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— Abstract —

Innovations in the mortgage market since the mid-1990s have effectively reduced a number of financing constraints. Coinciding with these innovations, we document a significant change in the propensity for households to own their homes, as well as substantial increases in the share of household income devoted to housing. These changes in housing expenditures are especially large for those groups that faced the greatest financial constraints, and are robust across the changing composition of households and their geographic location. We present evidence that young, constrained households may have used newly designed mortgages to finance their increased expenditures on housing.

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1 Introduction

Financing constraints hinder the smoothing of housing and non-housing consumption. However, relative to the early 1990s, innovations in the mortgage market have effectively reduced these constraints in a variety of ways.[1] For instance, the increase in the menu of mortgage instruments allows consumers to better match housing decisions with permanent income instead of current income. Also, mortgage lenders have increased their ability to measure and price the risk of mortgage applicants, allowing, among other things, lower down payment requirements. Finally, consumers face lower costs today for refinancing existing mortgages and extracting home equity, effectively increasing the liquidity of their homes. Coinciding with these developments in the mortgage market has been a marked increase in the demand for owner-occupied housing, as witnessed by a sharp increase in the homeownership rate and also in the share of income devoted to housing consumption.

Innovations in the mortgage market and the increase in demand for housing are likely linked. To explore this linkage, we model the consumer's housing consumption problem in the face of several financing constraints. As the financing constraints are relaxed by innovations in the mortgage market, households enjoy higher utility and optimally choose to increase the share of income devoted to housing. Coupled to these models, our empirical strategy examines the timing of the house purchase decision (the extensive margin) and also on the share of income devoted to housing by homeowners (the intensive margin). In

terms of the house purchase decision, the homeownership rate witnessed a remarkable 5 percentage point increase between 1994 and 2004 after being relatively stable for several decades. The homeownership rate increased sharply for young households, especially for households with relatively high educational attainment; it is these households that have the greatest discrepancy between current income and permanent income, and therefore it is these households that would benefit greatly from innovations in mortgage markets.

On the intensive margin, owner-occupied households have increased the share of their income devoted to housing by several percentage points from 1997 to 2005. We document that lower income households increased their spending on housing more sharply than did higher income households, consistent with the view that higher income households faced less binding financing constraints. To address a competing hypothesis that households increased their share of income going to housing because housing became a more attractive asset, we examine how spending varied between markets differentiated by observed house price appreciation. We find that spending on housing as a share of income increased markedly in virtually all markets, regardless of what happened to house prices in those markets. Insofar as alternative mortgage products may have increased the potential for housing consumption smoothing, we find that young and educated households have chosen mortgage products with relatively low mortgage interest rates.

This paper builds upon a growing literature on the evolution of financial constraints

in housing markets and their effects on the consumption of housing, housing prices, and the consumption and prices of other goods and assets in the economy. The paper that is perhaps the most similar to ours is Gerardi, Rosen, and Willen (2006); in that paper, the authors argue that homeowners have improved their ability to better match their future income with house prices, and the reason for this better matching is because of innovations in mortgages. Chambers, Garriga, and Schlagenhauf (2005) also examine the changes in the home ownership rate via a dynamic general equilibrium model. They argue, like us, that mortgage market innovations are a quantitatively important part of the explanation for the rise in the homeownership rate in the 1990s.[2] Our paper differs from these two papers in that we examine empirically how demand for housing has increased at the time that these mortgage market innovations have taken place. We identify the demographic groups whose behavior has changed the most, while presenting some preliminary evidence on the way these changes in housing consumption were financed.

The paper is organized as follows. In Section 2 we provide a brief summary of developments in the mortgage market that have reduced the constraints faced by home buyers and owners. Section 3 outlines a household's consumption/housing consumption problem to motivate the main empirical predictions of mortgage market innovation for consumer behavior. Section 4 presents a series of empirical results from a wide variety of datasets that support the implications of the model and Section 5 concludes.

2 Innovations in the mortgage industry

Since the mid-1990s, the most profound changes in the mortgage market appear to have stemmed from improvements in the ability of mortgage issuers to gather and process information. Information technology has reduced the costs incurred in the mortgage origination process, has assisted lenders in learning about the credit quality of borrowers and the value of collateral, and helped in offering a greater array of mortgage products.

In terms of reducing the costs associated with the mortgage origination process, lenders must share information with credit bureaus, title companies, appraisers, and insurers, among others. Prior to the availability of easy-to-use email and fax machines, much of the data needed to make an underwriting decision was assembled slowly as the different parties exchanged information through the mail. The industry now speaks of the "paperless" mortgage and its potential to dramatically reduce the amount of time between closing of the loan and securitization.[3] Danforth (1999) estimates that, prior to the introduction of internet-based features to the mortgage origination process, transaction costs associated with mortgage origination reached three percentage points of total loan value. While it is difficult to obtain precise mortgage lending costs for commercial banks or mortgage companies, one crude measure suggests that labor productivity in the mortgage industry increased substantially (about 2-1/2 times) from the early 1990s to the mid-2000s. Also, the points and spreads for 1-year adjustable rate mortgages (ARMs) have drifted steadily down over the past decade.[4]

Statistical models designed to estimate changes in collateral value, or automated valuation models (AVMs), have gained widespread use in the mortgage industry over the past decade. AVMs have been particularly important for reducing the cost of refinancing, as many lenders rely heavily on the AVM for a quick estimate of the collateral value to see whether the borrower (re)qualifies for the new mortgage loan.[5]

Statistical models are also used to produce credit scores, and beginning in the mid-1990s, credit scores have been used by the mortgage industry.[6] Credit scoring models have led to better risk management and have helped lenders to form better estimates of repayment probabilities, particularly for borrowers with more opaque credit quality, like first-time and low-income home buyers.[7] As a result, credit scoring could have helped a greater share of the population to become eligible for a mortgage and could have also helped reduce the down payment requirements for others.

A final class of innovations concerns the design of the mortgage instruments themselves. Product differentiation in the mortgage market reflects the great diversity of tastes and demographics amongst borrowers, as well as the financial conditions in the overall economy.[8] Beyond the simple matching of tastes, lenders have incentive to offer a menu of contracts as a way of mitigating the adverse selection problems in the borrower pool.[9] While the traditional 30-year fixed rate mortgage remains a popular instrument, other less-traditional instruments have gained market share, especially during the early 2000s.[10] These instruments vary by

interest rate charged, term, amortization and payment schedule, and differ substantially from more traditional fixed-rate or even many adjustable-rate mortgages. One reason that mortgage issuers are better able to tailor mortgage instruments to consumers is because of thicker secondary markets and the increased ability of participants in these secondary markets to assess the risk of mortgage-backed securities.

