer debt, LTVs, and housing demand is substantial. As a consequence, the examination of the hypotheses regarding the demand for mortgage debt seems to require a multivariate econometric model.

Estimation Procedure and Results

Procedure

The primary econometric problem associated with the estimation of the demand for mortgage debt is the large number of households with little or no outstanding mortgage debt. As a consequence, the observed amount of mortgages is censored and ordinary least squares (OLS) estimates of the coefficients of the mortgage equation coefficients and σ^2 are biased. The Tobit estimator is used to address this problem. Tobit is a maximum likelihood estimator takes into account the censoring and produces unbiased estimates of the coefficients and σ^2. The specific estimator used to estimate the reduced form equation is the maximum likelihood procedure in LIMDEP Version 7.0 (1995). The Tobit direct or marginal effects of each variable and their standard errors are computed using the Wald procedure in LIMDEP.

The second version of the mortgage demand equation includes housing demand as an additional right hand-side variable. If housing and mortgage demand are simultaneously determined, then a potential bias in the estimates of the mortgage demand equation exists with the Tobit estimator. A simultaneous Tobit estimator available in LIMDEP is used to account for potential simultaneous equations bias between housing and mortgage demand. This approach also allows for an explicit test of whether housing demand is exogenous and provides asymptotically efficient estimates of the standard errors.

Results

The estimates of the mortgage demand equations are presented for a variety of estimators, model specifications, and subsamples in order to shed light on the robustness of the key results. Table 4 reports the estimates of mortgage demand for a variety of specifications and estimators for a sample of the 1983 SCF that includes all but those designated as high income households.[6] The marginal effects

associated with one specification of the reduced form equation and various subsamples of the 1983 SCF are presented in Table 5. The marginal effects are computed as:

$$\frac{dln\ M}{dln\ x_i} = \Phi(\bar{x}\beta/\sigma)\beta_i \qquad \textbf{(8)}$$

where β_i is the coefficient of x_i , and $\Phi(.)$ is the normal cumulative distribution function evaluated at the mean value of *x*. Tables 6 and 7 contains the same results for the 1989 SCF. Estimates of the housing demand equations for 1983 and 1989 obtained with the use of the simultaneous Tobit are contained in Tables A-4 and A-5.

The coefficient of the difference between the after-tax cost of equity and mortgage debt finance ($(1-t_y)-(1-t_m)$) is the focal point of this research.[7] The coefficient in the first column of Table 4 is 7.84 and statistically significant; column one contains estimates of the reduced form equation for the natural log of mortgage demand obtained by OLS. The second column reports estimates of the reduced form obtained by the Tobit estimator; the critical coefficient is 8.69 and highly significant. The next four columns use the loan to value ratio as the dependent variable; the first two are based upon the book value of debt and the last two are based upon the market value of the debt.[8] Again, the estimated coefficients of the tax price variable are all positive and significant.

The last four columns of Table 4 use the simultaneous Tobit estimator and examine the relationship between the log of mortgage debt and the log of house value; net worth and an instrumental value for net worth are also included. The main point to note is that the estimates of the coefficient of the difference in the cost of equity and mortgage debt are all positive and significant; they are also smaller than the reduced form coefficient estimates. This suggests that the reduced form coefficient is capturing two separate effects. The first is the substitution away from debt toward equity in response to a hike in the tax price; the other is caused by the reduction in the demand for housing caused by the increase in the tax price of debt.

The test for the exogeneity of housing value in the mortgage demand equation rejects exogeneity in all cases, which suggests the simultaneous Tobit estimator is appropriate. On the other hand, the coefficient estimates of home value seem excessively large. Other aspects of the simultaneous Tobit results reveal some differences and similarities to the Tobit estimator of the reduced form. Using net worth or an instrument for net worth has little impact on the results or on the coefficient of net worth. The pattern for the age variables is similar to that obtained for the reduced form model with the Tobit estimator; so is the estimate of σ. Another interesting result is the increase in the size of the coefficient of income with the simultaneous Tobit estimator.

Several important conclusions emerge from an examination of the marginal effects reported in Table 5.[9] First, the effect of the tax price variable is positive and significant for a variety of subsamples. Second, the magnitude of the response is substantial. For example, a decrease in the tax rate at which mortgage debt is deductible (an increase in the tax price of mortgage debt) from .28 to .18 reduces the demand for mortgage debt by 66 percent, which implies the elasticity of the demand for mortgage debt with respect to the tax rate at which it can be deducted is about -1.5. Third, the elasticity appears to be larger for the higher income subsamples than for lower income subsamples. Consider, for example, the coefficient for the top 50 percent subsample (13.58) versus the one for the bottom 50 percent subsample (3.46). The only possible anomaly pertains to the estimates for the unconstrained and constrained households (6.08 vs 11.64). We expected the elasticity for the unconstrained group to be higher. The unexpected result may reflect a problem with our definition of constrained or the small number of households defined to be unconstrained.

The estimates of the other coefficients in the demand for mortgage equation also generate some interesting insights. First, note that the elasticity of the demand for mortgage debt with respect to after-tax income is consistently positive and significant for the large sample; however, the elasticity seems to differ substantially among the income groups. It is negative for the high income groups and positive for

the low income groups. Second, net worth is negatively related to mortgage demand for the large sample. Both of these suggest the potential importance of liquidity constraints in the demand for mortgage debt. Third, our measure of wasted deductions does not perform as expected. It is usually the wrong sign and often insignificant. Fourth, age has an important and nonlinear impact on the demand for mortgage debt and the pattern of the coefficient estimates seems stable across specifications. The relationship is positive until the household head is in his or her mid-thirties and then it becomes negative (using the results in column 3 of Table 5).

The results for 1989 are generally consistent with those for 1983. Consider, first, the impact of the tax price on the demand for mortgage debt, which is computed as the sum of the coefficients of the first two variables in Tables 6 and 7.[10] For example, the impact of the tax price of mortgage debt is given by 13.37 + 7.96 in Table 7 for the Tobit estimator of the reduced form. The reduced form estimates of this sum obtained using Tobit are consistently positive and significant.[11]

Second, as with the 1983 results, the elasticity of mortgage demand with respect to the tax price based upon the Tobit reduced form results is even larger than the estimate obtained using the 1983 results. For example, the results for the unconstrained sample in Table 7 indicate an elasticity of mortgage debt with respect to the tax rate at which mortgage debt is deductible of about -3.5. The 1989 results also suggest that the elasticity estimates are modestly larger for high income households than for households in the lower half of the income distribution, but unlike the 1983 results, the differences are more modest.

The 1989 results are sensitive to the estimator used. Although the Tobit estimates of the reduced form make sense, the estimates obtained using the simultaneous Tobit and OLS do not always perform as expected. The coefficient estimates of the two tax price variables are generally positive and significant, but this is not so in two cases. Note, also, that the coefficient of house value is large and

varies among specifications. Such sensitivity leads us to prefer and focus upon the Tobit reduced form estimates.

