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**Discussion Papers in
Economics and Econometrics**

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No. 0907

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ISSN 0966-4246

Why Has Home Ownership Fallen Among the Young?*

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March 6, 2009

Abstract

We document that home ownership of households with “heads” aged 25–44 years fell substantially between 1980 and 2000 and recovered only partially during the 2001–2005 housing boom. The 1980–2000 decline in young home ownership occurred as improvements in mortgage opportunities made it easier to purchase a home. 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. Our findings indicate that a trend toward marrying later and the increase in household earnings risk that occurred after 1980 account for 3/5 to 4/5 of the decline in young home ownership.

Journal of Economic Literature Classification Numbers: E0; E2; J1; R21.

Keywords: Housing, home ownership, tenure choice, first-time home-buyers, marriage, income risk

*We thank Francesco Caselli, Morris Davis, François Ortalo-Magné, Filippo Scoccianti, and seminar participants at various institutions for their comments. We are grateful to Faisal Ahmed, Nishat Hasan, and Eric Vogt for excellent research assistance. The views expressed herein are those of the authors and do not necessarily represent those of the Federal Reserve Bank of Chicago or the Federal Reserve System.

1 Introduction

Increasing home ownership has long been 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 declined substantially between 1980 and 2000, even as the aggregate home ownership rate was rising. Young ownership 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. Below we document that marriage and home ownership are tightly linked. This fact underlies why, for any given cohort and age, the married tend to own more than the unmarried. Because of this tendency, a decline in the incidence of marriage mechanically lowers home ownership. Between 1980 and 2000 marriage rates for individuals aged 25–44 fell by 15 percentage points. But, this fall in marriage rates does not account for all of the decline in young home ownership: combining the 2000 shares of unmarried and married with the corresponding 1980 home ownership rates accounts for only half of the decline. Another indication that something else must be going on is that home ownership has fallen for young, married households as well.¹

The other main source of decline in young home ownership we point to is a rise in household earnings risk. There is a large literature that documents increases in individual and household earnings inequality and variability, but less research documenting earnings *uncertainty*.² [Cunha and Heckman \(2007\)](#) have examined earnings uncertainty in two waves of the National Longitudinal Survey. They study white males born between 1957 and 1964, surveyed starting in 1979, and an earlier sample born between 1941 and 1952, surveyed starting in 1966. They find for college

¹We 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. \(1996\)](#).

²See [Katz and Autor \(1999\)](#) for an early review of this literature and [Dynan et al. \(2007\)](#) for a more recent review.

graduates earnings risk increased 11% between the 1966 and the 1979 cohorts and for high school graduates uncertainty rises by 52%. These findings suggest there has been a substantial increase in earnings uncertainty in two cohorts important for understanding the changes in home ownership between 1980 and 2000.

Higher earnings risk has two opposing effects on home ownership. Precautionary savings increase with earnings risk, and this should ease the transition to home ownership. In our analysis we find this effect is dominated by the impact of risk on the value of delaying home ownership. Other things being equal, an increase in earnings risk reduces the incentive to own a home when there are proportional adjustment costs. It is well-known that such costs exist for housing transactions. In the presence of proportional transactions costs, the option of delaying the first 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 that *a priori* should have worked to *raise* young home ownership between 1980 and 2000 and make the observed decline seem puzzling. 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 rose by 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. As in [Kiyotaki et al. \(2007\)](#), home ownership is desired because the service flow from renting is discounted relative to owning the same house. For simplicity, our model has a representative household. Marriage is modeled as the middle stage of a three stage life-cycle and the link between marriage and home ownership is captured by allowing the rental discount to be greater when married compared to the first stage of life.

We account for less marriage by reducing the rate of transition to the middle stage of life, since evidence we discuss below suggests delayed entry into marriage is the main determinant of declining marriage rates. Higher 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 U.S. 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. We compare the 1980 calibration with the stationary equilibrium incorporating key structural changes affecting home ownership in 2000, including delayed marriage, increased earnings risk, improved female labor market outcomes, lower growth in the number of households, and relaxed credit constraints. The effects of delayed marriage and increased earnings risk are large enough to offset the other structural changes, which boost home ownership, leading the model to account for between 3/5 and 4/5 of the decline in young home ownership. We also find that easier access to mortgage credit has a relatively small positive impact on home ownership.

Our paper contributes 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 the labor supply implications of rising income risk as well as evidence that consumption inequality has risen by less than income inequality since 1980. This literature has yet to address how rising earnings risk is connected to trends in home ownership.

The second literature studies housing choices within the context of equilibrium life-cycle models. [Gervais \(2002\)](#) examines the preferential tax treatment of houses on tenure choice. We abstract from this issue, but do discuss the possible role of taxes in the decline in young home ownership. [Chambers et al. \(2009\)](#) study the rise in home ownership after 1995 and, in contrast to our findings, argue that weaker borrowing constraints played a big role. [Kiyotaki et al. \(2007\)](#) explore the global run-up in house prices. In our model house prices are fixed, since houses are perfectly substitutable with other goods. Still, similar to our analysis, they find relaxing mortgage constraints has little effect on the demand for housing. Finally, [Díaz and Luengo-Prado \(2006\)](#)

examine the lifetime pattern of housing tenure. 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 document the trends in home ownership and marriage as well as the connection between home ownership and marriage. 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 model. Section 6 considers other possible explanations for the decline in young home ownership, including changes in house prices, mobility, tax policy, and inflation. Section 7 concludes.

2 Evidence on Home Ownership and Marriage

This section documents the decline in young home ownership and discusses the role marriage seems to have played in this decline.

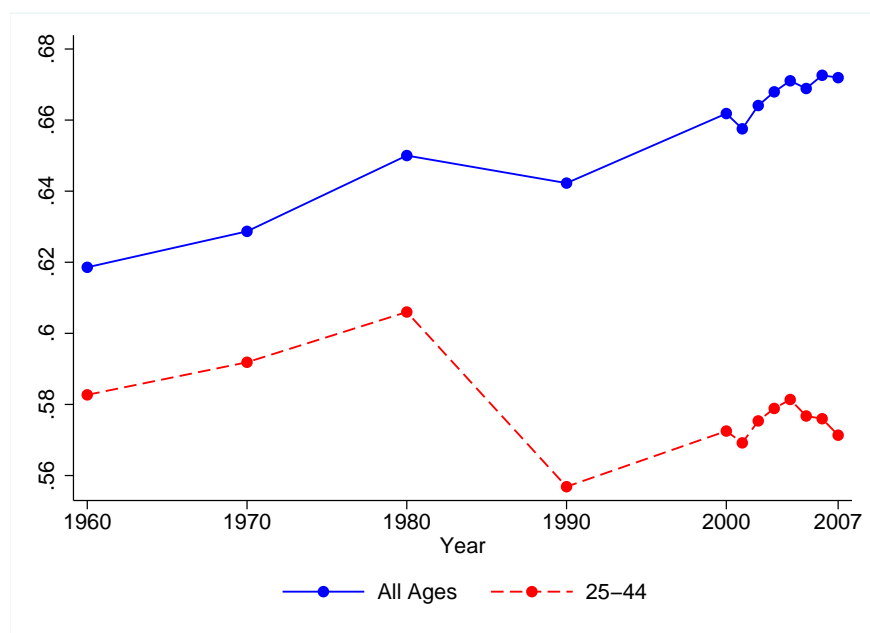
2.1 Trends in Home Ownership, 1960-2007

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.³ These rates are calculated using the Census of Population and Housing for the years 1960–2000, and the American Community Survey for 2001–2007 (ACS). We use the Census Bureau definition of the home ownership rate for a household with particular characteristics such as age: the number of households with those characteristics who own divided by all households with those characteristics.