3 A simple model of housing consumption

This section presents a simple model that demonstrates how consumers respond to mortgage market innovations that relax different types of financial constraints. The first constraint is the down payment requirement when purchasing a home. As shown in several surveys, the households that are most likely to benefit from the loosening of this constraint are households with few non-housing assets, such as the young and lower income. A second constraint households face is how much they can borrow relative to current income.[11] This constraint is particularly binding for young, college-educated households whose future income may be much higher than current income. To illustrate this point, Figure 1 shows indexes of average wages estimated by age for different educational attainment categories using the 2000 Decennial Census.[12] A striking result from Figure 1 is the extent to which wages increase for individuals with a college education over their 20's and 30's, and how current income can be significantly below permanent income. For individuals with only a high-school education

or less, real incomes typically grow much more slowly over time.

To explore the way in which innovations that relax financial constraints might be expected to affect the consumption decisions of households, we develop a two period model of a household with preferences for a consumption good c and a housing good h. A household lives for two periods, receiving period income y_1 and y_2. There is no uncertainty. Preferences are given by,

$$\sum_{t=1}^{2} \beta^{t-1} \frac{(c_t^{\theta} h_t^{1-\theta})^{1-\gamma}}{1-\gamma}. \tag{1}$$

Expenditures on housing consist of a down payment, expressed as a fraction, δ, of the value of the house, h (the per-unit price of housing is set equal to 1), and mortgage payments made in the first and second periods, m_1 and m_2. These constraints can all be written as,

$$c_1 + m_1 + \delta h \leq y_1, \tag{2}$$

$$c_2 + m_2 \leq y_2, \tag{3}$$

$$m_1 + m_2 = (1-\delta)h. \tag{4}$$

Equations (2) and (3) are the budget constraints for the first and second periods, and (4) is the solvency constraint requiring borrowers to eventually repay the loan in full.

The household problem is to choose c_1, c_2, and h to maximize (1) subject to (2)-(4). The problem is admittedly simplified, as it abstracts away from the rent-to-buy decision, uncertainty over income or interest rates, bequests motives, and the like. However, the problem illustrates two of the three constraints we wish to focus on. The first is the down payment constraint which limits the amount of the housing purchase that can be financed. Housing is perfectly divisible in this model, so low income households are not shut out of the housing market. Instead, they consume small quantities of housing. If we were to specify a minimum amount of the housing good, $\bar{h}$ that can be purchased, then the down payment constraint can be much more important for households with initially low income. Indeed, if prices are such that a household can not afford to buy the minimum quantity $\bar{h}$, then reducing the down payment constraint will literally make homeownership possible.

The second constraint that the problem highlights is the timing of the repayment of the mortgage. We consider cases where the repayment schedule is constant over time ($m_1 = m_2$), as is the case for the standard fixed-rate fully amortizing loan. Alternatively, we can allow for payments to grow over time, $m_1 < m_2$. As stated above, this shifting of the burden of the mortgage repayment from early in the life of the loan to the latter periods has been one of the defining characteristics of the so-called alternative mortgage products. Other representations of the timing constraint could include, for example, a constraint on m_1 not exceeding a certain fraction of y_1. These other representations yield results very similar to

those presented below.

The model is solved numerically. In these simulations, the housing preference parameter, $(1-\theta)$, is set to .3, slightly above the share of income that the average household devotes to housing. The parameter γ is equal to 2; the greater the value of γ, the less easily households can substitute consumption in one period for another. The main results are not sensitive to to the choice of γ, so long as $\gamma > 1$.

We study two hypothetical households that differ by their income growth; both households have the same income in period 1, but one household enjoys income growth of 50 percent in the second period (similar to the growth experienced by educated households over a multi-year period), while the other household's income grows by just 10 percent. We examine the effect of changes in the down payment constraint on the housing expenditures made by the two households. We also consider two different scenarios for the timing of the mortgage repayment. In the first, the mortgage payments are equal in both periods. In the second scenario, the mortgage payment is allowed to grow in the spirit of some alternative mortgage products. In this scenario, we assume that $m_2 = 1.5 * m_1$.

The model's solution includes utility, spending on consumption of the nonhousing good (c_1 and c_2), and spending on housing. To better match available empirical measures, we focus on the share of income spent on housing, and the model's results are summarized in Figure 2. This figure shows how the share of income spent on housing varies by income

growth, the down payment constraint, and the alternative scenarios for the timing of the mortgage payment. Several points emerge from the simulations. First, housing expenditures as a share of income increase as the down payment constraint is eased from 20 percent to 5 percent, regardless of income growth or assumptions about the timing of the mortgage payments. Second, the slope of these expenditure functions is greater for high income growth households (dashed lines) than for households with low income growth (solid lines). Third, shifting the burden of the mortgage repayment to the second period (when income is higher) induces households to spend more on housing. These changes in housing expenditures are larger for high income growth households than they are for lower income households. Indeed, for low income growth households that have access to a mortgage that grows over time (bold solid line), there comes a point where the down payment constraint no longer binds, and further relaxation of the constraint does not change the housing consumption decision.

These results are based on a very simple model that examines two of the three innovations we have emphasized. A more complex multi-period model is required to examine the effects of the third innovation–the lower costs associated with refinancing and extracting equity from the home. Such an extension yields many of the same qualitative results from the simple two-period model. Namely, if households are allowed access to their home equity to use as income insurance, then reducing the costs of equity extraction (making the home equity more liquid) will have the effect of making the home a more attractive asset, all else

equal, and demand for housing will increase. The increase in the liquidity of home equity will benefit all households, and particularly those with fewer non-housing assets (such as the young and lower income), and those with volatile income.[13]

4 Empirical results

The models presented in the previous section generate a diverse set of predictions. As one of the important margins of housing adjustment from the consumer's perspective is the rent-to-buy margin, our first set of results examines the change in the homeownership rate from 1994 to 2004. Then, focusing only on homeowners, we examine how the share of income devoted to housing has increased over time. The final set of results explores the choice of mortgage characteristics by demographic groups.

4.1 Changes in homeownership rates

Our models illustrate how innovations in mortgage markets would increase demand for housing, and one manifestation of that increased demand would be an increase in the homeownership rate.[14] The homeownership rate fluctuated within a tight range between 1970 and 1994. Starting in 1994, the homeownership rate began a steady rise of five percentage points to 69 percent in 2004, and has since remained close to this elevated level. The 1994 to 2004 increase in the homeownership rate reflected an increase of 12 million homeowners.[15]

One factor behind the increase in the homeownership rate could have been the improvement in overall economic conditions, as the 1994-2004 period witnessed a period of above-average growth. However, there are several reasons to discount the improving economy story. First, although economic growth was strong overall during this period, there was a recession in 2001, and despite this downturn, the homeownership rate steadily increased. Further, as has been documented in numerous studies, gains in real income were largely confined to the upper tail of the income distribution during this time period (see Autor, Katz, and Kearney 2005), and, as we show and discuss below, the homeownership rate increased rapidly for the low to middle income groups. Finally, looking over a longer time period (back to the 1960s), changes in the homeownership rate do not correlate closely with economic cycles.