The estimates of the other coefficients in the demand for mortgage equation reveal some differences and similarities between the 1983 and 1989 results. First, the elasticity of the demand for mortgage debt with respect to after-tax income is typically insignificant using the full sample in 1989, unlike the positive and significant relationship obtained in 1983. However, it is positive and significant for constrained households and those in the bottom portion of the income distribution as in 1983. Second, net worth is negatively related to mortgage demand for the large sample in four of the five specifications as in 1983. Third, just as in 1983, our measure of wasted deductions does not perform as expected. Fourth, age also has an important and nonlinear impact on the demand for mortgage debt. The pattern of the coefficient estimates is not as stable among specifications in 1989 as it is in 1983; however, the age at which the relationship shifts from positive to negative is in the low thirties (using the results in column 1 of Table 7) , which is quite consistent with the 1983 results.

The 1989 results also shed some light on the impact of the elimination of consumer credit interest as a deductible item. The coefficient of the variable that measures the difference between the cost of consumer credit and mortgage debt is generally positive and significant, as expected. The elasticity of the demand for mortgage credit with respect to the tax price of consumer credit is -1.5 for the reduced form estimate obtained using all households (column 1 of Table 7), which is similar to the result obtained by Maki. What is surprising is the variation in the coefficient among income groups. The coefficient estimate is actually negative for high income households and positive for lower income households. This may be correct, but it does seem at odds with the dramatic change in the use of consumer credit by households in the top income bracket revealed in Table 3. Further research on this issue should probably distinguish between home equity debt and other mortgage debt.

The 1989 data allow an examination of the relationship between mortgage type (adjustable rate versus fixed rate mortgage). The simultaneous Tobit analysis includes mortgage type as a right hand side variable and its coefficient is positive: those with an adjustable rate mortgage demand more debt than those with a fixed rate, all else equal. We view this as preliminary and suggestive. More work along these lines would be interesting to pursue.

Conclusions

The primary goal of this research is to learn more about the demand for home mortgage debt. Of particular interest is the elasticity of mortgage demand to variations in the after-tax cost of mortgage financed housing investments. This parameter is central to the determination of the likely impact of various proposals to reduce the MID. These goals are pursued by estimating the demand for mortgages using the 1983 and 1989 SCF. Estimates are obtained for various subsamples of these two surveys.

Several patterns are apparent and are summarized below.

1. The demand for mortgage debt is especially sensitive to the after-tax cost of mortgage debt. Estimates of the elasticity of the demand for mortgage debt with respect to a decrease in the tax rate at which mortgage debt is deductible (from .28 to .18) are -1.5 in 1983 and -3.5 in 1989. The elasticity estimates for households in the top 50 percent of the income distribution are in the range of - 4.0 Clearly, these estimates suggest that mortgage demand would be reduced by the elimination of the MID.

2. The relationships between mortgage demand and household after-tax income are nonlinear. Elasticities are generally positive for low levels of income and negative at higher levels.

3. The relationship between mortgage demand and the age of the household head is also nonlinear; demand appears to peak in the mid-1930s and declines thereafter.

4. The estimates suggest that the elimination of the deduction for consumer credit interest would lead to an increase in the demand for mortgage debt; however, the estimates indicate that households in the lower portions of the income distribution are more likely to make such a substitution than higher income households. This is a curious result that warrants further analysis.

The next goal of our research is to simulate the impact of the elimination of the MID using the estimates produced in this paper and the SCF. First, the tax liability will be recomputed for each household assuming the elimination of the MID using simulated tax variables; households will not be allowed to alter their demand for mortgage debt or housing demand. This is the static approach and it should yield tax revenue gains close to the $50 billion amount noted earlier. Second, households will be allowed to reduce their mortgage demand. The extent of the decline will depend upon the amount of nonhousing wealth available to the household, the change in the tax rate at which mortgage debt is deductible, and the elasticity estimates obtained in this paper. This should reveal substantially lower revenue gains. Further steps may be attempted to take into account possible reductions in housing demand and interest rates.

Table 1. Basic Statistics of Survey of Consumer Finance

	1983				1989			
	Weighted		Unweighted		Weighted		Unweighted	
Assets and Liabilities	**Mean**	**Median**	**Mean**	**Median**	**Mean**	**Median**	**Mean**	**Median**
Number of Observations	53,879,598		2,794		55,590,644		2,194	
Current Value of Home (dollars)	70,569	53,000	115,219	60,000	108,947	75,000	298,618	120,000
Car Value (dollars)	5,660	4,415	7,042	4,973	10,306	7,900	24,137	11,000
Other Assets (dollars)	134,940	18,515	773,263	26,829	225,685	64,514	3,004,790	183,000
Total Assets (dollars)	211,169	85,914	895,524	100,627	357,716	170,000	3,394,416	337,542
First Mortgage	15,697	6,306	19,683	6,291	26,740	8,000	50,784	8,000
All Mortgage Debt	17,197	7,019	21,893	7,010	30,669	12,000	66,485	13,000
Consumer Credit	4,678	622	20,121	572	1,430	500	1,232	0
Total Liabilities (dollars)	26,815	11,886	59,746	13,322	69,188	20,400	644,821	30,890
Net Worth w/o Pensions	184,353	65,016	835,778	78,309	288,528	133,220	2,749,595	280,016
Net Worth With Pensions	258,338	133,166	927,008	162,804	301,306	137,880	2,816,466	297,575
Income and Taxes (dollars)								
After Tax Income	29,138	22,576	67,775	25,670	40,919	29,340	257,576	44,169
Tax Liability	5,184	2,051	21,721	2,831	6,526	1,703	54,540	3,518
Wasted Deduction	1,390	1,671	1,226	1,350	2,474	2,826	1,703	693
Ratios (percents)								
First Marginal Tax Rate	22	22	26	25	16	15	19	28
Last Marginal Tax Rate	21	22	25	23	15	15	19	15
Home/Assets	63	66	56	60	51	50	39	34
Car/Assets	7	5	6	4	6	4	4	2
Total Mortgages/Liabilities	48	57	45	45	50	62	44	40
Consumer Debt/Liabilities	24	6	24	5	11	1	9	0
Total Liabilities/Total Assets	22	13%	20	10	19	12	19	8
Net Worth/Income	48	290	142	318	679	464	1110	600

Table 1. Continued

Assets and Liabilities	1983				1989			
	Weighted		Unweighted		Weighted		Unweighted	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
After-Tax Cost of (percents):								
Consumer Debt	85	100	81	100	96	100	94	94
Mortgage Debt	85	100	81	100	89	100	84	85
Equity Financed Housing	78	78	74	75	84	85	81	72
Other Variables								
Age of Head (Years)	50	48	51	50	53	52	54	53
No. of Dependent Children	0.94	0	0.92	0	1.33	0	1.28	0
Age of First Mortgage (Years)	4.65	2	4.59	2	7.95	5	8.04	6
County Median Income (dollars)	17,016	16,664	16,718	16,272	NA	NA	NA	NA
County Median Home Value (dollars)	49,283	45,800	47,585	43,400	NA	NA	NA	NA
County Households (dollars)	249,605	86,446	215,099	72,064	NA	NA	NA	NA
Duca & Rosenthal Constrained (percent)	10	0	9	0	12	0	9	0