The overall home ownership rate grew by 3 percentage points between 1960 and 1980, dropped by about 1 percentage point between 1980 and 1990, and rose another 3 percentage points between 1990 and 2006, before dipping slightly in 2007. Key factors driving the post-1990 rise in aggregate home ownership are higher ownership rates for households over age 65 and an aging population. We discuss this further

³Before 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.

Figure 1: Home Ownership Rates, 1960-2007



Source: Our estimates for 1960–2000 are based on the Census of Population and Housing and for 2001–2007 the ACS.

below. 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 1960 level. Young ownership peaks two years earlier than the aggregate rate and in 2007 is essentially back to its 2000 level. The trough in home ownership in 1990 undoubtedly is driven in part by the large housing recession at the time, but other factors must be in play as well because the young home ownership rate never again attains its 1980 level.

For concreteness, we focus our analysis on the years 1980 and 2000. The year 1980 is the year of the highest young home ownership rates. We use the year 2000 for three reasons. First, by this time the structural changes we emphasize are firmly in place, including the developments that have made it easier to purchase a home. Second, unlike 1990, cyclical factors should be playing a limited role at this time. Third, the years after 2000 involve unique driving forces which are beyond the scope of this paper.

The Census is not the only source for aggregate home ownership rates. It is in-

Table 1: Changes in Home Ownership Rates by Age between 1980 and 2000

Source	All Ages	25-29	30-34	35-39	40-44	45-64	65+
Census							
1980	65.0	43.4	60.7	69.7	74.3	78.0	70.8
2000	66.2	36.0	53.0	63.4	69.1	76.8	77.5
Change	1.2	-7.4	-7.7	-6.3	-5.2	-1.2	6.7
CPS							
1980	68.0	46.6	63.5	72.8	76.3	80.7	74.1
2000	67.2	37.1	54.6	63.6	70.4	77.9	80.5
Change	-.8	-9.5	-8.9	-9.2	-5.9	-2.8	6.4
AHS							
1980	66.5	44.2	62.3	72.3	75.1	79.1	72.9
1999	66.9	37.0	54.4	64.2	70.7	77.8	80.3
Change	0.4	-7.2	-5.9	-8.1	-4.6	-1.3	7.4

Note: Home ownership rates and their changes are reported in percentage points.

structive to consider two other sources as well: the Current Population Survey (CPS) and the American (formerly Annual) Housing Survey (AHS). Table 1 displays changes in home ownership rates, by age, between the years 1980 and 2000 for the Census and CPS and between 1980 and 1999 for the AHS. Interestingly there are noticeable differences in the levels of the home ownership rates across the three datasets, with home ownership rates the highest in the CPS. However, the qualitative patterns are quite similar, except that the CPS indicates a slight decline in the overall home ownership rate, while the other two data sources show a small increase. Most importantly, regardless of the source of the evidence, the changes for the young age groups 25-29, 30-34, 35-39, and 40-44 are all large and negative. We conclude that, regardless of the source of the data, the evidence strongly suggests there has been a substantial decline in home ownership among the young between 1980 and 2000. For simplicity, we base our analysis on the Census.⁴

⁴We are more confident in the Census home ownership numbers because home ownership is a primary measurement target for this data source. The Census Bureau appears to place more weight on the Census when it uses it to re-calibrate the CPS periodically. The CPS uses weights designed

Table 2: Young Home Ownership by Household Characteristic

Characteristic	1980	2000	Difference
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 in Household			
None	41.4	45.1	3.8
One	63.3	60.4	-3.0
Two or more	72.5	67.0	-5.5
Adults in Household			
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

Source: Census of Population and Housing, 1980 and 2000.

All three datasets indicate the home ownership rate for the 45-64 age group declined by a small amount, while the rate for the over 65 age group rose by a large amount. The structural changes we have in mind should have smaller effects on these two age groups. We think their home ownership rates are primarily influenced by decisions made younger in life. This last point is easiest to see with the over 65s. The 2000 over 65 age group corresponds to the 45-64 age group in 1980, and, consistent with older home ownership being driven by decisions made when younger, their home ownership rates are very close. This deterministic feature of home ownership for older households is the reason we do not focus on them in our analysis.

Table 2 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. These include, 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 mainly due to the wealth effect discussed in the introduction.

2.2 Trends in the Mortgages of First-Time Home Buyers

The decline in home ownership among the young 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 and the regulatory changes since the early 1980s.⁵ Public and private initiatives expanded mortgage opportunities by lowering transactions costs, the underlying real interest rate, and the required down-payment, among other factors. We now briefly document how mortgage criteria for the young became less stringent after the 1970s, concurrent with the changes to mortgage markets.

Table 3 describes borrowing characteristics of first-time home buyers over the

to improve the precision of its labor market variables, not home ownership rates. Similarly, the AHS is designed to measure home sales, not home ownership rates.

⁵Florida (1986) contains several essays describing mortgage market deregulation. Gerardi et al. (2007) provide a recent overview of how the mortgage market has evolved. Edelberg (2003) discusses the expanded use of sophisticated credit scoring methods in the mid-1990s. Ryding (1990) and Van Order (2000) describe the evolution of the secondary mortgage market.

Table 3: 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

Source: Various issues of *The Guarantor*, 1978-1999.

period 1976–1999. The mortgage market changes should have their largest impact on first-time home buyers, because they are more likely to have lower income and wealth and greater credit constraints than other buyers. Also, first-time home buyers are typically within the young age groups we focus on. Table 3 indicates that first-time buyers financed their house purchases with progressively larger value to income ratios, lower down-payments, and higher monthly payments. In the 1976-80 period the median house price averages 2.0 times 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 an average down-payment of just 14 percent of the house value 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 3 strongly suggests mortgage criteria for first-time home buyers became less stringent after the 1970s.

