Why Has Home Ownership Fallen Among the Young?*

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Abstract

Home ownership of households with "heads" aged 25–44 years peaked in 1980. By the 2000 census the rate had fallen by roughly ten percent and it recovered only partially during the 2001–2006 housing boom. The 1980–2000 decline in young home ownership occurred as improvements in mortgage opportunities made it demonstrably easier to purchase a home for the first time. This paper uses an equilibrium life cycle model calibrated to micro and macro evidence to understand why young home ownership fell over a period when it became easier to own a home. We show that a trend toward marrying later and the increase in family income risk from delayed marriage and greater individual income risk are sufficient to account for most of the decline in young home ownership. We explain how changes to taxes, house prices, or household mobility rates are unlikely to be important factors affecting the decline.

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1 Introduction

Increasing home ownership has long been, and continues to be, a high priority of policy makers. This strong interest has led to a proliferation of legislated institutions and regulations intended to make home ownership easier. Despite these efforts, home ownership of households with "heads" aged 25–44 years reached its peak in 1980, twenty-six years before the peak of the aggregate home ownership rate in 2006. In the 2000 census the young home ownership rate was ten percent lower than in 1980, and it recovered only partially during the 2001–2005 housing boom. The declines in young home ownership after 1980 occurred as government intervention and private innovation in mortgage markets should have made it easier to purchase a home. This paper seeks to understand why home ownership of the young declined so much during this period when owning should have become easier.

Our explanation is driven by changes in marriage and idiosyncratic earnings risk. The key change in marriage is that individuals aged 25-44 marry less than they used to. Between 1980 and 2000 marriage rates for these individuals fell by 15 percentage points. Falling marriage rates mechanically lower home ownership, because the married tend to own more than the unmarried. But, this does not account for all of the decline: combining the 2000 shares of unmarried and married with the corresponding 1980 home ownership rates accounts for only half of the decline in young home ownership. Another indication that something else must be going on is that home ownership has fallen for young, married households as well.[1]

The other source of decline in young home ownership we point to is a rise in household earnings risk. Less marriage increases household earnings risk by reducing the time spent in the two-worker household state in which risk sharing is possible. Higher individual earnings uncertainty should also raise household earnings risk. There is a large literature which documents heightened individual and household earnings risk after 1980, including recent work by Cunha and Heckman (2007), and Heathcote et al. (2008). Other things equal, an increase in household earnings risk necessarily lowers home ownership when there are proportional adjustment costs. It is well-known that

[1] We are not the first to notice the decline in home ownership of the young or the potential for marriage to play a role in this decline. See, for example, Haurin et al. (1988) and Haurin et al. (1996).

such costs exist for housing transactions. In the presence of proportional transactions costs, the option of delaying the home purchase until the household is possibly wealthier and can afford a larger house has value. An increase in household earnings risk increases the value of this option, thereby delaying the transition to home ownership and lowering the home ownership rate.

There are other factors which *a priori* should work to raise young home ownership between 1980 and 2000. We have already emphasized the possible impact of mortgage innovations and government intervention on home ownership. Another important factor is the greater participation and improved outcomes of young females in the labor market after 1980. From 1980 to 1990 the employment rate of 25–44 year old females continued the increase that began in the early 1960s, rising close to 10 percentage points. Concurrently, the male–female average wage premium was shrinking. So, households with at least one female worker, other things unchanged, are richer, which can increase home ownership. Like Caucutt et al. (2002) we suspect that these changes in female labor market outcomes also drive the decline in marriage. However, we do not account explicitly for this connection in our analysis.

We disentangle the effects of the competing factors driving young home ownership with an equilibrium life-cycle model of consumption, saving, and housing. For simplicity, our model has a representative household. Marriage is modeled as the middle stage of a three stage life-cycle faced by the household. We account for less marriage by reducing the rate of transition to the middle stage of life, since evidence suggests delayed entry into marriage is the main cause. The impact of lower marriage rates and heightened individual earnings risk on household earnings risk is accounted for by increasing the variance of the household's idiosyncratic earnings process. We calibrate the model so that its stationary equilibrium is consistent with key features of the US economy in the years leading up to 1980. At the calibrated parameters, the model is consistent with microeconomic evidence that income, wealth and marriage are significant predictors of home ownership. Using the calibrated model we find that delayed marriage and increased earnings risk account for two-thirds to four-fifths of the decline in home ownership of the young, after taking into account developments in mortgage and labor markets. We also find that easier access to mortgage credit has only a small impact on home ownership.

Our paper is related to two emerging literatures. Several papers, including Blundell et al. (2008), Krueger and Perri (2006), and Heathcote et al. (2008), have begun to investigate the aggregate implications of rising idiosyncratic earnings risk. This work emphasizes empirical evidence suggesting consumption inequality has risen by less than income inequality since 1980. It does not address how rising income inequality may influence housing outcomes.

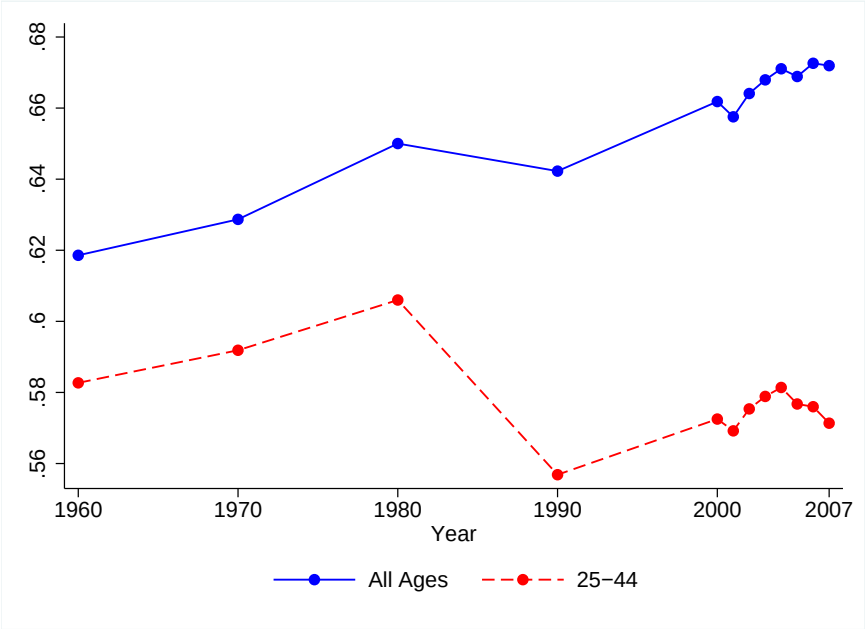
The second literature seeks to understand housing choices within the context of quantitative equilibrium life-cycle models. Gervais (2002) studies the impact of the preferential tax treatment of houses on tenure choice. We abstract from this issue since, as we argue below, we do not think it has played a role in the decline in young home ownership. Chambers et al. (2005) study the rise in home ownership after 1995 and, in contrast our findings, argue that weaker borrowing constraints played a big role. Kiyotaki et al. (2007) investigate factors leading to increases in house prices. Like us, they find that relaxing mortgage constraints has only modest implications for housing demand. Finally, Díaz and Luengo-Prado (2006) examine the determinants of the lifetime pattern of tenure and housing. Consistent with our analysis, they find an important role for idiosyncratic earnings risk.

The rest of the paper proceeds as follows. In section 2 we defend our focus on marriage and earnings risk in part by arguing that alternative explanations involving changes to tax policy, house price volatility, or household mobility patterns are unlikely to account for the decline in young home ownership. In section 3 we describe our life cycle model and in section 4 we describe our calibration. Section 5 decomposes the decline in home ownership of the young into the influence of the various factors we consider. We conclude in section 6.

2 Motivating Evidence

This section describes the evidence motivating our study. It includes evidence on (i) the decline in young home ownership during a time when it appears as if first time buying became easier, (ii) the connection between marriage and home ownership, (iii) marriage delay and instability, (iv) individual earnings uncertainty, and (v) why we do not focus on changes to tax policy, house prices, or household mobility patterns.

Figure 1: Home Ownership Rates, 1960-2007



Note: These are our estimates for 1960-2000 are based on the Decennial Census of Housing and for 2001–2007 the ACS.