Table 2. Percentage of Sample with Certain Characteristics (in percents)

	Percentage of Sample			
	1983		1989	
Household Traits	**Weighted**	**Unweighted**	**Weighted**	**Unweighted**
Total Liabilities > 0	76.0	75.0	79.0	79.0
First Mortgage > 0	59.0	58.0	59.0	57.0
Second Mortgage > 0	7.0	6.0	6.0	6.0
All Mortgages > 0	60.0	59.0	64.0	62.0
Consumer Debt > 0	63.0	61.0	58.0	47.0
Auto Loan > 0	31.0	29.0	37.0	30.0
Auto Value > 0	92.0	92.0	93.0	94.0
Total Assets > 0	100.0	100.0	100.0	100.0
Rest of Assets > 0	96.0	96.0	98.0	98.0
Net Worth> 0	100.0	100.0	100.0	99.0
Net Worth without Pensions > 0	100.0	100.0	100.0	99.0
Itemize	44.0	51.0	46.0	62.0
Married	73.0	76.0	70.0	77.0
High Income Sample (=1)	2.0	15.0	NA	NA
North East Dummy	19.0	16.0	NA	NA
North Central Dummy	28.0	26.0	NA	NA
South Dummy	34.0	30.0	NA	NA
West Dummy	16.0	12.0	NA	NA

Table 3. Distribution of Debt Characteristics by Itemization Status and Income Quartile

	Non-Itemizers									
	First Income Quartile		Second Income Quartile		Third Income Quartile		Fourth Income Quartile		All Non-Itemizers	
Year	**1983**	**1989**	**1983**	**1989**	**1983**	**1989**	**1983**	**1989**	**1983**	**1989**
Number of Observations	643	476	503	270	205	80	29	11	1,431	855
Means										
First Mortgage (dollars)	2,642	3,622	4,709	7,319	3,476	5,036	5,201	1,455	3,446	4,818
Any Mortgage (dollars)	2,938	4,209	5,766	8,738	4,172	5,402	6,359	1,455	4,074	5,627
Consumer Debt (dollars)	997	590	2,510	1,413	2,647	982	3,401	174	1,778	869
Auto Loan (dollars)	427	246	656	580	962	459	335	33	567	364
Loan to Value for Home (percent)	11	9	16	16	8	6	4	4	12	11
Loan to value for Auto (percent)	8	5	11	6	12	3	3	0	9	5
Households Who Possess:										
First Mortgage (percent)	26	26	46	47	40	39	31	18	34	33
Any Mortgage (percent)	27	32	49	54	42	41	31	18	36	39
Consumer Debt (percent)	40	37	62	59	61	50	28	18	49	44
Auto Loan (percent)	15	18	26	43	28	34	10	9	20	27
				Itemizers					All Itemizers	
Number of Observations	57	80	194	271	493	469	670	537	1213	1490
Means										
First Mortgage (dollars)	32,281	65,575	29,395	42,336	27,203	50,274	43,449	124,774	41,273	72,014
Any Mortgage (dollars)	33,768	101,416	30,837	46,794	29,614	60,875	49,005	170,787	45,622	94,670
Consumer Debt (dollars)	6,742	1,603	4,725	1,895	5,445	1,872	74,163	821	44,249	1,316
Auto Loan (dollars)	1,505	436	2,201	748	2,365	598	1,616	175	2,276	411
Loan to Value for Home (percent)	59	47	56	45	41	35	22	26	41	31
Loan to value for Auto (percent)	22	6	29	7	25	4	11	1	22	3
Households Who Possess:										
First Mortgage (percent)	100	81	97	83	88	79	67	58	93	65
Any Mortgage (percent)	100	86	97	87	88	82	68	62	94	69
Consumer Debt (percent)	72	60	85	75	83	60	58	23	83	44
Auto Loan (percent)	37	30	54	53	50	43	24	12	44	29

Table 4. Alternative Specifications of the Demand for Mortgage Debt: All But High Income Households in 1983 (t-ratios in parentheses)

	Specification									
	Mortgage[a]		LTV[b]		Market Value[c]		Mortgage with Housing[d]			
Variable	OLS	Tobit	OLS	Tobit	OLS	Tobit	Model A	Model B	Model C	Model D
Constant	-5.68	-22.22	0.71	-0.23	0.80	-0.13	-75.33	-74.27	-120.28	-106.67
	(1.60)	(3.85	(3.20)	(0.70)	(0.39)	(0.39)	(10.35)	(7.12)	(13.94)	(12.28)
Equity-Mortgage Cost	7.84	8.69	0.62	0.72	0.62	0.77	4.72	5.16	2.88	3.89
	(10.91)	(7.29)	(13.85)	(10.31)	(14.26)	(10.97)	(4.71)	(4.64)	(2.78)	(3.57)
Wasted Deduction	-0.00003	0.00007	0.00002	0.00002	0.00002					
	(0.26)	(0.42)	(2.45)	(2.60)	(2.48)					
Log of After-Tax Income	0.47	0.69	0.03	0.04	0.03	0.04	0.91	0.96	0.92	1.74
(millions)	(3.24)	(2.80	(3.15)	(2.60)	(3.76)	(3.13)	(4.64)	(1.74)	(4.03)	(4.72)
Log Net Worth (millions)							-3.47		-5.54	
							(12.41)		(17.37)	
Log Net Worth (imputed)[e]								-3.45		-5.95
								(3.90)		(13.59)
Log of Current Home Value							6.83	6.69	10.79	9.79
							(11.95)	(8.58)	(15.96)	(14.18)
Years of Residence	-0.12	-0.28	-0.01	-0.02	-0.01	-0.02	-0.23	-0.31	-0.27	-0.32
Age of Head (1/100)	-1.54	34.79	-1.92	0.08	-1.68	0.43	25.85	30.02		
	(0.54)	(6.28)	(10.74)	(0.24)	(9.79)	(1.35)	(4.66)	(4.22)		
Age of Head^2 (1/100)	-6.24	-48.03	1.31	-0.95	1.16	-1.22	-36.12	-37.88		
	(2.23)	(8.34)	(7.47)	(2.87)	(6.90)	(3.64)	(6.42)	(6.06)		