2.3 Marriage and Home Buying

To understand the changes in young home ownership, we need to assess what drives the house purchase 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 that also has information on family level variables. The sample years are 1985-1994, 1996, and 1998.⁶ Since we have relatively few observations for individuals aged 40 and over, we restrict the sample to those aged 21–39. We use the NLSY because it has many more years of net worth

⁶Wealth data are not available prior to 1985.

Table 4: 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

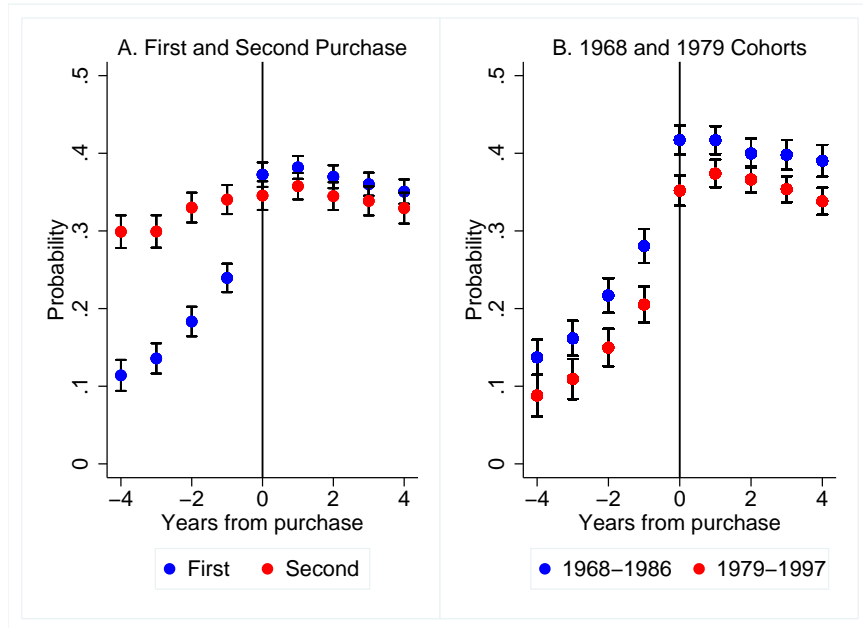
Source: Our estimates using the NLSY.

data over our sample compared to other datasets, and wealth is an important factor for home ownership.

We begin by estimating a linear probability model of young home ownership using the variables in Table 4 plus year effects as regressors. Assets and income are deflated by the CPI.⁷ The table displays coefficient estimates with robust standard errors.

⁷Net assets and income include those for the survey respondent and their spouse, if the spouse lives with the respondent. Income is labor plus transfer income. As in [Zagorsky \(1999\)](#), net assets are defined as the sum of home value, cash, stockholdings, trust holdings, business equity, car value, IRA holdings, certificates of deposit, 401(k) holdings, and non-car durables goods, less the sum of mortgage and other property debt, car debt, and any other debt. Top coding affects about 10 percent of the sample in the later years of the survey. Since individual items of net assets are top-coded, we drop observations with any top-coding. We use the weights provided by the NLSY in our estimation to correct for the oversampling of the poor and members of the military.

Figure 2: Marriage Near Home Purchases



Note: These are our estimates from the PSID. The coefficients corresponding to -4 to 4 years after the first or second purchase are plotted with 95% confidence intervals.

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 \$1,000 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.

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. 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 whether they own or rent.

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 that never buy a house. There is a big jump upward in the likelihood 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 and the first purchase are the most tightly linked.

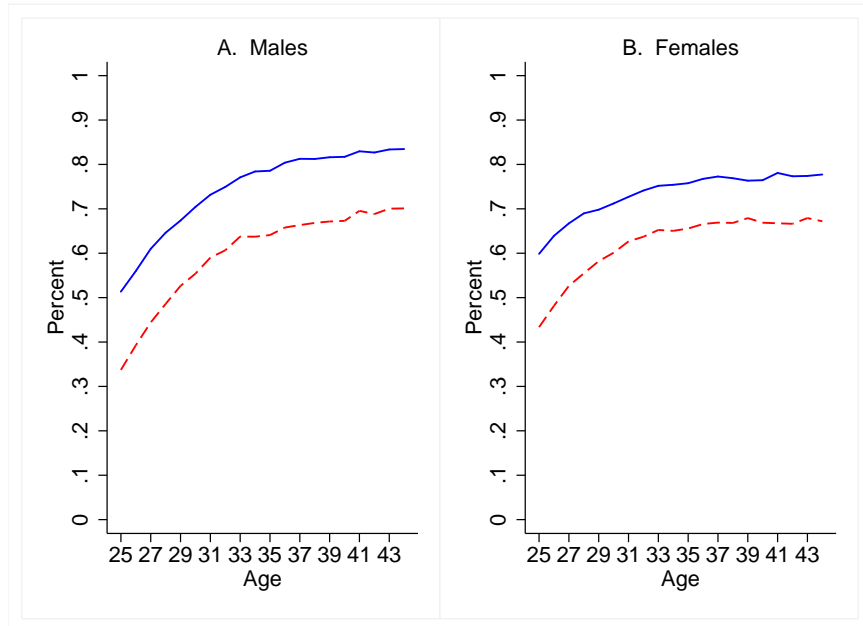
Figure 2's panel B shows that there has been little change over time in the dynamics of marriage and the first home purchase. Most importantly, the jump near marriage is about the same. Although there is a tight connection between marriage and the first home purchase for both cohorts, the trend toward later marriages has weakened the relationship somewhat. 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.

2.4 Delayed Marriage and Trends in Home Ownership

Taken together, the regression results strongly suggest that any trends in marriage will be important for understanding the decline in young home ownership. So, now we consider trends in marriage and their impact on young home ownership using the Census of Population and Housing.

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.