Another reason ownership rates could have increased is in response to demographic change. For instance, the median age of the population has been increasing as the baby boomers work their way up the age scale; if older people are more likely to be homeowners, then the increase in the homeownership rate could simply reflect changing demographics. Table 1 shows the change in the homeownership rate by various demographic breakdowns for 1994 and 2004 using the Current Population Survey (CPS) outgoing rotation panel in conjunction with the Residential Vacancy and Homeownership Survey. As discussed in other research and shown in Table 1, homeownership rates increased between 1994 and 2004 for nearly every demographic sub-group, but the largest increases occurred for the young and

college-educated.

To be more precise about the role of changing demographics, we decompose the change in the homeownership rate into the change attributable to changes in demographics and into changes in the propensity for homeownership for each demographic group. Using the procedure proposed by Fairlie (2005) that follows the spirit of Blinder-Oaxaca decompositions, we find that changes in the demographic distribution between 1994 and 2004 account for less than 20 percent of the increase in the homeownership rate. Most of the increase in the homeownership rate is attributable to an increased propensity for homeownership by each demographic slice of the population.

The models in section 3 are consistent with the results in Table 1 in several ways. Through the credit scoring channel, down payment requirements would be reduced, and that would assist the younger households that are traditionally cash constrained. Also, households with steep expected earnings profiles may be able to purchase their desired home earlier by using financing instruments that have payments that increase over time; that is, households where the head is college-educated. The households headed by younger people enjoyed the largest increase in ownership; according to our models, it is this group that may have faced the largest relaxation in borrowing constraints. Further down in Table 1 are results by age and education. As mentioned in the model section, we examine education because the curvature of lifetime earnings profiles varies tremendously by educational attainment. Within the

younger groups (households where the head is less than 40), it is the college educated that have increased their homeownership rates the fastest.

The results in Table 1 hold up to more formal analysis. Probit models of homeownership were estimated with the variables presented in Table 1 (age, education, income, etc.) and other controls include number of children, prime age adults, and seniors. The models were estimated where all of the independent variables were interacted with year (1994 or 2004). The number of estimated parameters is therefore large and we do not present them here. When simultaneously controlling for a wide variety of variables, the demographic groups that enjoyed the largest statistical increase in homeownership are those groups shown in Table 1, namely the young and higher-educated.

4.2 Housing costs as a share of income

The models in section 3 suggest several reasons why households would increase their lifetime expenditures on housing relative to income. We examine changes in household spending on housing relative to income, where housing costs include mortgage payments, utilities, property taxes, home insurance, condo fees, and other regularly occurring costs associated with homeownership that are collected in the American Housing Survey (AHS). There are several micro-level data sets with some measure of housing costs and income, including the Panel Survey of Income Dynamics, the Survey of Consumer Finance, the Consumer

Expenditure Survey, and the AHS. Although each data set possesses its own advantages, we focus on the results from the AHS because the AHS has a larger sample than the other surveys. Also, the AHS has some geographic detail, which, as we explain further below, could potentially be important for identification. Finally, the AHS has a wealth of information about the home, the demographics of its occupants, and the way the home is financed. We use observations from the AHS in the odd-numbered years between 1997 and 2005. We limit the sample from 1997 onward because the data are consistent over this time and edit flags are available. To be included in the analysis, we required observations to have reported mortgage payments, at least 50 percent of salary income not imputed, and the households were homeowners. In the analysis, we focus on the ratio of total housing costs to income. However, our results are robust to other measures as well, including the ratio of total mortgage costs to income and the cost of servicing just the primary mortgage to income.[16]

A visual representation of total housing cost to income is presented in Figure 3, the kernel density over our sample period. There is a notable rightward shift from 1997 to 2005 in these unconditional distributions. To more closely examine this rightward shift, we estimate a set of models of the form:

$$h_{it} = \alpha + \beta X_{it} + \gamma_t + \epsilon_{it} \tag{5}$$

where h_{it} is some measure of housing cost to gross income for family i and time t, and γ is a vector of time dummies. To ensure that the year dummy results do not arise from changing demographics, we include control variables, X, that measure basic information about the household, including educational attainment, the number of children, prime age adults, and elderly in the household. Further, we include a set of five age dummies for the head of household (20-29, 30-39, 40-49, 50-59, and 60-69). [17] A Tobit model is used to estimate these equations because the dependent variable is left-censored at zero and we impose a right-censor at 80.[18]

Table 2 reports results from differing specifications of equation (5). In all of the models, we include year fixed effects to examine the change in the ratio of housing costs to income over time for the mean household. The first column reports the estimates from a model that includes only year dummies. Column 2 reports the results for year dummies and basic demographic controls. As discussed above, the homeownership rate rose considerably during the sample period, resulting in a potential change in sample. To control for the possibility that the coefficients on the time dummies may be influenced by the influx of new homeowners, the model reported in column 3 includes the number of years the family has been living in the home and the number of years squared in addition to the demographic controls in column 2.[19] Finally, columns 4 and 5 include dummy variables for the metropolitan statistical area (MSA) of the household; column 5 drops those observations where the MSA is not reported

while column 4 codes those observations as their own unique MSA.

In terms of the coefficients on the year dummies, all of the models show that the share of income devoted to housing has increased several percentage points from 1997 to 2005, and this result is robust to numerous specifications.[20] In terms of the demographic controls, we generally find that higher educated households tend to spend a smaller share of their income on housing, as do households with persons over the age of 60. The opposite is true of households with more than one prime age adult. Perhaps not surprisingly, the total housing costs-to-income ratio falls as age increases. Households whose heads are of age 60 to 70 pay about 5-7 percentage points less in mortgage payments relative to income than households in their 20s. As a robustness check, the models were estimated separately by year and the coefficients on the demographic variables changed little over time.[21] Although these demographic controls are interesting in and of themselves, the main motivation for including them is to ensure that the results for the time dummies do not arise from demographic changes in the sample.

One of the main implications from the model section was that those households facing binding financial constraints will benefit the most from financial innovations. Applying this logic, lower income households are more likely to face finance constraints than higher income households. To examine how the share of income devoted to housing varies by income, Table 3 reports models estimated separately for each income quintile.[22] The two groups that

experienced the largest increases over time are the two lowest income quintiles, where the increase in housing expenditure share increased by approximately 3-3/4 percentage points from 1997 to 2005. By contrast, the sample that makes up the highest income quintile increased their share of income to housing by only 1-1/2 percentage points.

The model section also highlighted how households may benefit from mortgage innovations by age and educational attainment. Table 4 shows the results by age and educational attainment; the younger members of both educational groups–those with high school or less and those with some college or more–witnessed similar increases in the share of income devoted to housing costs. Additionally, when the models are estimated by income quintile interacted with educational attainment (not shown), the lower income groups in both educational categories witnessed the largest increases in housing costs-to-income ratios.