Table 4. Continued

	Specification									
	Mortgage[a]		LTV[b]		Market Value[c]		Mortgage with Housing[d]			
Variable	**OLS**	**Tobit**	**OLS**	**Tobit**	**OLS**	**Tobit**	**Model A**	**Model B**	**Model C**	**Model D**
Years of Education (head)	0.08	0.33	0.01	0.03	0.00	0.02				
	(0.71)	(1.53)	(0.96)	(1.97)	(0.69)	(1.70)				
Years of Education^2 (head)	0.00	-0.01	0.00	0.00	0.00	0.00				
	(0.15)	(1.12)	(0.41)	(1.57)	(0.24)	(1.33)				
Years of Education (spouse)	-0.01	0.12	-0.002	0.000	0.003	0.01				
	(0.05)	(0.52)	(0.22)	(0.01)	(0.39)	(0.50)				
Years of Education^2 (spouse)	0.0059	0.0020	0.0002	0.0001	0.0000	-0.0001				
	(1.02)	(0.20)	(0.43)	(0.24)	(0.13)	(0.22)				
Married Dummy	-0.30	-0.71	-0.01	0.01	-0.04	-0.03				
	(0.39)	(0.51)	(0.23)	(0.07)	(0.88)	(0.42)				
Number of Dependent Children	0.37	0.32	-0.001	-0.001	-0.005	-0.004				
	(5.50)	(3.11)	(0.30)	(0.19)	(1.12)	(0.75)				
Professional Dummy	0.38	0.45	0.00	0.01	-0.01	0.00				
	(1.92)	(1.48)	(0.01)	(0.54)	(0.76)	(0.25)				
Civil Servant Dummy	0.37	0.55	0.03	0.05	0.03	0.05				
	(1.75)	(1.70)	(2.25)	(2.55)	(2.51)	(2.70)				
Log of Resident's County:										
Median Household Income	-0.11	0.11	-0.01	0.01	-0.03	-0.02				
	(0.25)	(0.16)	(0.41)	(0.26)	(1.14)	(0.46)				
Median Home Value	1.50	1.98	0.04	0.05	0.04	0.06				
	(4.73)	(3.87)	(1.82)	(1.78)	(2.06)	(2.11)				

Table 4. Continued

Variable	Specification									
	Mortgage[a]		LTV[b]		Market Value[c]		Mortgage with Housing[d]			
	OLS	Tobit	OLS	Tobit	OLS	Tobit	Model A	Model B	Model C	Model D
Number of Households	0.11	0.25	0.005	0.014	0.003	0.013				
	(1.99)	(2.64)	(1.26)	(2.69)	(0.79)	(2.51)				
σ		4.89		0.28		0.27				
		(48.09)		(50.53)		(49.73				
ψ[f]							-3.98	-5.53	-8.12	-8.66
							(6.89)	(7.08)	(12.08)	(12.39
$\Sigma[\epsilon_1:\epsilon_2] = (\sigma_{12}\,(1-\rho_2)).5$							4.63	4.83	4.68	4.84
							(36.00	(34.89)	(37.36)	(36.49)
Adjusted R^2	0.52		0.48		0.45					
Log Likelihood		-4,792		-636		-602	-1,802	-2,445	-1,849	-2,474
N	2,363	2,363	2,363	2,363	2,363	2,363	2,363	2,363	2,363	2,363

[a]Log of mortgage debt, households with zero mortgage debt are assigned a zero mortgage debt value.

[b]Loan to value ratio in dollars.

[c]Market value is defined as market value divided by current home value in dollars.

[d]Housing demand and the demand for mortgage debt are estimated jointly as a simultaneous Tobit. Housing demand estimates are in Appendix A-3.

[e]Net worth is formed from an auxiliary regression reported in Appendix A-3.

[f]Exogeneity of housing is tested by a t-test of the hypothesis that ψ equals zero (i.e., $\rho[\epsilon_1:\epsilon_2] = 0$).

Table 5. Tobit Marginal Effects of the Demand for Mortgage Debt for Various Subsamples in 1983
(t-ratios in parentheses)

	Sample								
Variable	**High Income Only**	**All**	**All But High Income**	**Top 50 Percent with County**	**Top 50 Percent**	**Unconstrained**	**Bottom 50 Percent**	**Middle 50 Percent**	**Constrained**
Equity Mortgage Cost	15.96	7.56	6.66	12.78	13.58	6.08	3.46	10.14	11.64
	(2.09)	(7.18)	(7.25)	(8.85)	(8.61)	(6.37)	(3.71)	(8.74)	(4.22)
Wasted Deduction	0.0015	-0.0002	0.0000	0.0005	0.0005	0.0001	-0.0002	0.0001	0.0004
	(1.82)	(1.21)	(0.42)	(2.58)	(2.42)	(0.42)	(1.74)	(0.61)	(1.00)
Log of After-Tax Income	-0.50	0.03	0.53	-0.65	-0.67	0.64	0.48	-0.49	0.11
(millions)	(1.52)	(0.24)	(2.80)	(1.78)	(3.71)	(3.20)	(2.66)	(0.94)	(0.21)
Years of Residence	-0.22	-0.23	-0.21	-0.24	-0.24	-0.20	-0.12	-0.22	-0.33
	(6.67)	(17.86)	(17.88)	(12.60)	(13.73)	(16.46)	(7.32)	(12.87)	(7.64)
Age of Head (1/100)	33.94	33.81	26.66	29.13	37.70	21.76	14.91	29.62	66.11
	(1.61)	(7.35)	(6.38)	(3.67)	(5.18)	(5.01)	(4.38)	(4.97)	(4.37)
Age of Head^2 (1/100)	-43.80	-45.91	-36.81	-36.77	-47.18	-31.64	-20.54	-39.85	-73.12
	(2.31)	(9.80)	(8.53)	(4.36)	(6.36)	(7.12)	(5.39)	(6.27)	(4.15)
Years of Education (head)	-1.74	0.41	0.26	-0.13	-0.23	0.33	0.16	0.13	0.20
	(0.81)	(2.17)	(1.53)	(0.34)	(0.57)	(1.78)	(1.24)	(0.44)	(0.51)
Years of Education^2	0.06	-0.01	-0.01	0.01	0.01	-0.01	-0.01	0.00	0.00
(head)	(0.83)	(1.52)	(1.12)	(0.69)	(0.90)	(1.46)	(1.15)	(0.30)	(0.06)