Figure 3: Marriage Rates in 1980 and 2000



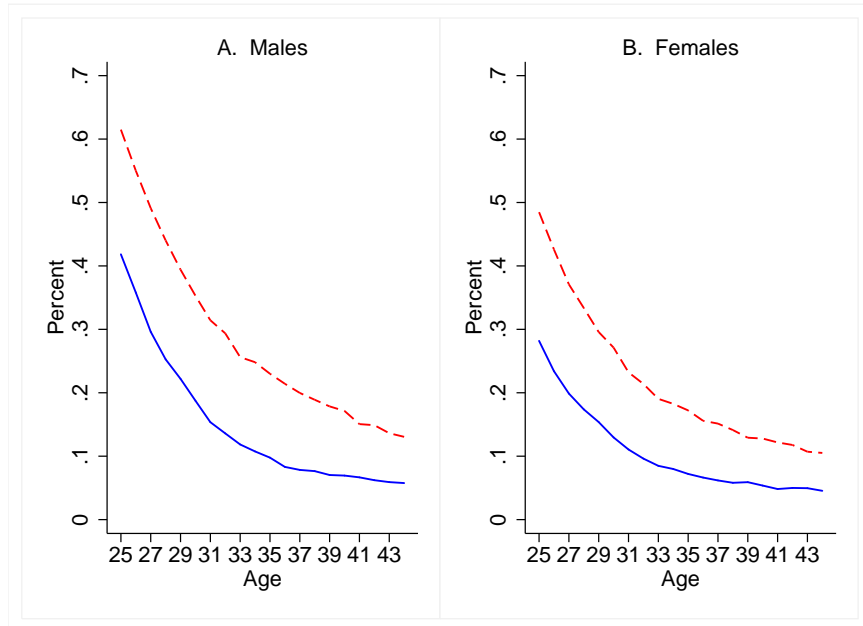
Note: Solid line – 1980, Dashed line – 2000. These are our estimates using the 1980 and 2000 Census of Population and Housing.

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 indicating increased exit is not the key factor underlying declining marriage rates since 1980, so we focus on entry into the state of marriage. The primary determinant of entry into marriage is the timing of the first marriage. As we just documented, the first home purchase is tightly connected to the first marriage. So, delayed entry into the state of marriage for the first time should 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

Figure 4: Never Married Rates in 1980 and 2000

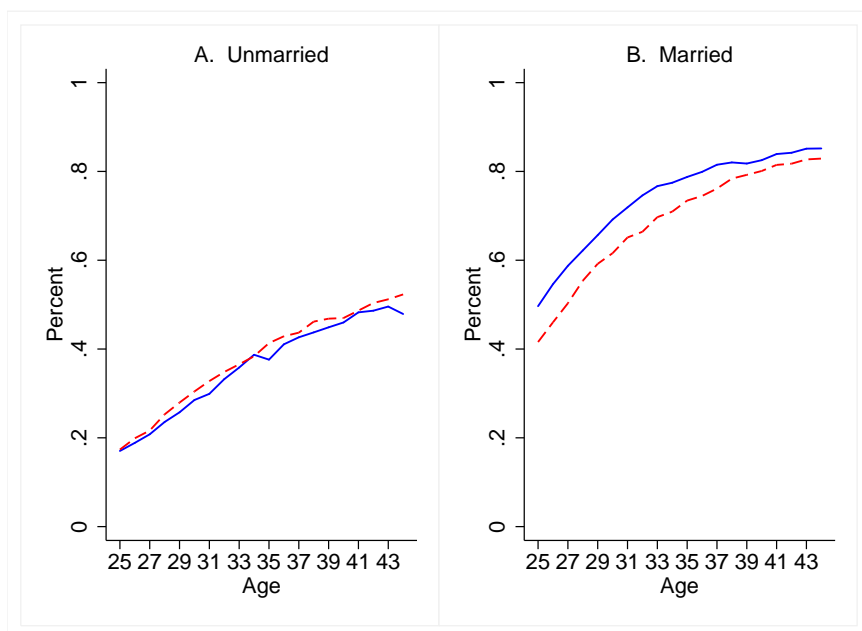


Note: Solid line – 1980, Dashed line – 2000. These are our estimates using the 1980 and 2000 Census of Population and Housing.

“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 shown in Figure 3. This points toward delayed marriage being the primary proximate cause of the decline in marriage among the young.

Figure 5 confirms that delayed marriage must lower home ownership rates. This figure displays home ownership rates by marital status in 1980 and 2000. There was a small increase in home ownership between 1980 and 2000 for unmarried household heads. This presumably reflects our discussion of Table 2 that home ownership has increased among single females. 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 must be involved. This motivates our consideration

Figure 5: Home ownership Rates in 1980 and 2000



Note: Solid line – 1980, Dashed line – 2000. These are our estimates using the 1980 and 2000 Census of Population and Housing.

of the role of heightened earnings risk.

3 The Model Economy

In this section we describe our life-cycle model of tenure choice with idiosyncratic earnings risk. The model consists of representative households, goods producing firms, and financial intermediaries. For parsimony, we do not model marriage explicitly. 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 rental housing yields services at a discount relative to owned housing. However, while changing rental housing is costless, owning requires a down-payment, 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 has a large number of ex-ante identical households who forever repeat the same three-stage life-cycle of being young, having a family, and retirement. 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

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

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 $s \in \mathcal{S} = \mathcal{Y} \cup \mathcal{F} \cup \mathcal{R} = \{1, 2, \dots, N\} \cup \{N + 1, N + 2, \dots, 2N\} \cup \{2N + 1, 2N + 2, \dots, 3N\}$. Households go through three stages of life. When $s \in \mathcal{Y}$, a household is a *young* type whose housing services when renting are discounted by $\psi(s, 0) = \psi_y < 1$. When $s \in \mathcal{F}$, a household is a *family* type. For this household type rented housing services are discounted at the rate $\psi(s, 0) = \psi_f$. We have in mind that $\psi_f < \psi_y$, to capture the tight connection between marriage and home ownership we have documented. This would also be consistent with the empirical phenomenon that many housing services desired by families, such as proximity to good schools and parks, are harder to obtain in rental housing. However in our calibration we do not impose this condition. Finally, when a 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 uninsurable idiosyncratic uncertainty with respect to their labor productivity. A 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 $e(s) = \theta\bar{e}/(1 - \tau_w)$ if $s \in \mathcal{R}$, where \bar{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 a 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. We use $\pi_{ss'}$ to denote individual elements of Π . 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. 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 $\Pi_{\mathcal{R}\mathcal{Y}}$ as follows:

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

where δ is the probability of dying, and $[\theta_1, \dots, \theta_N]$ is the part of the invariant distri-

bution Π associated with the young stage of life. As written, the matrix $\Pi_{\mathcal{R}\mathcal{Y}}$ 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 that currently own and occupy a house of size h_i have $x' = i$ and households who currently rent have $x' = 0$.

