# Changing Marital Transitions and Homeownership Among Young Households

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**Abstract**

This paper shows that the evolving likelihood of marriage and divorce is an important factor that helps account for the changes in homeownership rates among young single households and married couples from 1970 to the mid 1990s. A life-cycle model with housing decisions is constructed, incorporating age-dependent exogenous shocks related to marriage and divorce. The model is estimated using key life-cycle profiles from 1970, and structural changes are applied to generate predictions for the year 1995. The analysis reveals that the declined likelihood of marriage, along with increased non-housing asset returns, helps generate the observed rise in homeownership among singles aged 25-44 years. Conversely, the increased likelihood of divorce, in addition to higher house prices and labor market volatility, contributes to generate the decrease in homeownership among young couples.

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# 1 Introduction

Over the past decades, the proportion of single households has increased substantially due to changes in marriage and divorce behavior. For instance, the probability of an individual to get married in a given year between the ages of 25 and 44 declined by approximately 25%, and the likelihood of a married couple getting divorced more than doubled from the 1970s to the mid-1990s. Analyzing homeownership rates in relation to marital status reveals an interesting pattern that young singles became more likely to own homes, while young couples became less likely to be homeowners. The objective of this paper is to investigate the divergent evolution of homeownership rates between young single households and married couples during the period from 1970 to the mid-1990s, before the housing price boom.

Little attention has been paid in the macroeconomic literature to these "within-group" changes because they tend to offset each other and thus imply little change in aggregate homeownership. However, it is important to understand how housing demand has evolved among different marital statuses, as various tax and subsidy policies are specifically designed for single and married households. Based on the estimated structural model, this paper shows that the changes in marital prospects can account for the fact that singles became more likely to be homeowners, and that married households reduced investment in owned housing. The quantitative framework incorporates marital transitions, alongside other factors such as borrowing constraints and labor market uncertainty, to provide a comprehensive explanation for the changing homeownership rates by marital status.

The underlying intuition behind the connection between homeownership and the risk of family formation and dissolution is the following. When individuals get married, they may have a desire to live in a larger house or choose a different neighborhood to accommodate their spouse's preferences. Consequently, if forward-looking single individuals anticipate getting married in the near future, they may choose to delay purchasing a house until they can do so with their spouse. This decision is influenced by the transaction costs associated with selling or resizing a house. Similarly, the costs and complexities involved in dividing a house, as opposed to liquid assets like checking accounts, make married couples less inclined to own a house if there is a significant likelihood of divorce.

I construct the life-cycle profiles of homeownership by marital status using data from the Survey of Consumer Finances (SCF) and the Panel Study of Income Dynamics (PSID). By leveraging these datasets, I am able to account for changes in composition arising from education and non-housing assets. For the purpose of analysis, I specifically examine the years 1970 and 1995 as they mark distinct periods with noticeably different probabilities of marital transitions. This choice enables me to examine the evolution of homeownership while minimizing the influence of the housing price boom that started in the late 1990s and persisted until the crisis. Between 1970 and 1995, the homeownership rate among single households aged 25-44 years increased by an average of 4.6 percentage points. In contrast, the homeownership rate among young couples experienced an average decrease of -1.9 percentage points. Notably, the decline in homeownership among young couples is primarily driven by those younger than 35 years old.

To analyze these empirical observations, I develop a life-cycle model of single and married households that face age-dependent marital transition shocks similar to Cubeddu and Ríos-Rull (2003) and Fernández and Wong (2014). Taking into account the prospects of marriage and divorce, households decide how much to consume, save in non-housing and housing assets, and work. Owned housing incurs substantial transaction costs whenever it is sold or its size is adjusted. Given that a house purchased by an individual as a single person is often ill-suited for a married couple, the model assumes a high probability of selling the house when the person gets married. Likewise, most married couples sell their owned house when they get divorced. The probability of selling home with marital transitions is disciplined by the empirical counterpart observed in the data.[1]

Furthermore, the model incorporates various factors that can potentially influence housing decisions. Owned housing is considered as collateral for borrowing, and adjustments to the downpayment constraint can be simulated by modifying a single parameter in the model. The model also allows for an examination of how households adjust their housing investment in response to heightened labor market uncertainty, achieved by increasing the variance of idiosyncratic labor productivity shocks. The increase in spousal labor supply, generated by the decline in spouses' fixed cost of working, is also taken into account to analyze its impact on homeownership. Moreover, the model captures the variation in married households' marginal utility from consumption and housing services, which is influenced by the household size with children, enabling an assessment of the effect of fertility on housing decisions. The life-cycle profiles of household decisions are derived from the stationary equilibrium given prices. These prices are calibrated to reflect the economic conditions of different periods.