4.3 Possible alternative explanations

The increased expenditure shares on housing could arise for reasons other than those suggested by our models. For instance, over the period we examine, house prices increased sharply and steadily. If households' expectations about future gains subsequently increased, then households may increase their demand for housing and increase their share of income devoted to housing. Another possible reason for increased expenditure shares on housing could arise from expectations that future income will be higher, leading to increased spending

on housing and on other goods as well. We investigate each of these possible explanations in turn.

Although house prices increased significantly during our sample period (1997-2005), the changes were less than uniform across the country. In particular, several locations along the Atlantic and Pacific coasts witnessed tremendous increases whereas many other areas, especially in the south, experienced much more muted increases. To illustrate this point, Figure 4 shows the kernel density of house price appreciation from 2000 to 2005 for the MSAs in our sample.[23] We split the AHS data into four quartiles based on the change in home prices, and then re-estimate the models for each group.[24] The results are presented in Table 5. As a baseline, column 1 presents the model estimates from the entire sample and replicates the results in Table 2. The change in expenditure shares varies somewhat across regions, but not systematically with the degree of local housing market conditions. However, if expectations for house price appreciation are influenced not by local conditions but instead solely by national conditions (which we find unlikely), then the results in Table 5 do not rule out the possibility that increased expectations of appreciation could be partly responsible for increased expenditures shares on housing.

Another possible explanation for our results is that spending shares on all goods may have increased, perhaps as a reflection of increased future income expectations. After all, the aggregate savings rate fell considerably during our sample period. To examine this hy-

pothesis, we examined information from the Consumer Expenditure Survey (CES). Relative to the AHS, the CES does not contain geographical information or detailed information on costs associated with the servicing of property debt. However, an advantage of the CES is that it does contain information on expenditures other than housing costs. We compute several expenditure share measures using these data from 1994 to 2003 and run regressions similar to those using the AHS data. The results are presented in Table 6. In the first column we show results from a regression of spending relative to income that excludes housing on a set of year dummies and demographic characteristics for households that are homeowners. Between 1994 and 2003, there appears to be a slight decrease in the share of income devoted to non-housing consumption. The second column shows the same basic regression but where the dependent variable is the share of income going to mortgage payments. Roughly speaking, the decrease in the share of income going to other consumption goods is matched by the increase in income going to housing. This result is interesting in that it suggests that the increase in expenditures for housing did not come directly out of saving but instead out of consumption of other goods.[25]

4.4 Mortgage and demographic characteristics

The empirical sections above examined homeownership and the share of income devoted to housing of homeowners. In this section, we examine the choice of mortgage characteris-

tics. Recall that according to our model, younger, cash-constrained households with steep expected income profiles would stand to benefit from mortgages with low initial payments. One way households can reduce their mortgage payments, at least for a time, is to finance their housing consumption with mortgage products that have relatively low introductory interest rates.

The AHS data contain limited information about the primary mortgage of homeowners, including the interest rates for the primary and secondary mortgages. Using this information, we construct an average mortgage interest rate where the interest rates are weighted by the value of the mortgage. We then examine the relationship between interest rates and demographic characteristics, and those results are presented in Table 7. Before discussing the results, an important omitted variable in our models is credit quality. Given the importance of this variable, the results in Table 7 have to be viewed with greater skepticism than the results in the previous tables. With that caveat in mind, the results in Table 7 are entirely consistent with our models.

The first three columns of Table 7 are probit models where the dependent variable equals one if the average interest rate is in the lowest quintile for a year. The first column shows the results for the entire sample and the second and third columns estimate the models separately by whether households are in the bottom or top half of the income distribution. In addition to the controls used in Tables 2-6, the controls in Table 7 also include dummy

variables for the income decile of the household; it is hoped that these controls may be correlated with the unobserved credit quality of households.

The first three columns of Table 7 show that households headed by individuals with at least some college education are more likely to be in the lowest interest rate quintile. However, this result may be tainted from a positive correlation between education and credit quality that is not captured by the income deciles. The remaining rows of the table show the coefficients for the age dummies; in all three columns, younger households are more likely to have lower interest rates on their mortgages. This result is somewhat surprising as credit quality is likely to be inversely related to age. Comparing columns 2 and 3, we find that the age profile of interest rates is greater for lower income households than for higher income households. Again, lower income households are more likely to face the constraints addressed in our model, and therefore may be more inclined to choose mortgage instruments that offer initially low interest rates. We also estimated models where the dependent variable is the average interest rate; those models yield results that are qualitatively very similar to the probit results.[26]

5 Conclusion

Over the last decade there have been several innovations in mortgage markets, such as the lowering of down payment requirements, the increased flexibility in repayment schedules,

and the reduction of costs associated with extracting equity from homes. We develop a model that generates testable implications of how these innovations would affect household behavior. For instance, the lowering of down payment requirements should result in homeownership increasing, especially for young people who are traditionally cash constrained. In fact, we show that between 1994 and 2004, the homeownership rate for young people rose sharply. Our model predicts that lower down payments and more flexible mortgage payment schedules should lead to higher housing consumption for previously constrained households. Empirically we document that households have increased the share of their income devoted to housing by a substantial margin. The result is robust to the changing composition of households and also to location; the share of income devoted to housing costs has increased significantly in markets, regardless of what happened to housing prices in those markets. Finally, we find that young educated households have dramatically increased their housing expenditures between 1995 and 2005, but appear to be financing these expenditures with mortgages that have relatively low interest rates. We interpret this finding to be suggestive that these households may be financing their increased housing consumption with alternative, flexible mortgage products.

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Notes

[1] See Green and Wachter (2005) and Gerardi, Rosen, and Willen (2006) for longer-term historical descriptions of changes in the mortgage market and see LaCour-Little (2000) for a discussion of more recent changes.

[2] Bostic and Surette (2001) document the narrowing of the homeownership gap between whites and minorities over the past several decades, attributing a large part to mortgage market innovations such as credit scoring. Li (2005) notes that in addition to the increase in homeownership rates in the 1990's, leverage (the loan-to-value ratio) conditional on homeownership has also increased. See also Davidoff (2006) and Ortalo-Magne and Rady (2005).

[3] See Hochstein 2000.

[4] See Doms and Krainer (2007) for a fuller description of these measures.

[5] See Bennett, Peach, and Peristiani (2001) for evidence of structural change in the propensity to refinance.

[6] See LaCour-Little (2000) for an excellent summary of the role of technology in mortgage finance.

[7] See Barakova, Bostic, Calem, and Wachter (2003).

[8] Vickery (2006) documents that the choice between fixed-rate and adjustable-rate mortgage loans is very sensitive to the level of interest rates. Koijen, van Hemert, and Van Nieuwerburgh (2006) show that the variation in the total share of adjustable-rate mortgages over time is linked to the bond risk premium embedded in mortgage interest rates.

[9] See, for example, LeRoy (1996) and Stanton and Wallace (1998).