2.1 Why Less Ownership if it's Easier to Own?

Figure 1 displays home ownership rates for the economy as a whole and households with heads designated by the Census Bureau aged 25 to 44 years.[2] These rates are calculated using the Decennial Census of Population and Housing for the years 1960-2000, and the American Community Survey for 2001-2007 (ACS).[3] The ACS is the basis for the Decennial Census going forward. We use the Census Bureau definition of the home ownership rate for a household with particular characteristics: the number

[2]Before 1980 the husband was always classified as the head when he and his wife were living together. In 1980 and after the head could be any household member in whose name the property was owned or rented. If no such person was present, any adult could be selected.

[3]Home ownership rates can be calculated annually from the Current Population Survey (CPS) from 1976 onwards and from the American Housing Survey (AHS) annually from 1973-1983 and semi-annually from 1985-2007. However, these rates often differ by several percentage points from comparable rates calculated using the Census of Housing and ACS. Given that the home ownership rates we calculate are based on larger samples that have higher survey response rates than the CPS and AHS we think they are more reliable. Nonetheless, the CPS and AHS present a similar picture in terms of the long term trends in home ownership we emphasize here.

of households with those characteristics who own divided by all households with those characteristics.

The overall rate grew by 3 percentage points between 1960 and 1980, dropped by about a percentage point between 1980 and 1990 and rose another 3 percentage points between 1990 and 2006, before dipping slightly in 2007. Higher ownership rates for older households and an aging population are the main proximate causes of the post-1990 rise in aggregate home ownership. For the young the time path is quite different. There is a large drop between 1980 and 1990 which takes the young home ownership rate two percentage points below its level in 1960. The young ownership rate also peaks two years earlier than the aggregate rate and in 2007 is essentially back to its 2000 level.

For simplicity, we focus our analysis on the years 1980 and 2000. The year 1980 is chosen because it is the year of the highest young home ownership rates. We use the year 2000 for two reasons. First, by this time many of the developments that have made it easier to purchase a home have already occurred. Second, because the years after 2000 involve unique driving forces which we do not address in this paper.

Table 1 demonstrates that the decline in young home ownership between 1980 and 2000 is broad based. It breaks out the decline in ownership of young households by different household characteristics. For all distinguishing characteristics but four the home ownership rate has fallen between 1980 and 2000. This includes, race, number of children, number of adults, region, educational attainment and income quintile. The increases are concentrated among single females living alone. We suspect these increases are in part due to a wealth effect. As we emphasized in the introduction, between 1980 and 2000 female labor market participation rose and the male-female wage gap fell. This means women are comparatively richer in 2000 and should demand more housing.

This decline in home ownership is striking because it came during a time when mortgage opportunities for young families seem to have expanded dramatically. Many papers document the development of the mortgage market since the regulatory changes in the early 1980s.[4] Public and private initiatives expanded mortgage opportunities

[4] Florida (1986) contains several essays describing mortgage market deregulation. Gerardi et al. (2007) provide a recent overview of how the mortgage market market has evolved. Edelberg (2003) discusses the expanded use of sophisticated credit scoring methods in the mid-1990s. Ryding (1990)

Table 1: Home ownership of the Young by Household Characteristic

Characteristic	1980	2000	Difference
Head's Age			
25-44	60.6	57.3	-3.3
25-29	43.4	36.0	-7.4
30-34	60.7	53.0	-7.7
35-39	69.7	63.4	-6.3
40-44	74.3	69.1	-5.2
Head's Race			
White	64.1	63.4	-0.7
Black	38.2	36.6	-1.6
Other	48.2	41.4	-6.8
Head's Sex			
Male	67.2	63.9	-3.3
Female	36.0	43.1	7.1
Head's Marital Status			
Not Married	33.0	38.2	5.2
Married	74.0	71.9	-2.1
Children			
None	41.4	45.1	3.8
One	63.3	60.4	-3.0
Two or more	72.5	67.0	-5.5
Adults			
One	30.9	36.2	5.3
Two	69.6	66.4	-3.2
Three or more	71.7	61.2	-10.5
Region			
East	54.4	53.5	-0.9
Midwest	66.4	63.8	-2.6
South	62.4	59.1	-3.3
West	56.0	50.5	-5.5
Head's Education			
< High School	49.8	40.2	-9.5
High School or Some College	62.1	57.4	-4.5
College	64.8	62.7	-2.1
Head's Income Quintile			
1	29.9	27.6	-2.3
2	45.2	43.0	-2.2
3	64.3	59.1	-5.2
4	77.7	73.5	-4.2
5	86.4	83.9	-2.5

Table 2: Characteristics of First Time House Buyers

Statistic	1976-80	1981-90	1991-99
Median Price/Median Income	2.0	2.1	2.4
Mean Down-payment/Price	.18	.16	.14
Mean Monthly Payment/After-Tax Income	.29	.34	.35

Notes: The averages are calculated from data in various issues of *The Guarantor*, 1978-1999.

by lowering transactions costs, the underlying real interest rate, and the required downpayment, among other factors.

These changes should have their largest impact on first-time home buyers, because they are the most likely to be lower in income and wealth. Table 2 describes how market outcomes of first-time home buyers have evolved over the period 1976–1999. Over the periods covered in the table first-time buyers have been able to finance their house purchase with progressively larger value to income ratio. In the 1976-80 period the median house price averages 2.0 time median income, in the 1981-90 period the multiple is 2.1, and over the period 1991-99 the multiple is 2.4. These houses are purchased with a down-payment of just 14 percent of the house value on average over the period 1991-99, compared to 16 percent in 1981-90 and 18 percent in 1976-80. To acquire the higher value houses relative to income, first time buyers increase the share of income they devote to mortgage servicing, rising from .29 in 1976-80 to .35 in 1991-99. Overall, Table 2 strongly suggests it has become easier for first-time home buyers to buy a house.

2.2 The Connection between Home ownership and Marriage

What drives the housing tenure choice decision of the young? To start our analysis we use the National Longitudinal Survey of Youth (NLSY) for the 1979 cohort of about 13,000 individuals 14-22 years of age. This is a dataset of individuals but does have information on family level variables. The sample is 1985-1996 and 1998. With relatively few observations for individuals aged 40 and over we restrict the sample to

and Van Order (2000) describe the evolution of the secondary mortgage market.

those aged 21-39. We use the NLSY principally because of it has many more years of household net worth data over our sample period compared to other datasets.

We estimate a linear probability model of young home ownership using the variables in Table 3 plus year effects as regressors. Assets and income are deflated by the CPI.[5] The table displays coefficient estimates with standard errors. The coefficients on the categorical variables are interpreted as marginal effects on probability relative to the indicated omitted category. The coefficients on real wealth and assets are interpreted as the effect of an extra $1000 on the probability of owning. Every variable is highly significant. Marriage stands out as having a particularly large effect. The coefficient on marriage says that in our sample if you are married, then you are 23% more likely to own compared to someone of the same assets, income, sex, race, education, age, family structure and year who is not married. Other than wealth and income, only being relatively old and family size come anywhere close to the importance of marriage as an indicator for home ownership of the young.

The regression results suggest that studying the dynamics of marriage around the first home purchase could be illuminating. Figure 2 plots conditional probabilities of being married in the years surrounding a first or second home purchase estimated using the Panel Study of Income Dynamics (PSID). We want to measure the extent to which marriage is associated with home purchase decisions. We do so by regressing a dummy variable for whether the respondent is married on a set of dummy variables for the years before, during and after the first or second purchase, plus dummies for year, age, household size, educational attainment and sex. The figure plots the fitted values and 95% confidence intervals for the year relative to year of home purchase dummies. The omitted category in both cases is individuals who are never observed to own and for which we have at least fifteen years of data on tenure choice.