Table 5. Continued

Variable	Sample								
	High Income Only	**All**	**All But High Income**	**Top 50 Percent with County**	**Top 50 Percent**	**Unconstrained**	**Bottom 50 Percent**	**Middle 50 Percent**	**Constrained**
Years of Education	-3.12	0.23	0.09	0.42	0.27	0.17	-0.23	0.52	-0.37
(spouse)	(0.99)	(1.16)	(0.52)	(1.19)	(0.70)	(0.88)	(1.62)	(1.71)	(0.78)
Years of Education^2	0.11	0.00	0.00	-0.01	0.00	0.00	0.02	-0.01	0.01
(spouse)	(1.05)	(0.29)	(0.20)	(0.87)	(0.32)	(0.11)	(2.29)	(1.08)	(0.60)
Married Dummy	22.43	-1.34	-0.55	-2.01	-1.37	-1.07	0.89	-3.35	3.66
	(0.98)	(1.09)	(0.51)	(0.86)	(0.52)	(0.93)	(1.17)	(1.79)	(1.29)
Number of Dependent	0.31	0.27	0.25	0.12	0.17	0.26	0.21	0.36	-0.07
Children	(1.11)	(3.12)	(3.10)	(1.02)	(1.49)	(3.12)	(2.94)	(3.48)	(0.30)
Professional Dummy	1.39	0.48	0.34	0.22	0.44	0.46	0.31	0.49	-1.32
	(1.75)	(1.91)	(1.48)	(0.72)	(1.45)	(1.94)	(1.33)	(1.71)	(1.69)
Civil Servant Dummy	0.81	0.41	0.42	0.23	-0.01	0.32	0.27	0.39	0.71
	(0.42)	(1.44)	(1.70)	(0.69)	(0.04)	(1.23)	(1.20)	(1.26)	(1.00)
Log of Resident's County:									
Median Household			0.09	-0.75		0.05	0.52	0.17	1.49
Income			(0.16)	(0.97)		(0.08)	(1.23)	(0.24)	(0.98)
Median Home Value			1.52	2.40		1.48	0.58	1.67	0.75
			(3.87)	(4.29)		(3.61)	(1.76)	(3.25)	(0.68)
Number of Households			0.19	0.18		0.20	0.09	0.22	0.05
			(2.64)	(1.79)		(2.64)	(1.39)	(2.31)	(0.26)
σ	6.64	5.32	4.89	3.63	4.77	5.01	5.81	4.41	3.63
Log Likelihood	-930	-5,796	-4,793	-513	-3,282	-4,249	-2,441	-3,091	-513
N	418	2,781	2,363	980	1,397	2,142	1,383	1,382	221

Table 6. Alternative Specifications of the Demand for Mortgage Debt: All Households in 1989
(t-ratios in parentheses)

	Specification												
	Mortgage[a]		LTV[b]		LTV[b]		Market Value[c]		Mortgage with Housing[d]				
Variable	OLS	Tobit	OLS	Tobit	OLS	Tobit	OLS	Tobit	Model A	Model B	Model C	Model D	Model E
Constant	6.43	-5.10	0.98	0.20	0.88	0.06	4.53	-7.05	-112.97	-410.15	48.96	-748.19	-428.90
	(3.64)	(1.70)	(6.41)	(0.83)	(5.75)	(0.25)	(2.63)	(2.41)	(5.95)	(5.90)	(8.84)	(5.15)	(5.93)
Equity-Mortgage Cost	7.62	13.37	0.55	1.16	0.49	1.04	6.54	11.57	14.87	13.41	1.57	33.22	14.63
	(4.70)	(4.86)	(3.89)	(5.02)	(3.49)	(4.55)	(4.15)	(4.33)	(5.75)	(2.91)	(0.60)	(4.73)	(3.07)
Cons. Credit-Mortgage Cost	6.18	7.96	0.32	0.50	0.33	0.52	6.33	8.22	-0.66	-1.91	43.10	-61.37	-1.06
	(2.45)	(2.04)	(1.46)	(1.56)	(1.52)	(1.65)	(2.58)	(2.17)	(0.18)	(0.15)	(10.81)	(2.81)	(0.08)
Wasted Deduction (10^{-4})	0.8	1.5	0.1	0.2	0.2	0.2	0.9	1.6					
	(0.79)	(0.93)	(1.65)	(1.73)	(1.76)	(1.83)	(0.94)	(1.05)					
Log of After-Tax Income (millions)	-0.061	-0.137	0.005	-0.001	0.003	-0.006	-0.101	-0.194	0.011	3.941	-4.281	-4.349	4.428
	(0.69)	(0.98)	(0.68)	(0.11)	(0.39)	(0.48)	(1.17)	(1.42)	(0.05)	(2.92)	(9.03)	(3.04)	(3.12)
Log Net Worth (millions)									-4.86			-28.60	
									(7.10)			(5.46)	
Log Net Worth (imputed)[e]										-22.68	5.98		-24.02
										(7.42)	(12.09)		(7.45)
Log of Current Home Value									9.32	34.36	-3.02	61.14	36.00
									(6.23)	(6.07)	(7.14)	(5.19)	(6.10)
Age of Head (1/100)	3.48	42.92	-2.60	-0.24	-2.46	-0.15	5.97	43.95	44.44				
	(0.77)	(5.27)	(6.60)	(0.36)	(6.31)	(0.24)	(1.36)	(5.57)	(4.59)				
Age of Head^2 (1/100)	-16.99	-64.52	1.54	-1.59	1.49	-1.53	-17.89	-63.29	-64.70				
	(4.14)	(8.29)	(4.31)	(2.52)	(4.22)	(2.46)	(4.50)	(8.40)	(7.12)				
Years of Education	0.13	0.40	0.02	0.04	0.02	0.05	0.18	0.47					
	(0.73)	(1.35)	(1.16)	(1.74)	(1.38)	(1.98)	(1.08)	(1.64)					
Years of Education^2(head)	0.001	-0.006	-0.000	-0.001	-0.001	-0.001	-0.002	-0.010					
	(0.09)	(0.51)	(0.73)	(1.11)	(0.98)	(1.39)	(0.29)	(0.83)					

Table 6. Continued

	Specification												
	Mortgage[a]		LTV[b]		LTV[b]		Market Value[c]		Mortgage with Housing[d]				
Variable	OLS	Tobit	OLS	Tobit	OLS	Tobit	OLS	Tobit	Model A	Model B	Model C	Model D	Model E
Years of Education	0.19	0.36	0.01	0.03	0.01	0.02	0.14	0.28					
(spouse)	(1.43)	(1.75)	(0.90)	(1.53)	(0.64)	(1.24)	(1.05)	(1.40)					
Years of Education^2	-0.01	-0.012	-0.000	-0.001	-0.000	-0.001	-0.003	-0.009					
(spouse)	(0.94)	(1.31)	(0.85)	(1.43)	(0.63)	(1.18)	(0.60)	(1.01)					
Married = 1;	-1.31	-2.06	-0.06	-0.12	-0.03	-0.08	-0.92	-1.51					
else = 0	(1.64)	(1.66)	(0.81)	(1.18)	(0.49)	(0.83)	(1.19)	(1.26)					
Number of Dependents	0.34	0.36	0.01	0.01	0.01	0.01	0.33	0.35					
	(4.74)	(3.26)	(1.29)	(1.66)	(1.18)	(1.61)	(4.69)	(3.25)					
Professional Dummy	0.75	0.92	0.02	0.04	0.02	0.05	0.80	0.99					
	(3.21)	(2.53)	(0.90)	(1.39)	(1.06)	(1.61)	(3.53)	(2.81)					
ARM = 1;					0.18	0.26	3.16	3.84		3.63	4.33		
FRM = 0					(7.46)	(7.84)	(11.57)	(9.55)		(4.26)	(5.41)		
σ		6.02		0.49		0.48		5.84					
		(46.35)		(49.06)		(49.16)		(46.35)					
ψ[f]									-7.17	-33.66	5.89	-58.99	-35.11
									(4.77)	(5.93)	(10.95)	(5.00)	(5.95)
$\Sigma[\epsilon_1:\epsilon_2] = (\sigma_{12}(1-\rho_2)).5$									5.78	5.81	6.24	5.76	5.97
									(28.67)	(28.58)	(27.48)	(29.28)	(26.29)
Adjusted R^2	0.38		0.18		0.20		0.42						
Log Likelihood		-4,790		-1,348		-1,318		-4,745	-2,597	-3,005	-2,805	-2,619	-3,046
N	2,112	2,112	2,112	2,112	2,112	2,112	2,112	2,112	2,112	2,112	2,112	2,112	2,112