[10] While demand for alternative mortgage products surged in the early 2000s, these products could not be considered new at the time. For example, the graduated payment mortgage was first offered in 1977. See Alm and Follain (1984) for an analysis of the possible consumer gains to using this and other flexible mortgage products. Campbell (2006) notes that, historically, consumers have been slow to demand financial products that would seemingly be welfare enhancing. See Krainer (2006) for further discussion on the prevalence of alternative mortgages.

[11] The down payment and income constraints arise, in part, because of information asymmetries between borrowers and lenders. The down payment constraint guards against moral hazard that might lead borrowers to default on their loans. The payment-to-income constraints can be justified by the notion that lenders might not know what a borrower's true income growth prospects are.

[12] The results in Figure 1 hold using other datasets as well.

[13] Dynan, Elmendorf, and Sichel (2007) have explored this idea, arguing that innovations in mortgage markets may have helped households to better smooth nonhousing consumption. Hurst and Stafford (2004) examine the propensity to refinance for liquidity-constrained and non liquidity-constrained households.

[14] Housing services, the variable in the consumer's model, is difficult to measure. We assume that most households that became homeowners increased their flow of housing services from when they rented.

[15] For more comprehensive discussions on the increase in the homeownership rate, see Bostic and Surrette (2000), Gabriel and Rosenthal (2005), and Li (2005).

[16] We examined primary mortgage cost to abstract away from a change in debt structure

of households, such as a shift away from revolving credit to a home equity line of credit or a second mortgage.

[17] Households headed by individuals 70 years old or older are excluded. The results in this paper are robust to a wide array of other measures of demographics.

[18] The results are robust to choice of the right-censoring value.

[19] Our results are robust to a other specifications that control for new homeowners.

[20] The general result that the share of income devoted to housing has increased is consistent with results using other data sets, including the Survey of Consumer Finances, the Panel Survey of Income Dynamics, and the Consumer Expenditure Survey.

[21] One of the implications of the model is that the share of income devoted to housing would become more constant over time. However, discerning whether a flattening of the age-housing cost profile has occurred is difficult using a data set that spans only 8 years. To make more definitive statements whether housing costs-age profiles have changed shape, data for a sufficient period of time after the changes in mortgage markets have taken place would be required. The results presented here are limited to suggesting that more is being spent on housing for all age groups.

[22] The sample sizes in Table 3 are skewed to the higher income quintiles because the income quintiles are computed using the entire AHS sample, which includes renters. Renters tend to have lower incomes than homeowners. The results are robust to income quintiles being computed using only homeowners.

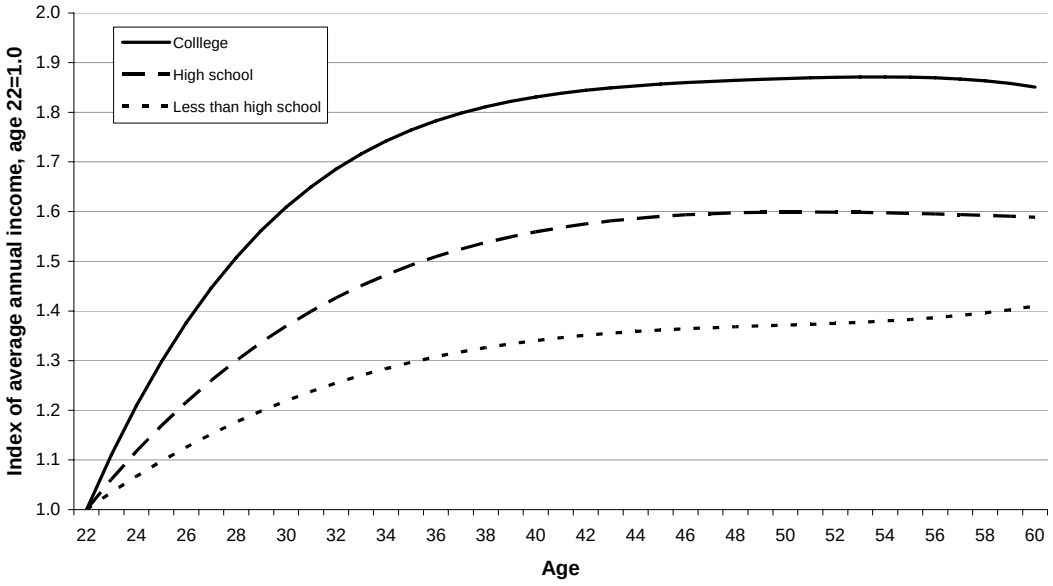
[23] We examined the price change for a number of different periods, and our results are robust to the time period examined.

[24] Several of the models run in Table 2 control for MSA in that a dummy variable is used for all time periods. This dummy variable will pick up mean differences in housing expenditures-to-income by region but will not capture changes in housing expenditures-to-income by region.

[25] There are several reasons why our results can be consistent with the decline in the national savings rate. First, the regressions in Table 6 represent the mean household whereas the national savings rate, in essence, weights households by income. As we saw previously, higher income households did not increase their housing expenditures as a share of income by as much as lower income households. Further, the decrease in the official national savings rate stems, in part, from an increase in health care expenditures. In the official statistics, employer contributions also go towards consumption, which reduces the savings rate.

[26] We also examined other observable characteristics of the mortgage, such as whether the mortgage is adjustable or not. Unfortunately, the AHS data do not provide other information on how and when the interest rate is adjustable. For instance, a traditional 10-1 ARM would be coded the same as a 1-year ARM that offered a low initial teaser rate.

Figure 1: Mean Income Profiles by Age and Education



Results from tobit models of the log of salary and wage income on a fourth-degree polynomial of age for each of three education groups. The models were estimated using data on full-time workers from the 2000 decennial census.