Figure 2's Panel A reveals that marriage is more closely associated with the first home purchase than the second one. In the first purchase case respondents are approximately 35 percent more likely to be married compared to respondents with the same characteristics but never buy a house. There is a big jump upward in the like-

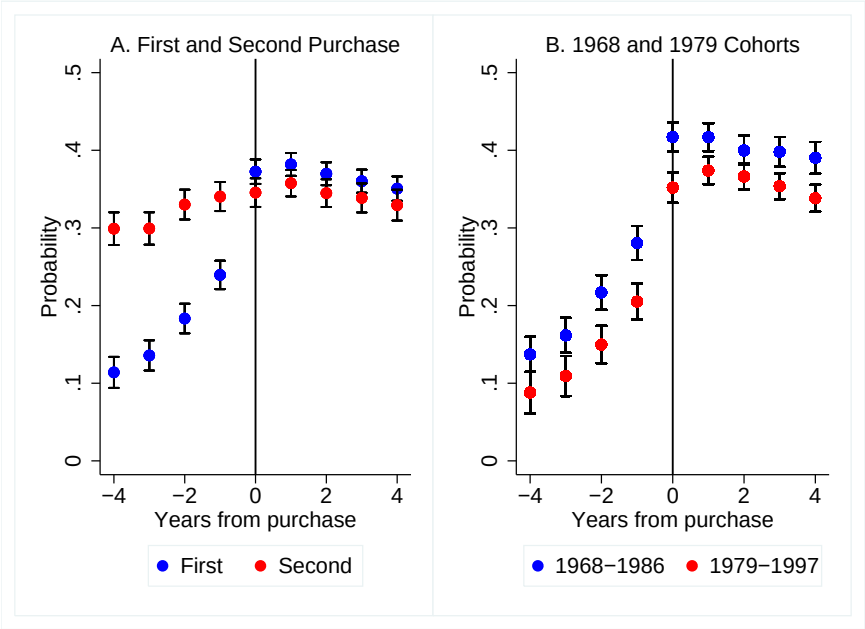
[5]Net assets and income include those for the survey respondent and their spouse, if the spouse lives with the respondent. Income is just labor income and net assets includes assets from all sources listed in the survey. We use the weights provided by the NLYS in our estimation to correct for the oversampling of the poor and members of the military.

Table 3: Linear Probability Model of Young Home ownership

	Coefficient	Standard Error
Real net assets (000s)	.006	.0002
Real household income (000s)	.003	.0001
Married (versus not married)	.23	.005
Female (versus male)	.01	.003
Race is White (versus not white)	.02	.004
Education is more (versus less) than college	-.03	.01
Age (versus under 25)		
25-29	.04	.004
30-34	.09	.01
35-39	.14	.01
Adults in household (versus single)		
2	.013	.004
> 3	-.09	.004
Children in household (versus none)		
1	.05	.005
2	.08	.005
> 2	.04	.01
Number of Observations	52,233	
$\mathcal{R}^2$	.34	

Note: The reported coefficients are from a regression of a dummy variable for home ownership on wealth, income and dummy variables for the indicated categorical variables plus year effects.

Figure 2: Marriage Near Home Purchases



Note: These are our estimates from the PSID. They correspond to coefficients from a linear probability model of marriage with dummy variables for each age, year and each number of years before, during and after the first or second home purchase, plus sex, educational attainment and household size. The coefficients corresponding to -4 to 4 years after the first or second purchase are plotted with 95% confidence intervals.

lihood of being married in the year of the first purchase. After the purchase there is little change in the likelihood of being married. The qualitative pattern of marriage around the second purchase is similar but much more muted. The peak is about the same, but there is not the jump at zero which occurs in the first purchase case. We draw two conclusions from this plot. First, marriage and home purchases occur at similar times. Second, marriage is more tightly connected to the first purchase than the second.

Figure 2's panel B shows that there has been little change over time in the dynamics of marriage and the first home purchase. Although there is a tight connection between marriage and the first home purchase in both the 1968-1986 and the 1979-1997 sample periods, the trend toward later marriages has weakened the relationship.

Note that this reduction is *in addition* to the secular decline in marriage rates by age which is accounted for in our regression model by the year dummies. Since individuals purchase homes for reasons other than family formation, we expect the association between marriage and the first-purchase to decline if individuals marry later.

Taken together, the regression results strongly suggest that trends in marriage should be important for understanding the decline in young home ownership.

2.3 Marriage Delay and Home Ownership

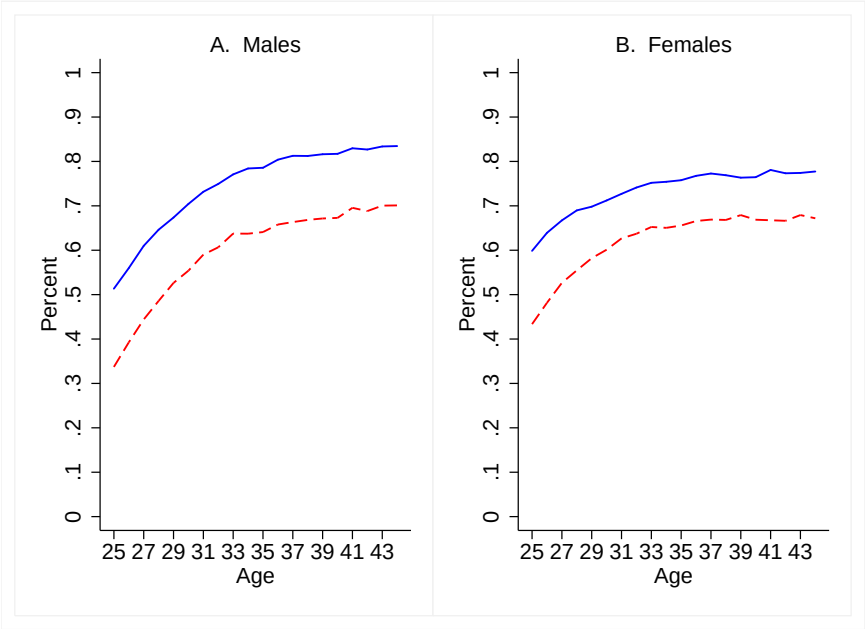
We now consider trends in marriage and their impact on home ownership among the young using data from the Decennial Census of Population and Housing. For our analysis the key trend in marriage is that young people are much less likely to be married at any given age today than they were in 1980. This is demonstrated in Figure 3. For males, in 1980 there was roughly a 50% chance that you were married at age 25. By 2000 you would have to be 30 years old to have the same chance. Females behave similarly, but not identically, since the age distribution of marriage matches is different for males and females.

The marriage rate reflects two effects: entry into and exit from the state of marriage. Stevenson and Wolfers (2007) describe evidence which strongly suggests increased exit is not the key factor underlying declining marriage rates since 1980, so we focus on entry into the state of marriage. One way entry into marriage is affected is if the first marriage is delayed. Since the first home purchase is so tightly connected to marriage, a delay into entering the state of marriage for the first time could delay the transition to home ownership as well.

Figure 4 demonstrates that the first marriage is substantially delayed in 2000 compared to 1980 for both males and females. It displays the fraction of males and females of a given age who have never been married. The upward shift in the profile of "Never married" rates in 2000 compared to 1980 indicates that individuals are much less likely to have ever married in 2000 compared to 1980. The magnitude of the shift is similar to that for marriage rates. This points toward delayed marriage being the primary proximate cause of the decline in marriage among the young.

How should we expect a decline in the marriage rate to affect home ownership?

Figure 3: Marriage Rates in 1980 and 2000



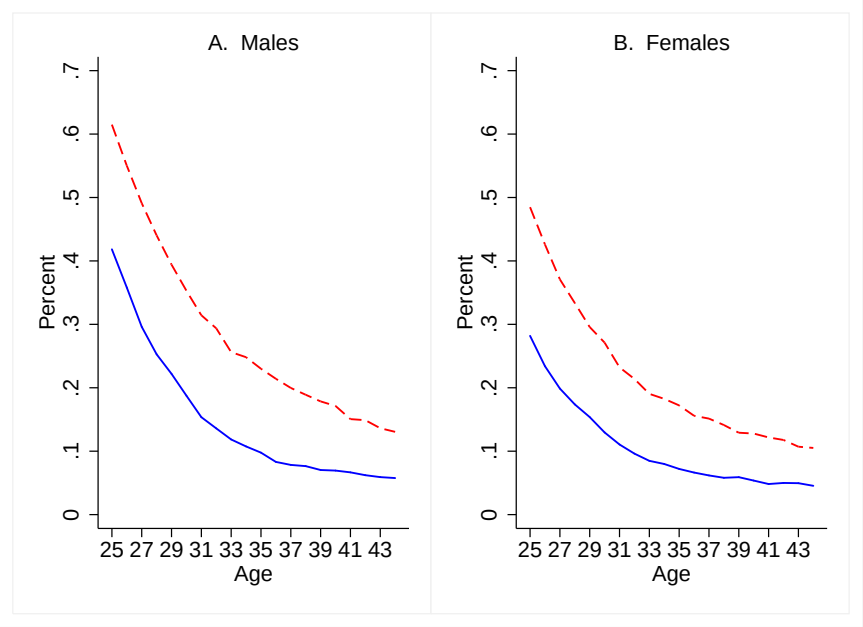
Note: Solid line – 1980, Dashed line – 2000. The marriage rate is the percent of individuals who are married. These are our estimates using the 1980 and 2000 Decennial Census of Housing.