Owned houses must be chosen from a finite grid,

$$\mathcal{G} = \{h_i, i = 1, 2, \dots, M : h_i \in [\underline{h}, \bar{h}]\}.$$

Households that rent may choose a continuous quantity of housing for houses smaller than \underline{h} , but are confined to the set \mathcal{G} for larger houses. The parameter \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

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

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

In addition to assuming that there is a minimum sized house that can be owned, \underline{h} , we also 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 *down-payment constraint*. After the first year, and as long as the household does not change the size of its house, the down-payment constraint does not apply. 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, τ_b and τ_s . 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. Because households borrow and lend at the same interest rate, they 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 down-payment 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 a household that 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

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

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

To address how to allocate assets of retired households who die between periods, we introduce annuities. We assume households face a 100% estate tax upon death so they would never bequeath any wealth to their children. To avoid accidental bequests, households participate in annuity markets. All retired households (the only households that 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 household 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 that enters a period with state variables s , x and a . The recursive representation of the household's problem is as follows:

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

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,

new residential capital or new non-residential capital. Consequently, the prices of these goods are all equal to one in a competitive equilibrium. Non-residential 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.⁸ 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 financial intermediary is:

$$\max_{\{K_f, H_f, M_f, D_f\}} (p_k - \delta_k)K_f + (p_h - \delta_h)H_f + iM_f - iD_f \quad (7)$$

subject to the constraint

$$K_f + H_f + M_f \leq D_f. \quad (8)$$

The solution to this maximization problem yields the following no-arbitrage conditions:

$$\begin{aligned} p_k &= i + \delta_k; \\ p_h &= i + \delta_h. \end{aligned} \quad (9)$$

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

⁸We 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 the time period in the model is one year we think this is a reasonable assumption.

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 $g_h(s, x, a)$, prices $\{i, w, p_h, p_k\}$, a fiscal policy $\{\tau, \theta\}$, aggregate quantities $\{K', H', L\}$, an allocation for financial intermediaries $\{D_f, K_f, H_f, M_f\}$, 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 (5) and (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 (9) 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:

$$\begin{aligned}
D_f &= \sum_{s \in \mathcal{S}} \sum_{x=0}^M \int_{a \geq 0} g_a \lambda(s, x, da) - \sum_{s \in \mathcal{S}} \sum_{x=1}^M \int_{a \geq 0} g_h \lambda(s, x, da) \\
&\quad + \sum_{s \in \mathcal{S}} \sum_{x=0}^M \int_{\{a: g_h > g_a \text{ and } g_x > 0\}} [g_h - g_a] \lambda(s, x, da); \\
H' &= \sum_{s \in \mathcal{S}} \sum_{x=0}^M \int_{a \geq 0} g_h \lambda(s, x, da); \\
H_f &= \sum_{s \in \mathcal{S}} \int_{a \geq 0} g_h(s, 0, a) \lambda(s, 0, da); \\
M_f &= \sum_{s \in \mathcal{S}} \sum_{x=0}^M \int_{\{a: g_h > g_a \text{ and } g_x > 0\}} [g_h - g_a] \lambda(s, x, da); \\
K_f &= K'; \\
L &= \sum_{s=1}^{2N} \theta_s e(s),
\end{aligned}$$

where 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 stationary equilibria of our model to quantify the role of structural change on young home ownership. Our baseline scenario is designed to capture the environment faced by households in the years leading up to 1980. We compare this baseline to one that embodies 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 the 1980 and

2000 calibrations. At the end of this section we briefly discuss household behavior in the model at the calibrated parameter values.

4.1 1980 Calibration

We assume the functional form of the utility function is

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

and the functional form of the production function is

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

We set the number of income states in each of the two working stages of life to $N = 9$ and the number of houses to $M = 20$. Our results are not sensitive to increasing the number of houses. 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, $\{\beta, \eta, \sigma, \psi_y, \psi_f\}$, production, $\{A, \alpha, \delta_h, \delta_k\}$, 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 process and some housing and preference parameters, and then to choose the remaining parameters to bring the model as close as possible to a short list of statistics. Table 5 displays parameter values which are held fixed across the 1980 and 2000 calibrations. Table 6 later in this section displays parameters which change between the two calibrations to account for various structural changes.

The income process involves three key inputs into our analysis: the speed of transition to “marriage”, differences in income over the life-cycle, and idiosyncratic risk. We assume that within each of the first two life stages, income follows a [Tauchen and Hussey \(1991\)](#) approximation to a first-order auto-regressive process. It follows that the income process is completely specified by the following elements: the average duration of each life stage, 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, and the growth rate for the number of households. We now describe how we calibrate these characteristics.

Table 5: Parameters Constant Across the 1980 and 2000 Calibrations

Preferences					
β	0.951	σ	2.0	η	0.879
ψ_y	0.9544	ψ_f	0.87		
Housing					
τ_b	0.0163	τ_s	0.0776	\underline{h}	1.15
Production					
α	0.257	δ_k	0.082	δ_h	0.044
Social Security					
θ	0.06	τ	0.061		
Income Process					
	Expected age at transition to retirement:				65
	Expected lifetime:				75
	Income ratio of family versus young:				1.47
	Autocorrelation of income:				.95

We interpret the transition from the young to family type as the event of marriage. The duration of the first stage of life is selected 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 6, 39, and 9 years. On average, the young stage of life is 18-24, the family stage is 25-64, and the retirement stage is 65-74.

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 NLSY.⁹ We normalize average income over the young and family stages of life to one and use

⁹Specifically, 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 get similar results using the PSID.

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 is risk. Income risk 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 from 1968 to 2004 by [Storesletten et al. \(2004\)](#) to guide our selection of these parameters. [Storesletten et al. \(2004\)](#) assume the autocorrelation of income does not change over the working years of the life-cycle. Accordingly, 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 [Storesletten et al. \(2004\)](#). Given the evidence discussed below 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, of how much the conditional variances increase, we calculate 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 calculate the innovation variances using our assumed autocorrelation coefficient.

To complete the specification of income, we need to assign values to the social security replacement ratio, the labor tax, 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_w , to be the value which finances the social security system. Since labor is supplied inelastically, the labor tax is really just a lump sum tax and so does not affect any decisions at the margin. The growth factor, G , is set to 2.35, corresponding to a growth rate of 2 percent, which is the mean growth rate of households from 1960 to 1980 as reported by the Census Bureau.

Housing transactions costs are very important for our analysis since they determine the magnitude of the effect of income risk on the option value of delaying a housing transaction. There are several kinds of housing transactions costs, often called “closing costs,” including real estate agent fees, fees and taxes associated with recording an official record of the transaction, attorney fees, real estate transfer taxes,

title search, and title insurance. Some of these costs vary widely by jurisdiction and the magnitude and complexity of the transaction. In addition, while the convention for real estate agents' fees is 6% of the property value, agents are sometimes willing to reduce their rate to close a deal. We obtain our estimates of average transactions costs from globalpropertyguide.com. This is a firm specializing in selling information relevant to real estate investors. They estimate U.S. housing transactions costs as a percentage of property values to be in the range 1.05% – 2.2% for buyers and 6.51% – 9% for sellers. These costs include those mentioned above, but exclude other costs such as appraisal fees, home insurance, mortgage and bank-related fees, and inspection fees. We use the mid-point of the ranges: $\tau_b = .0163$ and $\tau_s = .0776$.

The down-payment 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 down-payment of at least 20% is required to avoid paying mortgage insurance.