Figure 2: Housing Expenditure Shares, Income Growth, and Financial Constraints

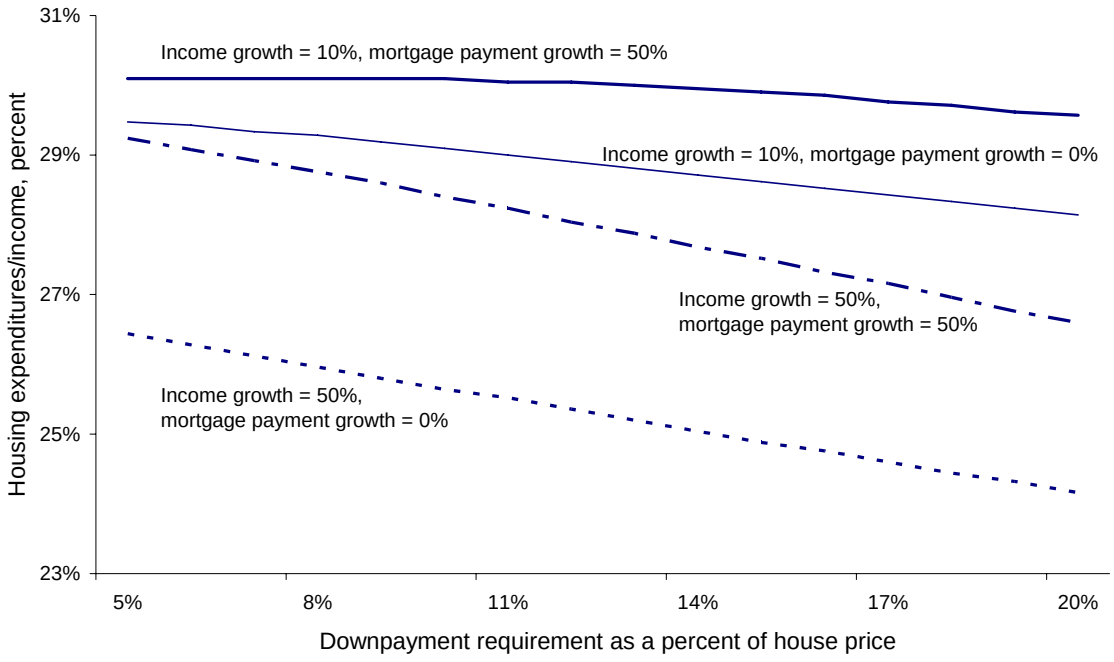
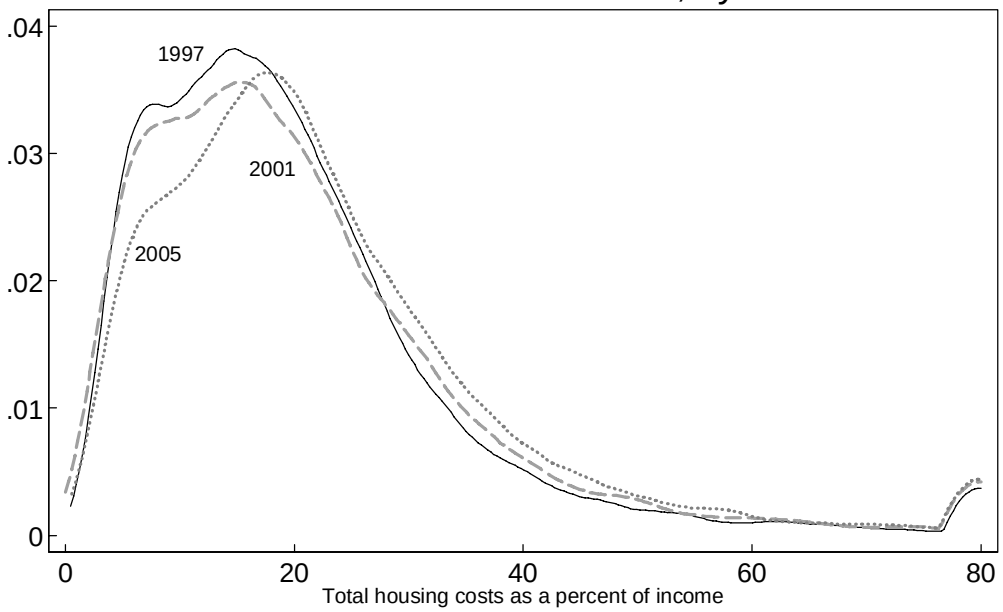
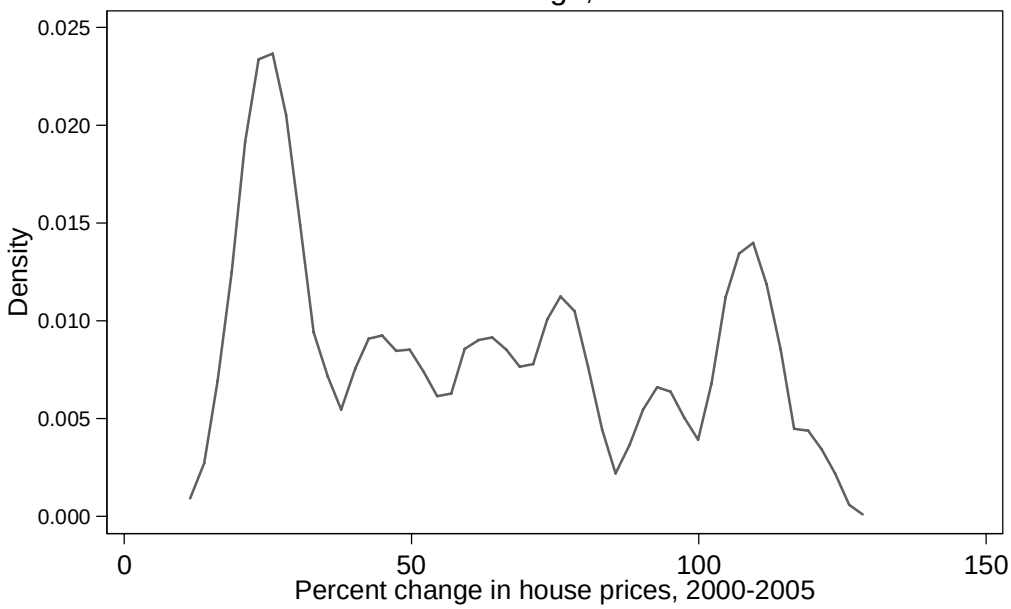


Figure 3: Kernel Densities of Total Housing Costs as a Percent of Income for Home Owners, by Year



Source: American Housing survey (various years) and authors' calculations. The distribution is right censored at 80.

Figure 4: Kernel Density of House Price Changes Across MSAs



Note: MSA house price data are from OFHEO and observations are weighted by the prevalence in the AHS.

Table 1: Homeownership Rates by Demographic Groups, 1994 to 2004

		Rates by year		Change
		1994	2004	2004-1994
Age of head of household				
18-29		26.6	33.2	6.6
30-39		55.8	61.8	6.0
40-49		70.5	74.1	3.6
50-59		77.8	79.6	1.8
60+		77.9	81.4	3.5
Education (in years of schooling) of head of household				
12 years or less		61.3	64.1	2.8
13 or more		66.6	72.9	6.3
Age and education of head of household				
18-29	12 years or less	25.4	30.0	4.6
	13 or more	27.7	35.6	7.9
30-39	12 years or less	50.2	52.0	1.8
	13 or more	60.4	67.9	7.5
40-49	12 years or less	63.6	66.1	2.5
	13 or more	75.8	79.6	3.8
50-59	12 years or less	73.4	73.2	-0.2
	13 or more	82.5	83.7	1.2
60+	12 years or less	75.3	78.2	2.9
	13 or more	83.4	86.0	2.6
Income quartile of family income				
1st quartile		41.2	44.7	3.5
2nd quartile		58.6	63.8	5.2
3rd quartile		72.9	78.5	5.6
4th quartile		87.1	91.1	4.0