The answer to this question is in Figure 5. This displays home ownership rates by marital status for 1980 and 2000. There has been a small increase in home ownership between 1980 and 2000 for unmarried household heads. This presumably reflects what we already know from Table 1 that single females have seen a large increase in home ownership. Since the home ownership rate of married household heads is always higher than for the unmarried at a particular age, it follows that the decline in the marriage rate mechanically leads to a decline in home ownership. However, the fact that the home ownership rate of the married falls between 1980 and 2000 implies that something else is going on as well.

2.4 Individual Earnings Uncertainty

Less marriage increases the representative household's earnings risk by reducing the time spent in the two-worker state in which risk sharing is possible. Another source

Figure 4: Never Married Rates in 1980 and 2000



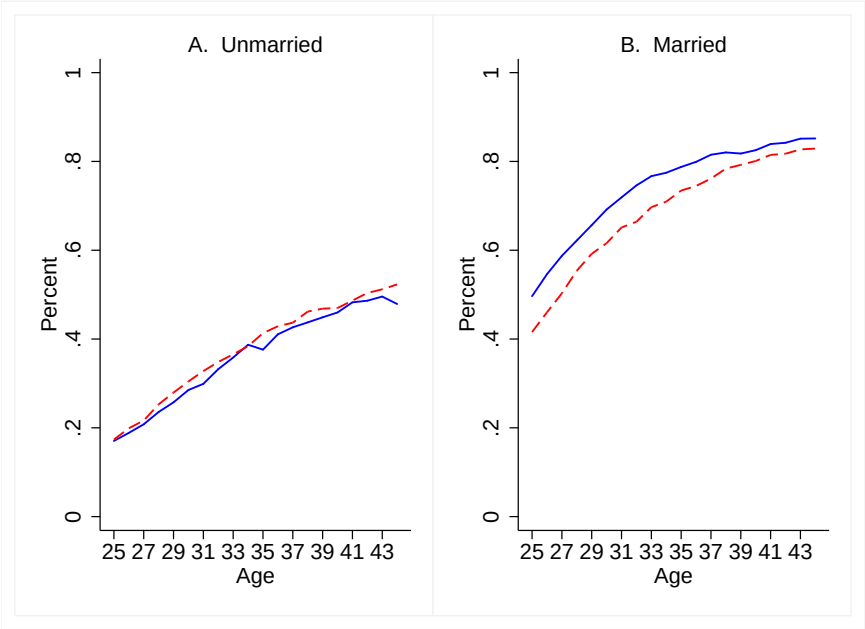
Note: Solid line – 1980, Dashed line – 2000. The never married rate is the percent of individuals who have never married. These are our estimates using the 1980 and 2000 Decennial Census of Housing.

of household earnings risk is individual earnings risk. Numerous papers document an increase in idiosyncratic earnings risk of both individuals and households over the last three or four decades. Two recent examples are Cunha and Heckman (2007) and Heathcote et al. (2008). The literature disagrees over when exactly the change occurred, how persistent it has been or whether another change in variability may have occurred. However there is little disagreement that idiosyncratic household risk has gone up since 1980.

2.5 Fiscal Policy, Home Prices and Household Mobility

We now address some potential alternative explanations for the decline in young home ownership. These include changes to tax policy, house prices and household mobility. We argue that neither of these changes seems promising as an explanation for the

Figure 5: Home ownership Rates in 1980 and 2000



Note: Solid line – 1980, Dashed line – 2000. The home ownership rate is the percent of households with a head who owns. These are our estimates using the 1980 and 2000 Decennial Census of Housing.

decline in young home ownership.

The key candidate for tax policy is the 1986 tax reform.[6] Poterba (1992) has postulated that the reductions in high income marginal tax rates in 1986 lowered the benefits to the mortgage interest tax deduction, thereby lowering the incentive to own a home. While there is a direct effect of lowering the top marginal tax rates on the tax implications of mortgage interest deductability, it is far from clear that this translates into a substitution from owned to rental housing. Gervais (2002) shows that even the elimination of mortgage interest deductibility would have only modest consequences for home ownership. Similarly, Gervais and Pandey (2008) argue that relatively high income families do not benefit from mortgage interest deductibility nearly as much

[6]Changes to the tax code in 1998 affected the amount of capital gains on selling the primary residence that is exempted from taxes. This should effect the timing of home sales and would make ownership more desirable since the expected after-tax returns from owning are higher. We think the latter effect will raise home ownership slightly.

as conventionally believed when the family's budget constraint is taken into account. There were other changes to the tax code in 1986 which increased the incentive to build multi-family rental units. Other things equal, an increase in the relative supply of rental housing should induce a substitution away from home ownership. There was a brief period in the mid-1980s when investment in multi-family units grew at a faster rate than single family homes. However, capital stock data from the Bureau of Economic Analysis suggest that the overall effect on the relative supply of rental housing was small.

Should changes in house prices be a consideration in the decline in young home ownership? If house price risk increased, then this would increase the value of delaying a home purchase. Aggregate measures of house prices do not suggest that if there has been a trend it is toward less volatility in real house prices.[7] We suspect this is driven by the fact that volatility of the consumer prices is lower now compared to 1980. Moreover, Sinai and Souleles (2005) convincingly argue that rent risk is more important than house price risk in the tenure choice decision. This arises due to the role of housing as a hedge against variation in rental rates. If rent risk were to decline, then there would be an incentive to substitute away from owned toward rented housing. This is an intriguing possibility, but we leave it as an open question for this paper.

A third possible reason for a decline in ownership is that households' mobility rates may have changed. If, for whatever reason, households were to move more frequently, then, holding all else equal, this should lower home ownership due to the additional costs involved with moving when a home is owned. As it turns out, mobility reports by the Census Bureau point toward less, not more mobility. For the young age groups we study in this paper, the probability that an individual lives at a different address than in the previous year has fallen from 23% in the mid-1960s to 18% in 2000.[8]

[7] We have studied regional price indexes published by the Census Bureau, Office of Federal Housing Enterprise Oversight and Freddie Mac. It is hard to obtain house prices for finer geographical classifications, such as by city, which begin early enough for our purposes.

[8] This is based on the Current Population Survey findings reported in various issues of "Geographical Mobility" a publication of the Census Bureau.

3 The Model Economy

In this section we describe our life-cycle model. For parsimony, we choose not to model marriage explicitly. The model consists of representative households, goods producing firms, and financial intermediaries. Households experience a three stage life-cycle, where the second stage of life is interpreted as marriage. They derive utility from consumption and housing services, are subject to an exogenous, stochastic flow of labor income, and via intermediaries invest in non-residential and housing capital. We assume that owned housing is always preferred to rental housing of the same size. However, while changing rental housing is costless, owning requires a downpayment and buying and selling an owner-occupied house involves transactions costs. We now describe the model in detail.

3.1 The Representative Household

Preferences The economy consists of a large number of ex-ante identical households who forever repeat the same "life cycle" of birth, work, retirement and death. The transitions between the stages of life occur with fixed and known probabilities. Households care about their future selves as much as they care about their current self and so preferences are represented by

$$U_t = E_t \sum_{j=t}^{\infty} \beta^{j-t} u(c_j, \psi_j h_j), \quad 0 < \beta < 1. \tag{1}$$

For the incarnation of the household alive in period j, c_j denotes the quantity of goods consumed and h_j is the quantity of housing the household occupies and either rents or owns. The variable ψ_j determines how much the household prefers to own rather than rent. When the household rents its home $\psi_j < 1$ and when the household owns its home $\psi_j = 1$. The parameter β is the household's time discount factor. We assume a time period equals one year. For simplicity, below we drop time subscripts. With a couple of exceptions, the prime symbol denotes the current value of a choice variable and the absence of this symbol indicates the previous period's value of the same variable.

Stages of the Life-cycle The state variable s controls both the life-cycle status and labor earnings of a household. Let $s \in \mathcal{S} = \mathcal{Y} \cup \mathcal{F} \cup \mathcal{R} = \{1, 2, \ldots, N\} \cup \{N+1, N+2, \ldots, 2N\} \cup \{2N+1, 2N+2, \ldots, 3N\}$. Households go through three stages of life. When $s \in \mathcal{Y}$, an household is a *young* type whose housing services when renting are discounted by $\psi(s, 0) = \psi_y < 1$. When $s \in \mathcal{F}$, an household is a *family* type. For this household type rented housing services are discounted at the rate $\psi(s, 0) = \psi_f < \psi_y$. We assume the rental discounting is greater for a family household compared to a young household to capture the empirical phenomenon that, in general, some of the housing services required by families, such as proximity to good schools and parks, are hard to obtain in rental housing. Finally, when an household's state transits to $s \in \mathcal{R}$, the household retires and the rental discount reverts to $\psi(s, 0) = \psi_y$.