[a]Log of mortgage debt, households with zero mortgage debt are assigned a zero mortgage debt value.
[b]Loan to value ratio in dollars.
[c]Market value is defined as market value divided by current home value in dollars.
[d]Housing demand and the demand for mortgage debt are estimated jointly as a simultaneous Tobit. Housing demand estimates are in Appendix A-3.
[e]Net worth is formed from an auxiliary regression reported in Appendix A-3.
[f]Exogeneity of housing is tested by a t-test of the hypothesis that ψ equals zero (i.e., $\rho[\epsilon_1:\epsilon_2] = 0$).

Table 7. Tobit Marginal Effects of the Demand for Mortgage Debt for Various Subsamples in 1989 (t-ratios in parentheses)

	Sample					
Variable	**All**	**Unconstrained**	**Constrained**	**Bottom 50 Percent**	**Middle 50 Percent**	**Top 50 Percent**
Equity Mortgage Cost	10.37	10.88	8.32	6.84	25.18	36.01
	(4.87)	(4.79)	(1.52)	(3.06)	(8.44)	(7.17)
Cons. Credit-Mortgage Cost	6.17	4.31	16.90	13.47	-1.35	-11.29
	(2.04)	(1.33)	(2.33)	(3.46)	(0.33)	(2.42)
Wasted Deduction	0.0001	0.0000	0.0005	0.0002	0.0002	0.0000
	(0.93)	(0.25)	(1.72)	(1.56)	(1.60)	(0.18)
Log of After-Tax Income (millions)	-0.11	-0.19	1.23	1.86	0.74	-0.51
	(0.98)	(1.72)	(3.61)	(6.70)	(2.68)	(3.48)
Age of Head (1/100)	33.26	29.22	32.02	16.15	32.81	52.64
	(5.32)	(4.34)	(1.88)	(2.37)	(4.02)	(4.85)
Age of Head^2 (1/100)	-50.01	-46.04	-39.55	-27.20	-50.53	-72.08
	(8.43)	(7.29)	(2.17)	(4.24)	(6.26)	(6.95)
Years of Education (head)	0.31	0.31	0.96	0.14	0.09	-0.73
	(1.35)	(1.22)	(1.91)	(0.58)	(0.26)	(1.14)
Years of Education^2 (head)	-0.005	-0.004	-0.037	-0.004	0.000	0.033
	(0.51)	(0.39)	(1.71)	(0.36)	(0.00)	(1.42)
Years of Education (spouse)	0.28	0.30	-0.01	0.12	0.11	0.11
	(1.75)	(1.80)	(0.01)	(0.56)	(0.46)	(0.45)

Table 7. Continued

Variable	Sample					
	All	**Unconstrained**	**Constrained**	**Bottom 50 Percent**	**Middle 50 Percent**	**Top 50 Percent**
Years of Education^2 (spouse)	-0.01	-0.01	0.01	0.00	-0.00	-0.00
	(1.31)	(1.42)	(0.30)	(0.25)	(0.51)	(0.33)
Married Dummy	-1.59	-1.79	0.35	-2.08	-0.21	-0.78
	(1.66)	(1.78)	(0.13)	(1.78)	(0.15)	(0.52)
Number of Dependents	0.28	0.28	0.29	0.36	0.25	0.11
	(3.26)	(3.03)	(1.54)	(3.22)	(2.49)	(0.90)
Professional Dummy	0.71	0.81	-0.16	0.84	0.79	0.37
	(2.53)	(2.71)	(0.22)	(2.50)	(2.46)	(0.84)
σ	6.02	6.21	3.95	5.75	4.42	5.85
Log Likelihood	-4,790	-4,281	-472	-2,115	-2,546	-2,613
N	2,112	1,921	191	1,051	1,071	1,061

Appendix Table A-1. Frequency of the Tax Price Variables

After-Tax Cost of Equity Minus After-Tax Cost of Mortgage Debt				
	1983		1989	
Value	All	Itemizers	All	Itemizers
-0.44	3			
-0.4	1			
-0.39	10			
-0.35	3			
-0.33	26			
-0.31	11			
-0.29	96			
-0.28	4		70	
-0.27	11			
-0.25	97			
-0.23	12			
-0.22	160			
-0.2	12			
-0.19	150			
-0.17	21			
-0.15	0		435	
-0.16	135			
-0.14	88			
-0.12	96			
0	1845	1373	1607	1288
Total	2781	1373	2112	1288

After-Tax Cost of Consumer Credit Minus the After-Tax Cost of Mortgage Debt				
	0	NA	880	56
	0.09	NA	232	232
	0.168	NA	703	703
	0.198	NA	297	297
Total			2112	1288

Appendix Table A-2. Unweighted Descriptive Statistics of the 1983 Sample Used in the Estimation

Dependent Variables	Mean	Standard Deviation	Skew.	Kurt.	Minimum	Maximum	Cases
Current Home Value (dollars)	115,600	219,100	9.2	141.6	318	5,000,000	2781
Log of Current Home Value (dollars)	11.04	1.065	0	4.4	5.762	15.42	2781
Loan to Value Ratio (percent)	23	28	120	410	0	236	2781
Loan to Market Value (percent)	20	26	140	520	0	225	2781
All Mortgage Debt (dollars)	21,860	54,640	15.9	433.7	0	1,787,000	2781
Log of all Mortgage Debt (dollars)	5.859	4.961	-0.3	1.2	0	14.4	2781
Household Characteristic Variables							
Age of Head (1/100)	0.51	0.16	0.10	2.10	0.17	0.98	2781
Age of Head Squared (1/100)	0.28	0.16	0.70	2.70	0.03	0.96	2781
Yrs of Education (head)	13	3	-1	3	0	17	2781
Yrs of Education Sq (head)	175	78	0	2	0	289	2781
Yrs of Education (spouse)	10	6	-1	2	0	17	2781
Yrs of Education Sq (spouse)	128	95	0	2	0	289	2781
Married Dummy (percent)	76	43	-120	240	0	100	2781
No. of Dependent Children	1	1	1	5	0	7	2781
Civil Servant Dummy (percent)	12	33	230	650	0	100	2781
Professional Dummy (percent)	33	47	70	150	0	100	2781
Years of Residence	14	11	1	4	0	71	2781
Sample Selection Variables							
High Income Dummy (percent)	15	36	200	480	0	100	2781
Duca & Rosenthal Dummy (percent)	9	29	280	880	0	100	2363