The remaining parameters are β , η , σ , ψ_y , ψ_f , A , α , δ_h , δ_k , and \underline{h} . The discount rate β is chosen so that the interest rate is 5% and A is normalized to 1. The parameters α , δ_h , and δ_k are chosen to match empirical estimates of the nonresidential plus residential investment to output ratio (.26), non-residential capital to output ratio (1.95), and the residential capital to output ratio (.97). The parameters η , ψ_y , ψ_f , and \underline{h} are chosen to match the share of owned residential capital in total residential capital (.7), the share of housing services in total consumption (.11), the overall home ownership rate of the 25–44 age group (60.6%), and the home ownership rate of the never married among the 25–44 age group (25.1%).¹⁰ Table 5 indicates that the calibrated value of ψ_f is smaller than that for ψ_y , consistent with the link between marriage and home ownership we have documented. Finally, σ is chosen, within a range consistent with estimated income elasticities of housing demand, to match the life-cycle profile of home ownership. By this latter criterion we mean the increase in home ownership from the 25–29 age group to the 40–44 age group of all households

¹⁰The home ownership rates are estimated from the Census of Population and Housing and the remaining statistics are estimated using NIPA data (described in the appendix) for the period 1955–1980. In practice, we do not exactly match the home ownership rate targets. Our target for the share of consumption spending that is on housing services is small compared to 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 excludes expenditures on household operations.

Table 6: Parameters Governing Differences in the 1980 and 2000 Calibrations

	1980	2000
Minimum down-payment requirement (γ_d)	0.200	0.133
Expected age at transition to family stage	25	27
Variance of innovations during young stage	0.025	0.033
Variance of innovations during family stage	0.042	0.056
Productivity effect (A)	1.000	1.041
Population growth (G)	0.020	0.013

and never married households. We found $\sigma = 2$ to do the best along these two dimensions. The implied income elasticity of housing demand in the model is .33, which is toward the low end of estimates in the literature, e.g. [Hansen et al. \(1998\)](#).

4.2 2000 Calibration

The 2000 calibration embodies several structural changes that should have influenced young home ownership between 1980 and 2000. These include a lower down-payment constraint, delayed marriage, slower growth in the number of households, heightened idiosyncratic income risk, and greater aggregate productivity due to the changes in female labor market outcomes. Recall that [Table 6](#) displays the model parameters which change across the two calibrations.

The down-payment constraint is set to .13, which is 2/3 of the value used in the 1980 calibration. The 2/3 value roughly corresponds to the ratio of the average down-payment in the 1990s compared to the 1970s. 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 the findings in [Cunha and Heckman \(2007\)](#) discussed in the introduction. Recall that this paper studies white males born between 1957 and 1964, surveyed starting in 1979, and an earlier sample born between 1941 and 1952, surveyed starting in 1966. Between the two samples, earnings uncertainty, defined as the variance of the unforecastable component of earnings, rises by 11% for college graduates and 52% for high school graduates. They also find uncertainty in the rate of return to schooling rises by 33%. Using the 1980 and 2000 Census we find the percentage of individuals aged 25-44 who were high school graduates rose from 59% to 61%. The college graduate share rose from 22% to 27%. These changes plus the findings in [Cunha and Heckman \(2007\)](#) translate to an increase in overall earnings uncertainty of 39%. We use the average of the increases in uncertainty in earnings and in returns to schooling, 36%, as the amount by which earnings risk rises in our 2000 calibration compared to our 1980 calibration.

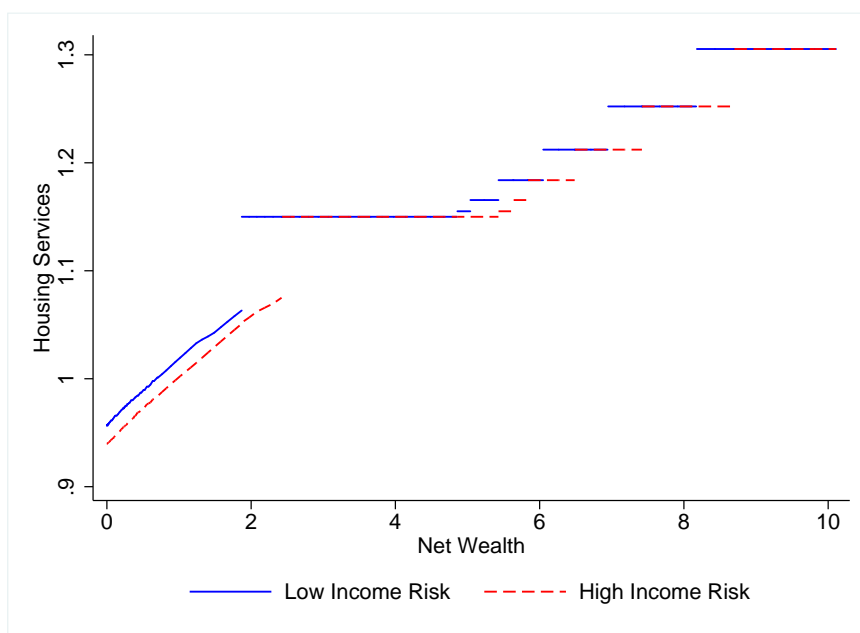
Two developments in the labor market experience of women likely affected young home ownership. First, the gender wage premium has declined. For example, [Heathcote et al. \(2008\)](#) use CPS data to show that the average wage paid to men relative to women for the period 1967–1980 was about 1.6, whereas between 1980 and 2000 this ratio averaged about 1.5. Second, women worked outside the home more after 1980. The data compiled by [Francis and Ramey \(2008\)](#) indicate that average weekly hours worked per female over age 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 as a change in the productivity parameter A from 1 to 1.041.¹¹

4.3 Discussion

It is helpful to briefly describe household behavior in the model. Figure 6 displays the housing service decision rule for a household in the young stage of life that rented in

¹¹The 4.1% increase in productivity equals the ratio of population share weighted average weekly pay for males and females in the second sub-sample relative to the first. The average pay is calculated as follows: for the early sample, $.47 \times 30.28 + .53 \times 12.42/1.6$ 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. \(2008\)](#).

Figure 6: Housing Decision of a Household that Rented in the Previous Period



the previous period, under the 1980 calibration, “Low Income Risk,” and with 1980 prices but income risk set according to the 2000 calibration, “High Income Risk.” The household’s level of income is almost identical in both cases, so essentially the only difference to the household’s environment is the income risk it faces.¹² On the horizontal axis is the beginning of period level of net worth, a , and on the vertical axis is the housing service choice. Figure 7 shows the housing decision of the same household except that it owned the smallest house, \underline{h} , in the previous period. The domain of assets considered in each figure differs to highlight different features of the decision rules.