Source: Current Population Survey and authors' calculations

Table 2: Tobit Models of Total Housing Costs as a Percent of Income

Year dummies (1997 omitted)	(1)	(2)	(3)	(4)	(5)
1999	-0.211	-0.253	-0.255	-0.239	0.052
	(0.176)	(0.173)	(0.171)	(0.170)	(0.273)
2001	0.885	0.863	0.886	0.863	0.713
	(0.173)**	(0.170)**	(0.169)**	(0.168)**	(0.270)**
2003	1.093	1.184	1.206	1.262	1.647
	(0.172)**	(0.169)**	(0.168)**	(0.167)**	(0.269)**
2005	2.632	2.702	2.714	2.860	3.263
	(0.172)**	(0.170)**	(0.169)**	(0.167)**	(0.272)**
Demographic Controls					
Education of head of household (=1 if some college or more, =0 otherwise)		-1.653	-1.987	-2.116	-4.190
		(0.113)**	(0.112)**	(0.113)**	(0.192)**
Age of head of household dummies (less than 30 omitted):					
30<=Age<=39		-2.076	-1.067	-2.322	-2.872
		(0.223)**	(0.225)**	(0.220)**	(0.362)**
40<=Age<=49		-2.966	-0.542	-3.203	-3.856
		(0.215)**	(0.223)*	(0.213)**	(0.354)**
50<=Age<=59		-3.770	-0.428	-4.017	-4.444
		(0.226)**	(0.242)+	(0.224)**	(0.366)**
60<=Age<=69		-5.630	-1.611	-5.753	-7.184
		(0.341)**	(0.354)**	(0.337)**	(0.526)**
Number of children		1.262	1.226	1.244	1.396
		(0.054)**	(0.054)**	(0.053)**	(0.085)**
Number of prime age adults		-3.350	-3.066	-3.581	-3.326
		(0.081)**	(0.080)**	(0.080)**	(0.118)**
Number of elderly adults		-1.534	-1.356	-1.997	-1.492
		(0.187)**	(0.185)**	(0.185)**	(0.273)**
Years living in the house			-0.405		
			(0.045)**		
Years living in the house, squared			-0.002		
			(0.003)		
SMSA dummies	No	No	No	Yes	Yes, SMSA unknown dropped
Constant	20.156	31.067	32.112	34.714	35.482
	(0.120)**	(0.324)**	(0.326)**	(3.873)**	(5.990)**
Observations	72443	72443	72443	72443	31020

Notes: Standard errors in parentheses, all models estimated by maximum likelihood. All data from the American Housing Survey.
+ significant at 10%; * significant at 5%; ** significant at 1%

Table 3: Tobit Models of Total Housing Costs as a Percent of Income by Income Quintile

	All	Income quintile (1=lowest, 5=highest)				
Year dummies (1997 omitted)	observations	1	2	3	4	5
1999	-0.253	-1.128	-0.181	0.510	0.020	-0.985
	(0.173)	(1.001)	(0.441)	(0.298)+	(0.218)	(0.183)**
2001	0.863	1.970	1.527	1.239	1.071	-1.295
	(0.170)**	(0.970)*	(0.439)**	(0.293)**	(0.217)**	(0.180)**
2003	1.184	1.425	1.402	1.314	1.321	-0.247
	(0.169)**	(0.972)	(0.433)**	(0.291)**	(0.215)**	(0.179)
2005	2.702	3.910	3.801	2.709	2.453	1.455
	(0.170)**	(0.998)**	(0.430)**	(0.295)**	(0.215)**	(0.178)**
Education of head of household (=1 if some college or more, =0 otherwise)	-1.653	7.903	3.915	3.246	2.310	1.983
	(0.113)**	(0.652)**	(0.281)**	(0.192)**	(0.151)**	(0.154)**
Age of head of household dummies (less than 30 omitted)						
30<=Age<=39	-2.076	2.751	0.003	0.906	0.348	0.088
	(0.223)**	(1.159)*	(0.483)	(0.341)**	(0.287)	(0.331)
40<=Age<=49	-2.966	3.065	-0.809	0.228	-0.431	-1.126
	(0.215)**	(1.114)**	(0.478)+	(0.333)	(0.281)	(0.323)**
50<=Age<=59	-3.770	0.369	-2.112	-1.678	-2.078	-2.298
	(0.226)**	(1.155)	(0.504)**	(0.353)**	(0.293)**	(0.325)**
60<=Age<=69	-5.630	-1.358	-5.579	-3.829	-4.353	-5.339
	(0.341)**	(1.639)	(0.771)**	(0.568)**	(0.458)**	(0.434)**
Number of children	1.262	2.495	1.525	0.991	0.959	0.802
	(0.054)**	(0.314)**	(0.134)**	(0.092)**	(0.069)**	(0.058)**
Number of prime age adults	-3.350	2.287	0.174	-0.349	-0.545	-0.061
	(0.081)**	(0.480)**	(0.219)	(0.148)*	(0.111)**	(0.084)
Number of elderly adults	-1.534	4.100	0.714	-0.050	0.003	0.694
	(0.187)**	(0.987)**	(0.443)	(0.325)	(0.243)	(0.198)**
Constant	31.067	21.089	18.192	14.746	14.025	11.359
	(0.324)**	(1.684)**	(0.785)**	(0.565)**	(0.470)**	(0.480)**
Observations	72438	7537	11637	15254	18212	19798

Notes: Standard errors in parentheses, all models estimated by maximum likelihood. All data from the American Housing Survey.
+ significant at 10%; * significant at 5%; ** significant at 1%

Table 4: Tobit Models of Total Housing Costs as a Percent of Income by Educational Attainment and Age

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
		High School or Less			Some College or More		
Year dummies (1997 omitted)	All	Age<=39	40<=Age<=49	Age>=50	Age<=39	40<=Age<=49	Age>=50
1999	-0.253	-0.095	-0.322	-0.345	-0.075	-0.518	-0.309
	(0.173)	(0.571)	(0.517)	(0.504)	(0.339)	(0.358)	(0.400)
2001	0.863	2.205	0.527	1.732	0.595	-0.248	0.921
	(0.170)**	(0.574)**	(0.515)	(0.500)**	(0.335)+	(0.353)	(0.388)*
2003	1.184	2.209	1.195	1.014	1.503	0.887	0.692
	(0.169)**	(0.580)**	(0.514)*	(0.502)*	(0.333)**	(0.351)*	(0.377)+
2005	2.702	4.224	2.976	2.039	3.300	2.021	2.278
	(0.170)**	(0.594)**	(0.520)**	(0.511)**	(0.329)**	(0.352)**	(0.375)**
Education of head of household (=1 if some college or more, =0 otherwise)	-1.653						
	(0.113)**						
Age of head of household dummies (less than 30 omitted)							
30<=Age<=39	-2.076						
	(0.223)**						
40<=Age<=49	-2.966						
	(0.215)**						
50<=Age<=59	-3.770						
	(0.226)**						
60<=Age<=69	-5.630						
	(0.341)**						
Number of children	1.262	1.447	1.770	2.250	0.968	0.814	1.793
	(0.054)**	(0.153)**	(0.149)**	(0.237)**	(0.093)**	(0.097)**	(0.191)**
Number of prime age adults	-3.350	-4.324	-3.316	-3.228	-5.255	-3.747	-2.743
	(0.081)**	(0.361)**	(0.228)**	(0.206)**	(0.222)**	(0.166)**	(0.146)**
Number of elderly adults	-1.534	1.250	3.724	-2.987	1.533	2.667	-2.137
	(0.187)**	(1.031)	(0.816)**	(0.285)**	(0.663)*	(0.587)**	(0.218)**
Constant	31.067	28.722	25.828	25.047	29.697	26.368	22.895
	(0.324)**	(0.785)**	(0.584)**	(0.566)**	(0.456)**	(0.419)**	(0.421)**
Observations	72438	7737	7746	10456	15645	14711	16143