Non-retired households supply one unit of labor inelastically and face idiosyncratic uncertainty with respect to their labor productivity. An household in state $s \in \mathcal{Y} \cup \mathcal{F}$ is endowed with $e(s)$ efficiency units of labor, each unit being paid after-tax wage rate $w = (1 - \tau_w)\hat{w}$, where τ_w is a labor income tax and $\hat{w}$ is the before-tax wage rate. The revenues from the labor income tax are used to operate a pay-as-you-go social security system. All retired households are entitled to a social security payment equal to a fraction, θ, of average before-tax earnings of the working population. To keep the notation consistent with working households, we let $e(s) = \theta\overline{e}/(1 - \tau_w)$ if $s \in \mathcal{R}$, where $\overline{e}$ is the average labor productivity of the working-age population. Given the simple structure of this social security system, it can easily be shown that $\tau_w = \theta\mu_{\mathcal{R}}/(1 - \mu_{\mathcal{R}})$, where $\mu_{\mathcal{R}}$ is the fraction of the population that is retired.

The process governing an household's state over time is described by the Markov matrix Π,

$$\Pi = \begin{bmatrix} \Pi_{\mathcal{Y}\mathcal{Y}} & \Pi_{\mathcal{Y}\mathcal{F}} & 0_N \\ 0_N & \Pi_{\mathcal{F}\mathcal{F}} & \Pi_{\mathcal{F}\mathcal{R}} \\ G\Pi_{\mathcal{R}\mathcal{Y}} & 0_N & \Pi_{\mathcal{R}\mathcal{R}} \end{bmatrix},$$

where 0_N denotes an $N \times N$ matrix of zeros and the other terms are non-zero $N \times N$ matrices. Since households need to go through an entire life-cycle, the probability of going from set $\mathcal{Y}$ to set $\mathcal{R}$ is zero. Similarly, the probabilities of transiting from set $\mathcal{F}$ to set $\mathcal{Y}$ and set $\mathcal{R}$ to set $\mathcal{F}$ are also zero. The elements of matrix $\Pi_{\mathcal{Y}\mathcal{Y}}$ and those of matrix $\Pi_{\mathcal{F}\mathcal{F}}$ control how efficiency units supplied by young and family households evolve over time. The matrices $\Pi_{\mathcal{F}\mathcal{R}}$ and $\Pi_{\mathcal{R}\mathcal{R}}$ are diagonal. The matrix $\Pi_{\mathcal{R}\mathcal{Y}}$ controls

the probability of dying and the magnitude of intergenerational earnings persistence. We use $\pi_{ss'}$ to denote individual elements of Π. At the same time as death, a new generation of households of size G are born, where $G > 1$ determines the rate at which the number of households grows.

Labor efficiency of the newborn is controlled by the elements of the matrix $\Pi_{\mathcal{RY}}$ as follows:

$$\Pi_{\mathcal{RY}} = \begin{bmatrix} \theta_1\delta & \cdots & \theta_N\delta \\ & \vdots & \\ \theta_1\delta & \cdots & \theta_N\delta \end{bmatrix},$$

where δ is the probability of dying, and $[\theta_1, \ldots, \theta_N]$ is the part of the invariant distribution Π associated with the young stage of life. As written, the matrix $\Pi_{\mathcal{RY}}$ assumes that there is no intergenerational earnings persistence because each household has the same probability of being any of the N types of young households, regardless of the parent's type at the time of death.

Housing We use the housing tenure variable x' to indicate whether the household rents or owns in the current period, and if it owns, the quantity of housing services consumed. Households who currently own and occupy a house of size h_j have $x' = j$ and household's who currently rent have $x' = 0$.

Owned houses must be chosen from a finite grid,

$$\mathcal{G} = \{h_j, j = 1, 2, ..., M : h_j \in [\underline{h}, \bar{h}]\}.$$

Households who rent may choose a continuous quantity of housing for houses smaller than $\underline{h}$, but are confined to the set $\mathcal{G}$ for housing larger than $\underline{h}$. We discuss below how $\underline{h}$ is important for reconciling home ownership rates with the quantity of owned housing in the economy. We summarize the set of possible house choices in the current period as follows:

$$h' \in \mathcal{H}(x'), \tag{2}$$

where

$$\mathcal{H}(x') = \begin{cases} (0, \underline{h}) \cup \mathcal{G}, & \text{if } x' = 0; \\ \mathcal{G}, & \text{if } x' > 0, \end{cases}$$

and

$$x' \in \mathcal{X} = \{0, 1, 2, ..., M\}. \tag{3}$$

All houses depreciate at the rate $\delta_h \in [0, 1]$. To accommodate the housing grid, we assume that each house requires a certain amount of maintenance each period in order to be habitable.

Due to the discounting of rented housing services, without additional assumptions, households would always choose to own. To motivate an interesting tenure choice we assume that owning a house involves two kinds of costs. First, we assume that to own a house the household must have an exogenously determined minimum equity stake in the house the first year the house is occupied, *i.e.* it faces a downpayment constraint. Second, if a household changes the size of its owned and occupied house it faces costs of buying and selling that are proportional to the size of the house involved. Transactions costs are given by

$$\tau(x, x') = \begin{cases} \tau_b h_{x'}, & \text{if } x = 0 \text{ and } x' > 0; \\ \tau_b h_{x'} + \tau_s h_x, & \text{if } x > 0,\ x' > 0 \text{ and } x \neq x'; \\ \tau_s h_x & \text{if } x > 0 \text{ and } x' = 0; \\ 0, & \text{otherwise.} \end{cases}$$

Saving Households accumulate wealth with two types of assets: owner-occupied houses and a generic asset called deposits, d, which pay interest i. We assume the interest is paid during the current period and the deposit is returned at the beginning of the next period. Let a denote the household's net worth at the beginning of the period. All households face a non-negative savings restriction, $a' \geq 0$. In addition, homeowners may borrow against their house by acquiring a mortgage at the interest rate i. Consistent with deposits, the interest is paid during the current period and the principal is paid at the beginning of the following period. Borrowing against a home involves a *downpayment constraint*. This constraint only applies the first year a house is occupied, that is when the mortgage is first obtained. Once the household has a mortgage, and as long as the household does not change the size of its house, the downpayment constraint does not apply. Households are indifferent between paying down their mortgage and accumulating financial assets. We assume that households pay down their mortgage before accumulating any financial assets.

The downpayment constraint says that a mortgage acquired in the current period, m', is limited to be no more than a fraction γ_d of the value of the home so that

$m' \leq (1-\gamma_d)h'$. Current savings of an household who chooses to be a homeowner next period are $a' = d' + h' - m'$. It follows that in the year the mortgage is acquired, savings must be at least as big as the minimum down-payment on the house: $a' \geq \gamma_d h'$. We summarize the constraint on savings as follows

$$a' \geq \gamma(x, x'), \tag{4}$$

where

$$\gamma(x, x') = \begin{cases} 0, & \text{if } x' = 0 \text{ or } x' > 0 \text{ and } x = x'; \\ \gamma_d h_{x'}, & \text{if } x' > 0 \text{ and } x \neq x' \ . \end{cases}$$

Recursive Formulation of the Household's Problem The problem faced by the representative household is to choose sequences of consumption, asset holdings, housing tenure, and housing services to maximize (1), subject to (2)–(4), $c > 0$ and the budget constraint

$$c + p_h h' + a' + \tau(x, x') = we(s) + a + ia' \tag{5}$$

where p_h is the price of housing services determined by a no-arbitrage condition described below.

To address the issue of how to allocate assets of retired households who die between periods, we introduce annuities. All retired households (the only households who have a positive probability of dying) pool their net worth together in the current period and divide that pool among the survivors in the following period according to their proportion of the pooled net worth. Since each unit of net worth has the same probability of surviving, $1-\delta$, each retired ends up with $1/(1-\delta)$ of their net worth tomorrow should they survive.