[1] Although some couples move in to the home that one partner already has, they tend to sell the house and move to another one within 5 years of marriage, which is the unit of my model period (Speare, 1970; Speare and Goldscheider, 1987; Deurloo et al., 1994). Likewise, divorcees are likely to move to a new house since the house bought as a married couple would not meet their needs after divorce (South et al., 1998).

I estimate the model parameters by matching the moments from the cross-section data of 1970, the benchmark year for my analysis. The model closely fits the life-cycle profiles of homeownership, housing asset share, and labor force participation across marital status observed in the data. Then I conduct counterfactual analysis to quantify the explanatory power of the marital transition channel while controlling for other potential channels that affect housing decisions. Alternative channels considered in this paper include financial constraints, labor market uncertainty, spousal labor participation, fertility, non-housing asset return, and house price.

When considering all channels that reflect the changes in 1995, the model effectively accounts for around 80% of the average rise in homeownership among single individuals aged 25-44. This translates to a 3.7 percentage point increase out of the total 4.6 percentage point increase observed in the data. The decomposition analysis, where each structural change is applied one at a time, provides valuable insights into the factors driving the increase in homeownership rates among young singles. The changes in marital prospects and non-housing asset return play an important role in predicting the increase in singles' homeownership between 1970 and 1995. The impact of the marital transition channel is pronounced for the age group 25-34, while the influence of non-housing asset return becomes more prominent for individuals aged 35-44.

Furthermore, the model correctly predicts the decline in homeownership rates for young married households. Specifically, the average predicted decline in homeownership for the age group 25-44 closely matches the average decline observed in the data (-1.9 percentage points vs. -1.7 percentage points). Various factors contribute to this decline in homeownership among couples, including changes in marital transitions, labor market volatility, fertility, and house price. However, if the changes in divorce risk are not taken into account, the predicted decrease in homeownership rates falls short of the observed decline. Thus, incorporating the changes in marital transitions contributes to closely align the model's prediction with the observed decrease in homeownership rates among young married couples.

This paper contributes to several distinct strands of the literature. First, it is related to the literature on housing in macroeconomics, of which Davis and Van Nieuwerburgh (2015) and Piazzesi and Schneider (2016) give a nice and extensive overview. My paper is closely related to a stream of quantitative papers that analyze portfolio choice with illiquid housing over the life-cycle (Cocco, 2005; Yao and Zhang, 2005; Fernández-Villaverde and Krueger, 2007; Kaplan and Violante, 2014; Chang et al., 2018; Nakajima and Telyukova, 2020). My paper builds on these papers while modeling transaction costs that arise in times of marital transitions, which affects the decisions of forward-looking households.

Second, this paper demonstrates the importance of changes in idiosyncratic risk on aggregate variables, which is also emphasized in the literature. For instance, idiosyncratic income shocks are analyzed to affect various aggregate variables such as income and consumption inequality (Blundell et al., 2008; Heathcote et al., 2010), output and associated welfare (Low et al., 2010), and homeownership (Díaz and Luengo-Prado, 2008). My paper studies the aggregate implication of marital transition risk and earnings risk whose stochastic nature changes over the life-cycle. Borella et al. (2021) emphasize that marriage tends to be ignored in macroeconomics but is helpful in fitting aggregate labor market outcomes and savings. In a similar spirit, my paper studies the effect of marital transition risk and earnings risk for homeownership of young couples and singles using a structural model.

Finally, this paper contributes to the literature that analyzes the importance of marital transitions for households' decisions.[2] Few recent papers attempt to study housing decisions in the presence of marital transitions. Fisher and Gervais (2011), for example, attribute the decline in the aggregate homeownership among the young to a trend of marrying later and having more singles in the economy. In contrast to my model, their framework does not model marriage explicitly and does not generate the observed increase in young singles' homeownership. Fischer and Khorunzhina (2019) study the role of divorce risk by comparing the simulated life-cycle profiles of housing decisions for those with and without divorce risk. By considering both the risks associated with marriage and divorce, I aim to link my estimated life-cycle model to the historical data to quantify how much of the change in marital prospects can account for the change in homeownership.

The rest of the paper is organized as follows. Section 2 describes the data and establishes the empirical facts. Section 3 outlines the model, and Section 4 provides the estimation results and model fit. Section 5 presents the model's prediction compared to the data and the decomposition analysis between 1970 and 1995. Section 6 provides discussion on the assumptions adopted in this paper and some other potential channels left for future research. Section 7 concludes.

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[2] This includes various non-housing decisions such as savings and female labor supply (Cubeddu and Ríos-Rull, 2003; Mazzocco et al., 2013; Fernández and Wong, 2014; Voena, 2015), fertility and child investment (Brown et al., 2015), and portfoilo choice without housing (Love, 2010).