Appendix Table A-2. Continued

Dependent Variables	Mean	Standard Deviation	Skew.	Kurt.	Minimum	Maximum	Cases
Tax Price Variables (percents)							
After Tax Return to Investments	77	12	70	220	56	100	2781
After Tax Cost of Home Equity	74	16	10	200	50	100	2781
After Tax Cost of Mortgage Debt	81	21	-40	140	50	100	2781
After Tax Cost of Consumer Debt	81	21	-40	140	50	100	2781
User Cost to Own Housing	78	18	-30	160	50	100	2781
Equity-Mortgage Cost	-7	10	-110	280	-44	0	2781
Log of Resident's County (dollars):							
Median Household Income	9.7	0.24	-0.1	2.9	8.96	10.31	2363
Median Home Value	10.7	0.37	0	2.7	9.84	11.73	2363
Number of Households	11.04	1.66	0	2.4	7.46	14.82	2363
Income and Wealth Variables							
After Tax Income (millions)	0.07	0.17	7.80	87.60	0.00	2.81	2781
Log of After-Tax Income (millions)	(3.56)	1.15	0.60	4.40	(9.21)	1.03	2781
Net Worth (millions)	0.84	3.87	11.80	189.40	0.00	86.85	2781
Log Net Worth (millions)	(2.26)	1.77	0.60	4.00	(10.08)	4.46	2781
Log of Consumer Credit (dollars)	4.87	4.16	(0.10)	1.40	0.00	15.78	2781
Wasted Deduction (dollars)	1,223	1,083	0	2	0	2,875	2781

Appendix Table A-3. Descriptive Statistics: Survey of Consumer Finance 1989

Dependent Variables	Mean	Standard Deviation	Skew.	Kurt.	Minimum	Maximum	Cases
Current Home Value (dollars)	290,800	583,100	8	102	1,000	12,000,000	2112
Log of Current Home Value (dollars)	11.78	1.22	0.10	3.70	6.91	16.30	2112
Loan to Value Ratio (percent)	25	40	940	20030	0	1012	2112
All Mortgage Debt (dollars)	63,730	185,400	8	80	0	2,500,000	2112
Log of all Mortgage Debt (dollars)	6.55	5.26	(0.40)	1.30	0.00	14.73	2112
House Hold Characteristic Variables							
Age of Head in (1/100)	0.54	0.15	0.20	2.20	0.22	0.91	2112
Age of Head Squared (1/100)	0.31	0.16	0.70	2.70	0.05	0.83	2112
Yrs of Education (head)	14	3	-1	4	1	17	2112
Yrs of Education Sq (head)	198	79	0	2	1	289	2112
Yrs of Education (spouse)	11	6	-1	2	0	17	2112
Yrs of Education Sq (spouse)	149	99	0	2	0	289	2112
Married Dummy (percent)	77	42	-130	270	0	100	2112
Number of Dependents	1	2	1	3	0	10	2112
Professional Dummy (percent)	54	50	-10	100	0	100	2112
Sample Selection Variables							
Duca and Rosenthal Dummy (percent)	9	29	290	920	0	100	2112
After Tax Income Rank	2.50	1.11	0.00	1.70	1.00	4.00	2112
Tax Price Variables (percents)							
After Tax Return to Investments	81	11	70	220	72	100	2112
After Tax Cost of Home Equity	80	11	60	210	67	100	2112
After Tax Cost of Mortgage Debt	84	14	10	120	67	100	2112
After Tax Cost of Consumer Debt	94	6	10	120	87	100	2112
User Cost to Own Housing	82	12	20	140	67	100	2112
Equity-Mortgage Cost	-4	7	-160	450	-28	0	2112
Cons. Credit-Mortgage Cost	9	8	-10	120	0	20	2112
Income and Wealth Variables							
After Tax Income (millions)	0.27	2.03	31.00	1,128.50	0.00	78.99	2112
Log of After Tax Income (millions)	(2.88)	1.46	0.70	4.10	(7.90)	4.37	2112
Net Worth (millions)	2.85	9.94	7.60	75.00	0.00	138.50	2112
Log of Net Worth (millions)	(0.96)	1.89	0.40	3.20	(7.91)	4.93	2112

Wasted Deduction (dollars)	1,728	1,858	0	2	0	4,775	2112
Mortgage Type Dummy (percent)	13	33	230	610	0	100	2112

Appendix Table A-4. Appendix to Table 4 (SCF 1983)
(t-ratios are in parentheses)

	Housing Demand Equations Estimated Jointly with Mortgage Demand[a]				
	Model A	**Model B**	**Model C**	**Model D**	**Net Worth[b]**
Constant	6.91	4.18	7.95	4.48	-6.76
	(13.46)	(7.40)	(18.06)	(8.89)	(-6.77)
User Cost of Ownership	-0.62	-0.51	-0.58	-0.42	0.37
	(05.34)	(-3.69)	(-5.79)	(-3.62)	(1.72)
Log of After Tax Income (millions)	-0.04	0.29	-0.05	0.29	0.78
	(-2.01)	(12.75)	(-2.59)	(13.52)	(17.90)
Log Net Worth (millions)	0.43		0.45		
	(57.26)		(60.45)		
Years of Residence	0.00	0.00	0.00	0.01	
	(-2.28)	(3.57)	(-0.55)	(3.89)	
Age of Head (1/100)	1.24	4.37	1.71	6.07	7.72
	(3.15)	(8.64)	(5.02)	(14.57)	(9.70)
Age of Head Squared (1/100)	-1.44	-3.34	-2.27	-5.10	-4.23
	(-3.68)	(-6.82)	(-6.73)	(-12.94)	(-5.42)
Years of Education (head)	0.03	0.09	0.03	0.09	0.11
	(2.21)	(5.53)	(2.64)	(7.03)	(3.42)
Years of Education Squared (head)	0.00	0.00	0.00	0.00	0.00
	(-0.83)	(-2.48)	(-1.26)	(-3.39)	(-1.77)
Years of Education (spouse)	0.00	0.03	0.00	0.03	0.05
	(0.18)	(1.52)	(0.31)	(2.02)	(1.49)
Years of Education Squared (spouse)	0.00	0.00	0.00	0.00	0.00
	(0.63)	(0.58)	(0.61)	(0.59)	(-0.10)
Married Dummy	-0.05	-0.28	-0.05	-0.32	-0.55
	(-0.62)	(-3.01)	(-0.72)	(-3.87)	(-2.59)
Number of Dependent Children	0.05	0.05	0.05	0.04	-0.01
	(5.04)	(4.01)	(5.27)	(4.09)	(-0.70)
Professional Dummy	0.04	0.07	0.04	0.07	0.06
	(1.24)	(1.95)	(1.67)	(2.58)	(1.07)
Civil Servant Dummy	0.02	-0.09	0.02	-0.11	-0.26
	(0.64)	(-2.35)	(0.84)	(-3.59)	(-4.38)