Let $V(s, x, a)$ denote the value function of a household who enters a period with state variables s, x and a. The recursive representation of the household's problem is as follows:

$$V(s, x, a) = \max_{\left\{\substack{c>0, x' \in \mathcal{X}, \\ a' \geq \gamma(x,x'), \\ h' \in \mathcal{H}(x')}\right\}} \left\{ U(c, \psi(s, x')h') + \beta \sum_{s' \in \mathcal{S}} \pi_{ss'} V(s', x', \varphi(s)a') \right\} \tag{6}$$

subject to (5), where $\varphi(s) = 1$ unless the household is retired in the current period, in which case it equals $1/(1-\delta)$.

3.2 Producers

Firms maximize profits

$$f(k,l) - wl - p_k k,$$

where $f(k,l)$ is a constant returns production function, k denotes non-residential capital used in production, l denotes the quantity of labor employed, measured in efficiency units, and p_k denotes the rental price of non-residential capital. We assume that producers' output can be costlessly transformed into consumption goods, and new residential and non-residential capital. Consequently, the prices of these goods are all equal to one in a competitive equilibrium. Capital depreciates at the rate $\delta_k \in [0,1]$.

3.3 Financial Intermediaries

Non-residential investment and investment in rental housing is undertaken by overlapping generations of two-period-lived risk neutral financial intermediaries. In their first period, intermediaries accept deposits from households, D^f, which they use to purchase from the previous generation of intermediaries non-residential capital, K^f and rental housing capital, H^f, and to issue mortgages to homeowners, M^f. During the period the newly purchased non-residential capital is rented to producers and the housing is rented to households.[9] Interest on deposits is paid at the end of the first period. At the beginning of the second period, the capital is sold to the new generation of intermediaries, the mortgage principal is repaid and the deposits are returned to households. The problem of a new financial institution is:

$$\max_{\{K^f, H_r^f, M^f, D^f\}} (p_k - \delta_k)K^f + (p_r - \delta_h)H^f + iM^f - iD^f \tag{7}$$

[9] We assume that new capital is productive immediately, *i.e.* there is no time-to-build. This assumption is made to treat non-residential capital symmetrically with housing. Since a time period in the model is one year we do not think this assumption is unreasonable.

subject to the constraint

$$K^f + H^f + M^f \leq D^f, \tag{8}$$

where ϕ is a transaction cost of issuing mortgages, which is introduced to permit a wedge between the borrowing and lending rate for households. The solution to this maximization problem yields the following no-arbitrage conditions:

$$\begin{aligned} p_k &= i + \delta_k; \\ p_r &= i + \delta_h. \end{aligned} \tag{9}$$

It follows that financial institutions are at the margin indifferent between their asset holdings and liabilities and they make zero profits in equilibrium.

3.4 Stationary Competitive Equilibrium

A *stationary competitive equilibrium* consists of a value function $V(s, x, a)$, decision rules for savings $g_a(s, x, a)$, tenure choice $g_x(s, x, a)$ and housing services $g_h(s, x, a)$, an allocation for financial intermediaries $\{D^f, K^f, H^f, M^f\}$, aggregate quantities $\{K', H', L\}$, prices $\{i, p_r, w, p_k\}$, a fiscal policy $\{\tau, \theta\}$, and a measure $\lambda(s, x, a)$ such that

1. Given prices and the fiscal policy, the value function and associated policy rules solve the household problem as given by (6);

2. Given prices and the fiscal policy, producers maximize profits. This implies factors are paid their marginal products: $p_k = f_1(K', L)$, $\hat{w} = f_2(K', L)$, where L is the aggregate demand for labor by producers;

3. Given prices and the fiscal policy, , $\{D^f, K^f, H^f, M^f\}$ solves the financial intermediaries' problem given by (7) and (8). This implies (8) holds with equality and the no-arbitrage conditions hold;

4. Aggregates are consistent with individual behavior: $\lambda(s, x, a)$ is generated by

$$\lambda(s', x', a') = \begin{cases} 0, & \text{if } s \in \mathcal{R},\ s' \in \mathcal{Y},\ a' > 0 \\ \sum_{s \in \mathcal{Y}} \pi_{ss'} \sum_{x=0}^{M} \int_{a \in \mathcal{A}(a', x')} \lambda(s, x, da) & \\ \quad + \sum_{s \in \mathcal{R}} \pi_{ss'} \sum_{x=0}^{M} \int_{a \geq 0} \lambda(s, x, da), & \text{if } s' \in \mathcal{Y}, x' = a' = 0 \\ \sum_{s \in \mathcal{S}} \pi_{ss'} \sum_{x=0}^{M} \int_{a \in \mathcal{A}(a', x')} \lambda(s, x, da), & \text{otherwise} \end{cases}$$

where

$$\mathcal{A}(a', x') = \{(a, x) : g_a(s, x, a) \leq a',\ g_x(s, x, a) = x'\};$$

5. The social security system is self-financed: $\tau_w = \theta\mu_{\mathcal{R}}/(1 - \mu_{\mathcal{R}})$;

6. Markets clear:

$$\begin{aligned}
D^f &= \sum_{s\in\mathcal{S}}\sum_{x=0}^{M}\int_{a\geq 0} g_a\lambda(s, x, da) - \sum_{s\in\mathcal{S}}\sum_{x=1}^{M}\int_{a\geq 0} g_h\lambda(s, x, da) \\
&\quad + \sum_{s\in\mathcal{S}}\sum_{x=0}^{M}\int_{\{a:g_h>g_a \text{ and } g_x>0\}} [g_h - g_a]\,\lambda(s, x, da); \\
H' &= \sum_{s\in\mathcal{S}}\sum_{x=0}^{M}\int_{a\geq 0} g_h\lambda(s, x, da); \\
H^f &= \sum_{s\in\mathcal{S}}\int_{a\geq 0} g_h(s, 0, a)\lambda(s, 0, da); \\
M^f &= \sum_{s\in\mathcal{S}}\sum_{x=0}^{M}\int_{\{a:g_h>g_a \text{ and } g_x>0\}} [g_h - g_a]\,\lambda(s, x, da); \\
K^f &= K';
\end{aligned}$$

$$L = \sum_{s=1}^{2N}\theta_s e(s).$$

Here we have suppressed the arguments of the decision rules when there is no ambiguity about what they are. These expressions are the clearing conditions for the deposit market, the aggregate housing market, the rental housing market, the mortgage market, the non-residential capital market, and the labor market. These conditions should be transparent except for the deposit market condition. This condition says all households' net worth minus total equity in owner occupied housing must equal deposits at financial intermediaries. If all these conditions are satisfied then the goods market must clear by Walras' law.

4 Calibration

We use our model to examine the role of various structural changes on the propensity to own a home. Our baseline scenario is designed to capture the environment faced

by households in the years leading up to 1980. We compare this baseline scenario to one which emodies the structural changes which occurred after 1980 and are a feature of the environment faced by households in the years leading up to 2000. This section describes how we assign values to the model's parameters in thee 1980 and 2000 calibrations. At the end of this section we briefly discuss household behavior at the calibrated parameter values.

4.1 1980 Calibration

We assume the functional form of the utility function is

$$u(c, \psi(s,x)h) = \ln(c) + \frac{(\psi(s,x)h)^{1-\sigma_h} - 1}{1-\sigma_h}, \qquad \sigma_h \geq 0.$$

and the functional form of the production function is

$$f(k,l) = Ak^{\alpha}l^{1-\alpha}$$

We set the number of income states to $N = 9$ and the number of houses to $M = 10$. Our results are not sensitive to increasing these values. The upper limits on house size and assets, $\bar{h}$ and $\bar{a}$ are also chosen so that increasing their magnitudes does not affect our results.

The parameters we need to calibrate include those governing the income process, $\{\Pi, e, \theta, \tau, G\}$, preferences, $\{\beta, \eta, \sigma_h, \psi_y, \psi_f\}$, the production technology, $\{\alpha, \delta_h, \delta_k\}$, and housing $\{\underline{h}, \tau_b, \tau_s\, \gamma_d\}$. Our calibration strategy is to first use direct evidence to assign values to the income and select housing and preference parameters, and then to choose the remaining housing, technology and preference parameters to bring the model as close as possible to a short list of aggregate first moments. Table 4 displays parameter values which are held fixed across the 1980 and 2000 calibrations. Table 5 displays parameters associated with the income process and the downpayment constraint, some of which change between the two calibrations to account for various structural changes.