Consider the low risk case for a renter first. This shows that for assets less than about $a = 2$ this household chooses to rent. The amount rented rises continuously with wealth. Near asset level $a = 2$ this household switches from renting to owning the minimum size house, $\underline{h} = 1.15$. The tenure choice is not evident in the figure, but the household chooses to own all houses equal to or exceeding the smallest house.

¹²Due to the way the income process is constructed, increasing income risk changes the level of income in each income state. Figure 6 displays the decision rules for the fourth highest income state which turns out to be very close across the two cases.

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. For assets of about $a = 5$, the household's desired level of housing services increases. The step function form of the policy rule continues to the right of $a = 5$. Another interesting feature of the decision rule is that the jump in housing services from renting to the smallest house is larger than the other jumps in the figure. Similarly, the interval of assets for which the household chooses to own the smallest house is wider than for larger houses. These characteristics arise because the switch from renting to owning ends the discounting due to renting which mitigates the transactions costs, while the other switches only involve the transactions costs. Therefore, the household is willing to incur the transactions cost of the move earlier than otherwise, that is with lower net wealth.¹³ The basic form of the decision rule of this household holds for all households in the model. All that changes are the asset cut-off values determining when the household selects a different level of housing services.

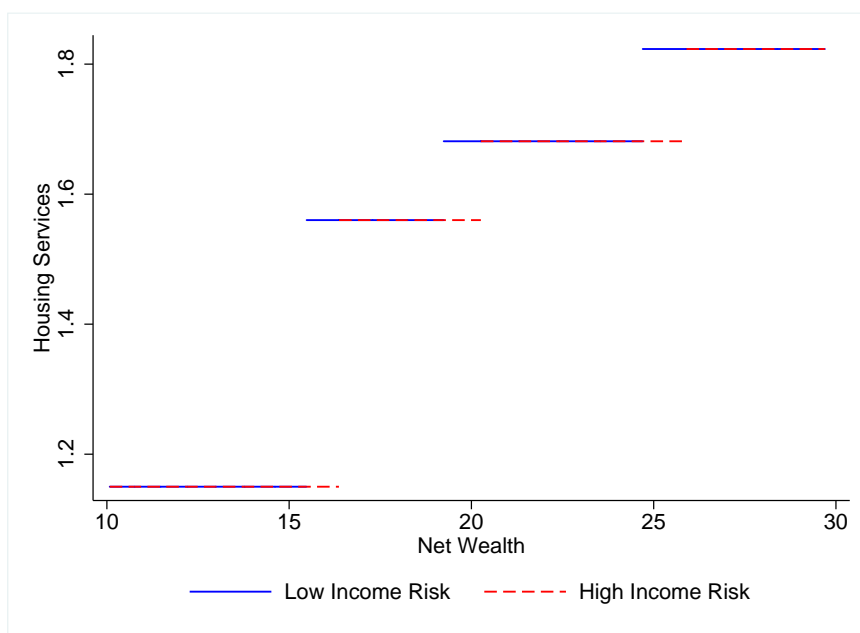
The impact of raising income risk is to delay switching from renting to owning. This is indicated in the figure by the fact that the dashed line lies to the right of the solid line. The rightward shift of the decision rule implies the household switches from renting to owning at a higher level of assets in the high income risk case. These higher assets take longer to accumulate on average and so higher income risk leads to delay in acquiring the first house and, other things being equal, lower home ownership.

The intuition for this is straightforward. In the presence of proportional adjustment costs and income risk, there is value to delaying the home purchase or sale until the household is possibly wealthier and can afford a larger house. Higher income risk increases the value of this option, thereby delaying home ownership and lowering the home ownership rate. An increase in risk also raises the amount of precautionary saving. Other things remaining the same, higher wealth eases the transition to home ownership and so this effect should raise the home ownership rate. As we see in the next section, at our calibrated parameter values the option value effect dominates the precautionary saving effect.

In Figure 7 the household always chooses to own in both the low and high risk

¹³After the second housing service jump, the interval of assets for which the housing choice is fixed gets larger as the size of the house increases. This is an artifact of the log linear manner in which the housing grid was constructed.

Figure 7: Housing Decision of a Household that Owned in the Previous Period



cases. Consequently the behavior of this household does not directly impact the home ownership rate. However, Figure 7 illustrates another effect of raising income risk, namely that it leads to delay in moving into larger houses. Note that for assets $a < 10$ the household chooses to continue owning the smallest house. When the household enters the period with more assets, larger houses are chosen. Delay is indicated by the fact that the asset level for which the switch to the next sized houses occurs is higher in the high risk compared to low risk case. The intuition for this effect of raising income risk is similar to before.

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 young age groups of interest in the U.S. data and under the stationary equilibrium corresponding to each calibration. The empirical values for 1980 and 2000 are taken from Table 2.

Table 7: Young Home Ownership in 1980 and 2000

Age Group	Data			Model		
	1980	2000	Change	1980	2000	Change
25–29	43.4	36.0	-7.4	48.1	43.0	-5.1
30–34	60.7	53.0	-7.7	59.9	55.2	-4.7
35–39	69.7	63.4	-6.3	67.6	63.1	-4.5
40–44	74.3	69.1	-5.2	72.9	68.6	-4.3
25–44	60.6	57.3	-3.3	60.3	56.1	-4.2

It is clear from Table 7 that the model goes a long way toward accounting for the reduction in home ownership rates by age and for the 25–44 category as a whole. By age group our model accounts for 3/5–4/5 of the fall in home ownership and, as in the data, the effects are larger for the younger age groups than for the older age groups. The model implies a larger drop for the 25–44 age group than in the data, but smaller drops for the individual age groups. The larger drop for the young group as a whole is because the change in the age distribution in the model from 1980 to 2000 is not identical to the data, despite our attempt to take changes in the rate of household formation into account.

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 differences in home ownership by age between the 1980 calibration and versions of the 2000 calibration where just one of the five structural changes is imposed. In each case we calculate the home ownership rates from the corresponding stationary equilibrium. This table 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. Income risk lowers home ownership rates by age by between 3.37 and 4.59 percentage points. Marriage delay lowers the rates by between 1.58 and 3.98 percentage points. The reasons for heightened income risk lowering home ownership were described at the end of the last section. Marriage delay lowers home ownership mechanically since, as in the data, the non-married have lower home ownership rates than the married in our model.

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

Age Group	Down-payment Constraint	Household Formation	Income Risk	Marriage Delay	Productivity Increase
25–29	0.20	0.69	-3.37	-3.98	4.87
30–34	0.22	0.54	-3.86	-3.08	4.50
35–39	0.21	0.33	-4.32	-2.26	3.92
40–44	0.19	0.13	-4.59	-1.58	3.37
25–44	0.20	0.80	-3.95	-2.83	4.28

The other factor having a large impact on home ownership is the productivity increase. Recall that this is our way of modeling the higher wages and market work of women after 1980. Not surprisingly higher productivity has a substantial 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.