Appendix Table A-4. Continued

	Housing Demand Equations Estimated Jointly with Mortgage Demand[a]				
	Model A	**Model B**	**Model C**	**Model D**	**Net Worth[b]**
Log of Resident's County:					
Median Household Income	0.01	-0.05	0.01	-0.05	-0.10
	(0.21)	(-0.76)	(0.29)	(-0.92)	(-0.82)
Median Home Value	0.43	0.62	0.32	0.55	0.44
	(8.81)	(11.00)	(7.85)	(11.45)	(4.94)
Number of Households	0.01	-0.02	0.01	-0.02	-0.06
	(1.09)	(-1.53)	(1.69)	(-2.25)	(-3.96)
$\psi = \sigma_{12}/\sigma_{22}$	-3.98	-5.53	-8.12	-8.66	
	(-6.89)	(-7.08)	(-12.08)	(-12.39)	
$\Sigma[\epsilon_1:\epsilon_2] = (\sigma_{12}(1-\rho^2)).5$	4.63	4.83	4.68	4.84	
	(36.00)	(34.39)	(37.36)	(36.49)	

[a]The dependent variable is log of current value of home. The housing estimates reported within correspond to the mortgage estimates reported in Table 4.

[b]The dependent variable is log of net worth in millions.

Appendix Table A-5. Appendix to Table 6 (SCF 1989)
(t-ratios are in parentheses)

	Housing Demand					
	Model A	**Model B**	**Model C**	**Model D**	**Model E**	**Net Worth**
Constant	12.26	11.90	13.95	12.83	11.92	-0.02
	(45.69)	(45.08)	(47.51)	(92.07)	(45.62)	(0.03)
User Cost of Ownership	-0.55	-1.39	-1.03	-0.68	-1.38	-1.90
	(3.64)	(8.39)	(6.63)	(4.64)	(8.36)	(8.09)
Log of After Tax Income (millions)	0.07	0.43	0.14	0.08	0.43	0.84
	(4.64)	(34.04)	(9.43)	(5.72)	(34.03)	(40.05)
Log Net Worth (millions)	0.43		0.41	0.45		
	(37.96)		(34.95)	(43.69)		
Age of Head (1/100)	0.34	4.98	-1.89	0.73	4.96	5.81
	(0.48)	(11.03)	(2.84)	(3.79)	(11.12)	(5.34)
Age of Head Squared (1/100)	-0.27	-3.33	1.87	-1.03	-3.32	-2.45
	(0.43)	(8.63)	(3.23)	(4.44)	(8.71)	(2.48)
Years of Education (head)	0.0227	0.0059	-0.0028	0.0063	0.0033	-0.0116
	(1.19)	(0.86)	(0.11)	(1.57)	(0.50)	(0.28)
Years of Education Squared (head)	0.0004	0.0018	0.0003	-0.0001	0.0020	0.0032
	(0.44)	(5.69)	(0.23)	(0.38)	(6.10)	(1.82)
Years of Education (spouse)	0.0101	0.0203	-0.0269	0.0060	0.0223	0.0196
	(0.67)	(3.15)	(1.46)	(1.47)	(3.42)	(0.61)
Years of Education Squared (spouse)	0.0005	0.0002	0.0018	-0.0002	0.0001	0.0006
	(0.71)	(0.77)	(2.25)	(1.15)	(0.51)	(0.43)
Married Dummy	-0.19	-0.21	-0.03	-0.03	-0.22	-0.25
	(2.21)	(5.12)	(0.29)	(1.31)	(5.36)	(1.28)
Number of Dependents	0.03	0.02	0.00	0.01	0.02	0.02
	(3.28)	(5.71)	(0.43)	(2.56)	(5.78)	(1.18)
Professional Dummy	0.03	0.13	-0.12	0.02	0.13	0.16
	(1.17)	(8.88)	(3.52)	(2.58)	(8.95)	(2.85)
$\psi = \sigma_{12}/\sigma_{22}$	-7.17	-33.66	5.89	-58.99	-35.11	
	(4.77)	(5.93)	(10.95)	(5.00)	(5.95)	
$\Sigma[\epsilon_1:\epsilon_2] = (\sigma_{12}(1-\rho_2)).5$	5.78	5.81	6.24	5.76	5.97	
	(28.67)	(28.58)	(27.48)	(29.28)	(26.29)	

Endnotes

1. The two equation approach is used to account for possible selectivity bias, which may arise because so many homeowners (one-third) have no debt at all.

2. The following is a brief summary of Follain and Wong (1995).

3. Housing services (*h*) enter the utility function and these are assumed proportional to the quantity of housing stock purchased (*H*).

4. Jim Shilling suggested that a similar arbitrage opportunity may exist if the corporate tax rate is less than the tax rate of the household. In such a case, the household should obtain the maximum size mortgage because the value of the tax shield associated with debt financing is greater to the household than to the corporation.

5. We also computed a tax price for high income households equal to one minus the marginal tax rate of the marginal investor in tax-exempt bonds to study possible arbitrage effects among high income borrowers. The results using this tax price for households with tax rates above this tax-exempt tax rate were basically the same as the ones reported below.

6. Information about the county in which the high income households live is not available in the 1983 SCF. Observations with missing information on some variables and either negative income or net worth were also eliminated. This produced a sample of 2,363 observations. Similar criteria were used to generate the 1989 sample for Table 6 of 2,112 observations.

7. The difference between the cost of consumer credit and mortgage credit is not included in 1983 because they are identical.

8. Market value is defined as the present value of remaining payments on fixed-rate mortgages at the market rate of interest in 1983; only first and second mortgages are included in this calculation.

9. The estimates in Table 5 are the Tobit estimator of the reduced form for various subsamples; column three of Table 6 reports the marginal effects associated with column two in Table 4.

10. Recall that it is possible to distinguish the tax prices of consumer credit and mortgage debt in 1989 because of TRA; as a result, two variables are included in the 1989 specifications: the difference in the tax prices of equity and mortgage debt and the difference between the tax prices of consumer credit and mortgage debt.

11. The significance tests are computed using the covariance matrix for the Tobit coefficient estimates; the t statistic is computed as the ratio of the sum of the two coefficients divided by the square root of the sum of the variances of the two coefficients minus two times the covariance between the two estimates).

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