The income process involves three key elements of our analysis. This is where the speed of transition to "marriage", differences in income over the life-cycle, and idiosyncratic risk are determined. We assume that within each of the first two life

Table 4: Parameters Constant Across the 1980 and 2000 Calibrations

Preferences					
β	0.951	σ_h	3.500	η	0.860
ψ_y	0.042	ψ_f	0.100		
Housing					
τ_b	0.03	τ_s	0.06	$\underline{h}$	1.15
Production					
α	0.257	δ_k	0.082	δ_h	0.044
Social Security					
θ	0.06	τ	0.061		

Table 5: Parameters Governing Differences in the 1980 and 2000 Calibrations

	1980	2000
Credit constraint		
Minimum downpayment requirement (γ_d)	0.200	0.133
Income Process		
Expected age at transition to family stage	25	27
Expected age at transition to retirement	65	—
Expected lifetime	75	—
Relative mean income of family versus young	1.47	—
Autocorrelation of income	0.95	—
Standard deviation of innovations during young stage	0.025	0.033
Standard deviation of innovations during family stage	0.042	0.056
Productivity effect (A)	1.000	1.041
Population growth	0.020	0.013

Note: No change between calibrations is indicated by "—".

stages that income follows a Tauchen and Hussey (1991) approximation to an AR(1) process. It follows that the income process is completely specified by the mean, innovation variance and serial correlation of income in the young and family stages of life, the replacement ratio for the retired life stage, the average duration of each life stage, and the growth rate for the number of households. We now describe how we calibrate these elements.

We interpret the transition from the young to family type as the event of marriage. This motivates selecting the duration of the first stage of life so that the fraction of individuals who do not marry, that is transit to the second stage of life, by age 27, corresponds to the estimate for the cohort born in the period 1948–1957 reported in Table IV of Caucutt et al. (2002). Life is assumed to begin at age 18 and we assume the average durations for the three stages are 7, 37 and 9 years. The length of the second stage is chosen so that on average people transit to retirement at 65, and the duration of the retirement stage is chosen so the average life expectancy is 72 years.

Household income jumps significantly around the time of marriage. To capture this phenomenon we assume that average income of the family type is higher than for the young type. We calibrate this increase in income by estimating the average amount by which family income rises upon first marriage using data from the National Longitudinal Survey of Youth (NLSY).[10] We normalize average income over the young and family stages of life to one and use our estimate of the marriage income increase, 47%, to determine average income in the two stages of life.

The third key feature of the income process involves idiosyncratic risk. This is governed by the autocorrelation coefficient and innovation variance for the young and family stages of life. We use the life-cycle income process estimated from the PSID by Storesletten et al. (2004) to guide our selection of the these parameters. Storesletten et al. (2004) assume the autocorrelation of income does not change over the working years of the life-cycle. So, we fix the autocorrelation for the two working life-cycle stages at a value, .95, which is within the range of estimates reported in Table 2 of

[10]Specifically, we regress percent changes in income on dummy variables for year, age, education, household size, sex and a dummy variable indicating the years before, during and after the year of first marriage. The estimate for our calibration is the coefficient on the dummy variable for year of first marriage. The income variable includes earnings income of the individual and, when relevant, their spouse. We describe the NLSY data more in the appendix. We get similar results using the PSID.

Storesletten et al. (2004). Given the evidence that idiosyncratic risk has risen between 1980 and 2000, we cannot directly use the variance estimates in Storesletten et al. (2004). Instead, we assume the life-cycle conditional variances they report are an equally weighted sum of variances from the two halves of their sample, corresponding to our 1980 and 2000 calibrations. Using an assumption, discussed below, on how much the conditional variances increase, we can calculate estimates of the conditional variances for both sub-samples. We take the average variance of earnings for the under 25 and the 26-55 age groups, .3 and .5, to calculate the young and family cross-sectional variances. Once we have the cross-sectional variances we calulate the innovation variances using our assumption on the autocorrelation coefficient.

To complete the specification of income, we need to assign values to the social security replacement ratio, the labor tax and the number of income states in each of the two working stages of life, and the rate at which the number of households grows. The replacement ratio for retirees is $\theta = 0.4$, which is taken from Mitchell and Phillips (2006). We set the labor tax, τ, to the value which finances the social security system. The number of income stages in each working stage of the life-cycle is set to $N = 9$. The growth factor, G is set to 2.35, which corresponds to a growth rate of 2 percent, which is the mean growth rate of households from 1960-1980 as reported by the Census Bureau.

The downpayment parameter, γ_d, is set to .2 in the 1980 calibration. This value is commonly used in the literature because of its important role empirically. Specifically, a downpayment of at least 20% is required to avoid paying mortgage insurance. Housing transactions costs are set to $\tau_b = .03$ and $\tau_s = .06$. These values are chosen as reasonable approximations to actual transactions costs. The main direct evidence on transactions costs is the percent of the sales price typically charged by realtors and nominally paid by sellers. This value varies per transaction but the contract rate is usually near 5%. In practice this value is probably lower since realtors often agree to cut the fee in order to facilitate a sale. We think it is reasonable to assume that buyers face transactions costs even though they do not pay the realtor fees directly, since there are significant search costs involved with buying a house. These considerations underly our parameter choices here.

The last parameter we fix using direct evidence is the exponent on housing services

Table 6: Summary Statistics for the 1980 Calibration

	Data	Model
Aggregate Ratios		
Investment:Output	0.26	0.26
Non-residential Capital:Output	1.95	1.95
Residential capital:Output	0.97	0.99
Owned residential Capital:Total residential capital	0.70	0.65
Housing services:Consumption plus housing services	0.11	0.11
Home-ownership Rates		
All households, ages 25–44	0.61	0.60
Never married, ages 25–44	0.25	0.23

Note: The data underlying the empirical statistics are described in the appendix.

in the utility function, σ_h. We choose this parameter so that our model implies an income elasticity of housing demand within the range of estimates in the literature, e.g. Hansen et al. (1998). In particular, we set $\sigma_h = 3.5$. This corresponds to an income elasticity of demand for housing equal to roughly .35.

The remaining parameters are β, η, ψ_y, ψ_f,, α, δ_h, δ_k, and $\underline{h}$. The discount rate β is chosen so that the interest rate in the stationary equilibrium corresponding to the 1980 calibration is 5%. The remaining five parameters are chosen to minimize the sum of squared differences between equilibrium values and empirical estimates of the following variables: the nonresidential plus residential investment to output ratio, non-residential capital to output ratio, the residential capital to output ratio, the share of owned residential capital in total residential capital, the share of housing services in total consumption, the overall home ownership rate of the 25–44 age group and the home ownership rate of the never married 25–44 age group. The first five moments are estimated using NIPA data (described in the appendix) for the period 1955–1980. The second two moments are estimated from the 1980 Census of Housing. Table 6 displays the empirical targets and model implied values for the seven moments. This table indicates that our model is very good at replicating the aggregate economic environment circa 1980.[11]

[11] Our target for the share of consumption spending that is on housing services is small compared to

4.2 2000 Calibration

The 2000 calibration embodies key structural changes that may have influenced home ownership rates of the young between 1980 and 2000. These include a lower downpayment constraint, delayed marriage, heightened idiosyncratic income risk, slower growth in the number of households, and greater aggregate productivity due to the labor market experience of women.

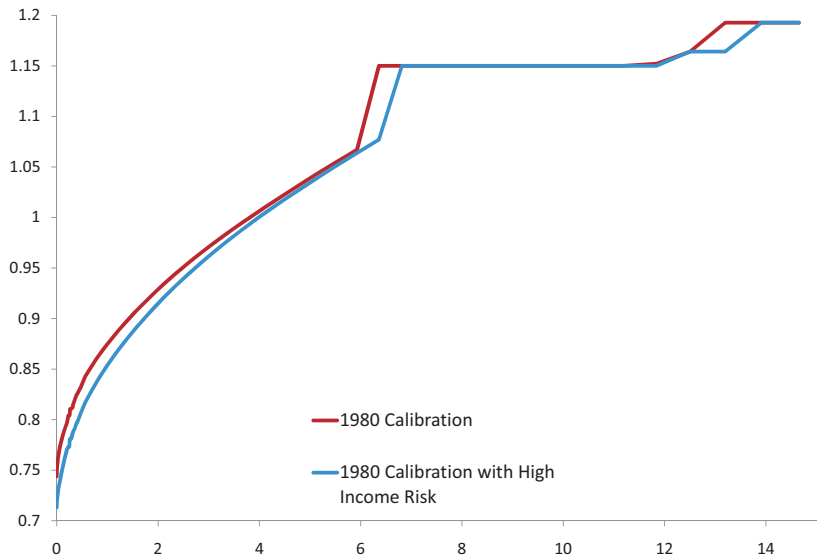
The downpayment constraint is set to .13, which is 2/3 of the value used in the 1980 calibration. The 2/3 value corresponds to the ratio of the average downpayment in 1996 to that in 1976 as reported in Table 2. To approximate the phenomenon of delayed marriage after 1980, we assume that the average duration of the young family stage is 2 years longer in the 2000 calibration. This implies the same value for the fraction of individuals who do not marry by age 27 for the cohort born in the period 1958–1967 reported in Table IV of Caucutt et al. (2002), 34%. We set $G = 1.83$ to match the rate of growth in the number of households over the period 1980-2000, 1.3%.