Lowering the down-payment constraint has a small positive impact on home ownership. This is despite the fact that in the 1980 calibration 10% of those switching from renting to owning are at the down-payment constraint and this percentage falls to zero with the reduction in the down-payment constraint. Lowering the down-payment even further has a very small additional effect on home ownership. That relaxing credit constraints has a small impact on home ownership in our model does not rule out the possibility that such constraints play an important role in cyclical fluctuations.

The reduction in the rate of household formation also has a small positive impact on home ownership. The lower rate of household formation raises the share of households in the family and retired stages compared to the young stage. This raises home ownership because of the higher home ownership rates of the married and retired compared to the young in the model. A side-effect of this change in the underlying distribution of households is that wealth accumulation is greater and so the equilibrium interest rate is lower. The impact of the lower rate of household formation on young home ownership is similar in magnitude to the effect of general equilibrium on

the total impact of the structural changes on home ownership in the 2000 calibration. In particular, if we do not impose market clearing in the 2000 calibration and keep the interest rate at its 1980 level, then home ownership rates would be about .5 percentage points lower.

6 Other Possible Explanations

We now address some other potential alternative explanations for the decline in young home ownership. We consider changes in house prices, household mobility patterns, tax policy and inflation.

6.1 House Prices

House prices may be important for understanding the changes in home ownership, either because of possible trends in the riskiness of houses as an asset, or because of changes in price–rent ratios. If house price risk increased, then this would increase the value of delaying a home purchase and lower home ownership. Aggregate measures of house prices suggest that if there has been a trend, it has been toward less volatility in real house prices.¹⁴ We suspect this is driven by the fact that consumer prices now are less volatile than in 1980. [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 substantial rise in the price of an owner-occupied house relative to the cost of rental housing should induce a shift away from owning toward renting. [Piazzesi and Schneider \(2008\)](#) find that the price–rent ratio actually declined from 25 to 22 between 1980 and 2000. Still, the value of the ratio in 2000 was about where it had been in the mid-1970s. [Davis et al. \(2008\)](#) find that the price–rent ratio was essentially the

¹⁴We have studied regional price indexes published by the Census Bureau, Office of Federal Housing Enterprise Oversight and Freddie Mac. We have been unable to obtain house prices for finer geographical classifications, such as by city, that begin early enough for our purposes.

same in 1980 and 2000. We conclude that there have not been large enough changes in the price–rent ratio to have a material impact on home ownership.

6.2 Mobility

A second 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. In fact, mobility reports by the Census Bureau point toward little change in mobility rates during the period in question. For the young age groups we study in this paper, the probability that an individual lives at a different address from the previous year was 22% in the mid-1970s and 20% in the mid-1990s.¹⁵

6.3 Tax Policy

One candidate for tax policy having an impact on home ownership is the 1986 tax reform. [Poterba \(1992\)](#) postulates 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 deductibility, 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 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. 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 pace than single family homes. However, capital stock data

¹⁵This is based on the CPS and reported in various issues of “Geographical Mobility,” a publication of the Census Bureau.

from the Bureau of Economic Analysis suggest that the overall effect on the relative supply of rental housing was small.¹⁶

While there do not seem to have been any tax policy changes with a substantial direct impact on home ownership, this does not discount the possibility that taxes have played a role in lowering young home ownership. Consider the wedge between taxation of owner-occupied housing and other capital. Both rental and owner-occupied housing are subject to property taxes, but the service flow from rental housing is also subject to capital income taxes while it is not for owner-occupied housing. Non-residential capital of course is subject to capital income taxes. Therefore, lowering capital income taxes lowers the wedge between returns on housing and non-housing assets, and therefore could lower the home ownership rate. There is evidence supporting the view that capital income taxes fell between 1980 and 2000. [Eichenbaum and Fisher \(2005\)](#) find that average capital taxes are generally lower after 1980 than before. [McGrattan and Prescott \(2005\)](#) find that the same is true for measures of average marginal capital taxes. While consistent with the decline in home ownership among the young, the tax explanation seems hard to square with the increase in home ownership among the old, on whom we should observe the greatest impact of changes in capital taxes due to their higher wealth levels. So, while tax changes may help explain the decline in young home ownership, any explanation involving taxes must simultaneously account for the behavior of older households. We leave this to future work.

6.4 Inflation

[Piazzesi and Schneider \(2008\)](#) document large swings in the share of owner-occupied real estate in the portfolio of the U.S. household sector. Their figure 2 indicates that the share fell from 55% in 1952 to under 50% in the late 1960s, it grew to over 70% by 1980, and declined back to its late 1960s values by 2000. [Piazzesi and Schneider \(2008\)](#) argue that inflation and inflation expectations induced these swings in the household sector's portfolio of assets. Their analysis does not say anything explicitly

¹⁶Changes to the tax code in 1998 affected the amount of capital gains on selling the primary residence that is exempted from taxes. This should affect the timing of home sales and would make ownership more desirable since the expected after-tax returns from owning are higher, which should raise home ownership slightly.

about home ownership, but it is suggestive. We think inflation in the 1970s probably had some role to play in the home ownership rate reaching such high levels in the 1980 Census. However, as with taxes, any explanation for home ownership trends driven by inflation must confront the fact that young and old households' ownership trends differ when there are similar incentive effects of inflation.

7 Conclusion

In this paper we have documented a striking decline in home ownership among the young between 1980 and 2000, a period when home ownership should have become easier. We have established, using a calibrated equilibrium life-cycle model, that the decline in young home ownership can be explained mostly by a slower rate of marriage formation and heightened income risk. Part of the reason these factors are able to account for the decline is that relaxing the down-payment constraint on mortgages has a small impact on home ownership rates.

To our knowledge, our paper is the first to draw the connection between heightened income risk and lower home ownership. We think it has important implications for public policy. To the extent that heightened income risk is here to stay, then we should expect aggregate home ownership rates to begin to decline going forward. If such a decline is the optimal response of households to an increase in risk, then policy makers should be wary of introducing market distortions to offset the decline. On the other hand, if high rates of home ownership are viewed as a desirable public policy objective, for example as discussed in [Glaeser and Shaprio \(2002\)](#), then existing institutions and regulations designed to boost home ownership will need to be rethought.

Our model abstracts from many interesting features of the tenure choice decision. One important omission from our analysis is that we did not model marriage explicitly. We think abstracting from marriage was justified for the purposes of this paper. Still, many of the trends in home ownership seem connected to factors which have influenced marriage. We think our model has shown the likely quantitative importance of some of these factors and points toward the value of future research in this area.

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 are 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 of 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-durable expenditures plus government consumption plus the service flow from consumer durables.

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