Standard errors in parentheses

+ significant at 10%; * significant at 5%; ** significant at 1%

Table 5: Tobit Models of Total Housing Costs as a Percent of Income by House Price Appreciation Region

		Region (1=lowest house price appreciation, 4=highest house price appreciation)				
	All observations	1	2	3	4	SMSA not defined
Year dummies (1997 omitted)						
1999	-0.253	-0.020	1.244	-0.742	-0.448	-0.437
	(0.173)	(0.501)	(0.510)*	(0.608)	(0.665)	(0.215)*
2001	0.863	0.673	1.630	0.579	-0.218	0.894
	(0.170)**	(0.498)	(0.500)**	(0.608)	(0.646)	(0.212)**
2003	1.184	1.639	2.483	0.829	1.020	0.978
	(0.169)**	(0.493)**	(0.500)**	(0.604)	(0.652)	(0.210)**
2005	2.702	3.047	3.576	2.072	3.783	2.554
	(0.170)**	(0.496)**	(0.503)**	(0.615)**	(0.666)**	(0.210)**
Education of head of household (=1 if some college or more, =0 otherwise)	-1.653	-2.464	-3.409	-3.959	-6.701	-0.900
	(0.113)**	(0.338)**	(0.362)**	(0.428)**	(0.461)**	(0.139)**
Age of head of household dummies (less than 30 omitted)						
30<=Age<=39	-2.076	-2.838	-3.513	-2.138	-1.823	-2.000
	(0.223)**	(0.608)**	(0.658)**	(0.875)*	(0.936)+	(0.274)**
40<=Age<=49	-2.966	-4.234	-4.077	-3.950	-1.768	-2.791
	(0.215)**	(0.590)**	(0.638)**	(0.861)**	(0.914)+	(0.263)**
50<=Age<=59	-3.770	-4.178	-5.382	-4.621	-1.879	-3.819
	(0.226)**	(0.620)**	(0.665)**	(0.877)**	(0.940)*	(0.279)**
60<=Age<=69	-5.630	-4.664	-8.472	-8.230	-5.665	-4.833
	(0.341)**	(0.997)**	(0.981)**	(1.200)**	(1.245)**	(0.434)**
Number of children	1.262	1.348	1.282	1.228	1.824	1.112
	(0.054)**	(0.151)**	(0.161)**	(0.194)**	(0.197)**	(0.068)**
Number of prime age adults	-3.350	-4.081	-3.888	-2.655	-2.327	-3.799
	(0.081)**	(0.225)**	(0.231)**	(0.255)**	(0.263)**	(0.107)**
Number of elderly adults	-1.534	-3.121	-1.063	-0.753	-0.399	-2.443
	(0.187)**	(0.586)**	(0.530)*	(0.560)	(0.594)	(0.246)**
Constant	31.067	33.560	36.746	37.514	40.999	29.767
	(0.324)**	(0.930)**	(1.019)**	(1.255)**	(1.375)**	(0.397)**
Observations	72438	7952	8212	6803	6533	42938

Notes: Standard errors in parentheses, all models estimated by maximum likelihood. All data from the American Housing Survey.
+ significant at 10%; * significant at 5%; ** significant at 1%

Table 6: Tobit Models of Housing Spending as a Percent of Income Using the Consumer Expenditure Survey, 1994-2003

	Spending as a percent of income by spending category		
	(1)	(2)	(3)
	Total spending ex. housing costs	Mortgage payments	Total housing costs
Year dummies, 1994 omitted			
1997	0.372	1.036	1.278
	(1.071)	(0.535)+	(0.692)+
1999	-2.289	1.391	0.958
	(1.064)*	(0.531)**	(0.687)
2001	-1.857	1.662	1.378
	(1.100)+	(0.552)**	(0.714)+
2003	-2.633	2.070	2.158
	(1.274)*	(0.636)**	(0.823)**
Constant	45.212	21.655	34.873
	(1.704)**	(0.850)**	(1.100)**
Demographic controls[1]	Yes	Yes	Yes
Observations	4599	4524	4524
R-squared	0.03	0.05	0.08

Standard errors in parentheses

+ significant at 10%; * significant at 5%; ** significant at 1%

[1] Demographic controls include number of income earners and children in the household, 5 age range dummies for the head of household, and 1 dummy variable for the education level of the head of household.

Table 7: Interest Rates on Mortgages and Demographic Characteristics

	Expected change in probability from a probit model of a household being in the bottom quintile of interest rates			OLS coefficients of the interest rate on the primary and second mortgages		
	(1)	(2)	(3)	(4)	(5)	(6)
	All households	Households below median income	above median income	All households	Households below median income	Household above median income
Head of household has some college education	0.023	0.018	0.025	-0.196	-0.251	-0.210
	(0.004)**	(0.006)**	(0.005)**	(0.013)**	(0.028)**	(0.015)**
Age of head of household dummies (less than 30 omitted)						
30<=Age<=39	-0.028	-0.035	-0.019	0.141	0.207	0.103
	(0.007)**	(0.009)**	(0.010)+	(0.022)**	(0.046)**	(0.027)**
40<=Age<=49	-0.036	-0.040	-0.030	0.215	0.284	0.208
	(0.007)**	(0.009)**	(0.009)**	(0.021)**	(0.045)**	(0.027)**
50<=Age<=59	-0.033	-0.057	-0.017	0.286	0.402	0.234
	(0.007)**	(0.009)**	(0.010)+	(0.023)**	(0.049)**	(0.028)**
60<=Age<=69	-0.027	-0.051	-0.014	0.290	0.496	0.234
	(0.011)*	(0.015)**	(0.016)	(0.038)**	(0.082)**	(0.044)**
Demographic controls	yes	yes	yes	yes	yes	yes
Observations	54648	16948	37575	54411	17062	37586
R-squared				0.28	0.16	0.33

Standard errors in parentheses

+ significant at 10%; * significant at 5%; ** significant at 1%

Demographic controls include the same variable reported in tables 2-6, dummy variables for income decile, and dummy variables for SMSA.