The percentage increase in idiosyncratic risk we assume for the later sample is based on Heathcote et al. (2008). They find the cross-sectional variance of log household earnings for households headed by males in the 20–59 age group is about 36% larger in the years leading up to 2000 compared to the years before 1980. This increase is comparable to other estimates in the literature.

There are two key developments in the labor market experience of women which may have affected home ownership rates of the young. First, the gender wage premium has declined substantially. For example, Heathcote et al. (2008) use CPS data to show that the average wage paid to men relative to women for the period 1967–1980 was about 1.625 whereas between 1980 and 2000 this ratio averaged about 1.5. Second, women worked more after 1980. The data compiled by Francis and Ramey (2008) indicates that average weekly hours worked per female over aged 14 rose from 12.4 for the 1955–1980 period to 17.5 for the 1981–2000 period. In terms of our model, these changes imply a larger effective supply of labor per household. We model this

that used by some other authors, for example Davis and Ortalo-Magné (2007). Their share is based on including household operation in housing services and computing it only for renters. Our measure of housing services is based on the NIPA and excludes expenditures on household operations.

Figure 6: Housing Decisions in the Model



as a change in the productivity parameter A from 1 to 1.041.[12]

4.3 Discussion

Before describing the impact of structural change on the home ownership rates of the young implied by our 1980 and 2000 calibrations, it is helpful to briefly describe household behavior in the model. We focus on the role played by income risk. Figure 6 displays the housing service decision rule for low income individuals in the young stage of life under the 1980 calibration and the 1980 calibration with the level of income rise set according to the 2000 calibration. On the horizontal access is the beginning of period level of net worth, a and on the vertical access is the housing choice.

Consider the 1980 calibration case first. This shows that for assets less than about

[12]The 4.1% increase in productivity is estimated by calculating the ratio of population share weighted average weekly pay for males and females in the two sub-samples. The average pay is calculated as follows: for the early sample, $.48 \times 30.28 + .52 \times 12.42/1.625$ and for the later sample, $.48 \times 27.49 + .52 \times 17.2/1.5$. The population shares are from the Census Bureau, the average hours worked per male and female are from Francis and Ramey (2008), and the relative wages are from Heathcote et al. (2008).

$a = 6$ this household chooses to rent. The amount rented rises with wealth. Near asset level $a = 6$ the household switches from renting to owning the minimum size house $h_1 = \underline{h}$. Due to the discreteness in house sizes and the transactions costs, there is an interval of assets for which the minimum size house is still chosen. When assets reach $a = 12$ the household's desired level of housing services switches to h_2. The step function form of the policy rule continues to the right of $a = 12$ (there is a very short flat spot at h_2 before the household switches to h_3. This basic form of the decision rule holds for all households in the model. All that changes is the location of the cut-off values of assets determining when the household selects a different level of housing services.

The impact of raising income risk (this experiment does confound the general equilibrium effects of such a change) is to delay switching from renting to owning. In addition the flat portions of the decision rule are wider. The intuition is straightforward. In the presence of proportional adjustment costs there is option value to delaying the home purchase or sale until you are possibly wealthier and can afford a larger house. An increase in family income risk increases the value of this option thereby increasing delay into home ownership. As we will see in the next section, the aggregate effect of this delay is to lower the home ownership rate.

5 Findings

We now discuss the impact of structural change on the home ownership rates of the young implied by our 1980 and 2000 calibrations. Table 7 displays home ownership rates for the age groups of interest in the US data and under the stationary equilibrium corresponding to each calibration. The empirical values for 1980 and 2000 are taken from Table 1.

It is clear from Table 7 that the model goes a long way to accounting for the reduction in home ownership rates by age and for the 25–44 category as a whole. The model implies a larger drop for the 25–44 age group than the data but smaller drops for the individual age groups. This is because the change in the age distribution in the model from 1980 to 2000 is not the same as in the data, despite out attempt to take changes in the rate of household formation into account. By age group our

Table 7: Young Home ownership in 1980 and 2000

	Data			Model		
	1980	2000	Change	1980	2000	Change
25–29	43.4	36.0	-7.4	47.1	41.8	-5.3
30–34	60.7	53.0	-7.7	59.0	54.3	-4.7
35–39	69.7	63.4	-6.3	67.0	62.6	-4.4
40–44	74.3	69.1	-5.2	72.7	68.4	-4.3
25–44	60.6	57.3	-3.3	59.6	55.3	-4.3

model accounts for about 2/3–4/5 of the fall in home ownership.

Table 8 sheds light on the factors driving our model's ability to account for a large fraction of the decline in young home ownership. This table displays the difference in home ownership by age for versions of the 1980 calibration where just one of the five structural changes are imposed. In each case we calculate the home ownership rates from the corresponding stationary equilibrium. This does not provide a clean decomposition of the overall effects of structural change due to the general equilibrium forces at work. Still, we find these experiments informative.

Table 8 indicates that heightened income risk and delayed marriage are the driving forces behind our findings. These effects lower the home ownership rate substantially for each age group, the former for the reasons described at the end of the last section and the latter for the mechanical reason that non-married have lower home ownership rates compared to married.

The other factor having a large impact is the productivity increase. Recall that this is our way of modelling the higher wages and work effort of women after 1980. Not surprisingly this has a large positive impact on home ownership. Still, when all the structural changes are incorporated, the productivity increase is dominated by the effects of marriage delay and heightened income risk.

Interestingly lowering the downpayment constraint has a very small positive impact on home ownership. This is despite the fact that the number of "constrained" home buyers falls from about 10% of those switching from renting to owning to zero. By "constrained" we mean the fraction of households who switch from renting to

Table 8: Effects of Individual Structural Changes on Young Home ownership

	Downpayment Constraint	Household Formation	Income Risk	Marriage Delay	Productivity Increase
25–29	0.01	0.22	-1.82	-2.80	3.59
30–34	0.02	0.15	-2.87	-1.86	3.59
35–39	0.02	0.03	-3.53	-1.09	3.33
40–44	0.02	- 0.08	-3.94	-0.55	3.02
25–44	0.02	0.46	-2.89	-1.67	3.42

owning who do so with a downpayment exactly equal to the constraint. This small impact of reducing the rate at which home buyers are constrained is consistent with Kiyotaki et al. (2007) but stands in contrast to Chambers et al. (2005) who argue that the reduction in downpayment constraints have a large impact. The reduction in the rate of household formation also has a small positive impact on home ownership. This is due to a general equilibrium effect on the implict rental price of owning. The lower rate of household growth leads to a greater fraction of wealthier households and consequently a lower interest rate.

6 Conclusion

Our findings strongly suggest that the decline in home ownership among the young between 1980 and 2000 is mostly due to a slower rate of marriage formation and heightened family income risk. According to our model, relaxing the downpayment constraint on mortgages has a quantitatively small impact on home ownership rates in the long run. Our findings leave open the possibility that mortgage constraints may play an important role in cyclical fluctuations.

Data Appendix

Data Underlying Estimates of Aggregate Ratios

Except where noted, all expenditure data is from the National Income and Product Accounts. The capital stock data is from the Bureau of Economic Analysis publication "Fixed Assets and Consumer Durable Goods."

- Output is measured as GDP plus the service flow of consumer durables obtained from the Federal Reserve Board.
- Non-residential capital includes producer durable equipment and non-residential structures, plus the stock of consumer durables and the stock non-residential government capital.
- Residential capital is the stock of private and public residential capital.
- Owned residential capital is the stock of privately owned residential capital.
- Housing services are the flow of housing services component of consumer expenditure on services.
- Consumption includes non-housing services plus non-druable expenditures plus government consumption plus the service flow from consumer durables.

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