# 2 Data

In this section, I illustrate the data sources used to construct the life-cycle profiles of homeownership rates in 1970 and 1995. I chose 1970 and 1995 as two periods with similar house prices,[3] but with substantially dissimilar likelihood of marital transitions. The year 1970 was chosen as a representative period with high marriage and low divorce probabilities.[4] If we look at the time series data,[5] the marriage rate showed a local peak in 1970 and started to fall from then on. In contrast, with the legalization of no-fault divorce, the divorce rate surged throughout the 1970s.[6] The year 1995 was chosen as the representative period with high divorce and low marriage probabilities. It is suitable to analyze periods before the start of the housing price boom in the late 1990s, a trend that continued until the Great Recession.

I use two data sources, the Survey of Consumer Finances (SCF) and the Panel Study of Income Dynamics (PSID), to construct life-cycle profiles.[7] More details on construction of the variables of interest are presented in Appendix A.1.

## 2.1 Data source for 1970

**1970 SCF.** The 1970 SCF data are accessible via the Inter-University Consortium for Political and Social Research (ICPSR), whereas the SCF data since 1983 are available from the Federal Reserve's website. The value of using the historical SCF data before 1983 has recently been highlighted by Kuhn et al. (2020), and my paper is also in line with their attempt to incorporate these data to answer the following question: how much of the change in homeownership can be accounted for by the change in marital transition probabilities?

However, there is a challenge to answering this question because the number of observations of single households in the 1970 SCF is relatively small due to the high marriage

[3]For example, Corbae and Quintin (2015) call the period 1940-1998 as the period with intermediate, "normal" house price level. I include the time-series of the real house price index in Appendix A.5.

[4]I only treat legally-married couples as married households. Cohabitation was uncommon in 1970 and in 1995. For instance, Stevenson and Wolfers (2007) report that cohabitation rate among adults was 2.9 percent based on the 1995 Current Population Survey.

[5]Source: Centers for Disease Control and Prevention National Center for Health Statistics (CDC NCHS).

[6]See Voena (2015) for the overview of US divorce laws and for the literature review.

[7]In Appendix A.2, I examine whether it is preferable to use PSID alone or to augment it with information from the SCF. Augmenting the PSID data with the SCF data yields average homeownership rates that are more aligned with values from other data sources in the 1970s.

rate. This results in a jagged life-cycle profile for single households. This calls for the need to secure more observations that can inform me about homeownership rate in 1970.

**1970 PSID.** I use the PSID data, which is the longitudinal household survey that has been administered since 1968. Despite the larger number of observations on homeownership and demographic characteristics in the 1970 PSID, it does not provide enough information on households' non-housing assets, which later will be used to control for composition effects. Therefore, I use a cross-imputation strategy similar to Blundell et al. (2006) to obtain a relation between housing assets and non-housing assets from the 1970 SCF data and impute the missing non-housing assets for the PSID sample using the fitted regression. The cross-imputation is done as follows: using the 1970 SCF sample, I first add 1% of the average net value of housing to each household $i$'s net value of housing, denoted by $\textit{net value of housing}_{i,SCF}$. This is done to secure more observations used in the regression of log-log specification. I regress this logged net value of housing on the logged non-housing asset with various controls included in $X_i$,

$$\log(\textit{net value of housing}_{i,SCF}) = X'_{i,SCF}\beta + \gamma \log(\textit{non-housing asset}_{i,SCF}) + u_{i,SCF}.$$

By using the estimated coefficients $(\widehat{\beta}, \widehat{\gamma})$ and assuming that the relation between variables will be the same between the different data sets, I can obtain the cross-imputed value of non-housing assets in the PSID data for household $i$ as

$$\widehat{\textit{non-housing}}\ \textit{asset}_{i,PSID} = \exp\left(\frac{\log(\textit{net value of housing}_{i,PSID}) - X'_{i,PSID}\widehat{\beta}}{\widehat{\gamma}}\right).$$

The imputed non-housing asset value is used in Section 2.3 to control for potential composition changes over time. Also, the imputed non-housing asset value and the observed housing asset value can be used to construct the housing asset share for household $i$.

In Appendix A.1, I show that the regression applied to the 1970 SCF data where the control variables $X_i$ include marital status, age of head, education of head, labor supply of head, homeownership status, and whether a household has children. Furthermore, I show that the mean and the standard deviation of the imputed housing asset share of the PSID data are close to those observed in the SCF data.

## 2.2 Data source for 1995

**1995 SCF.** I use the 1995 SCF data, which is conducted every three years and is available from the Federal Reserve's website. This data is a repeated cross-section that provides detailed information on households' portfolio choices as well as their demographic characteristics such as age and marital status. To be consistent with my model, I categorize assets into either housing or non-housing assets. Then the homeownership variable is constructed as a dummy variable whose value is one if a household holds a positive amount of housing assets.

**1994 PSID.** I use the 1994 PSID data instead of using the 1995 PSID data for two reasons. First, between 1994 and 1995, the homeownership rates for young households did not change much. Second, in contrast to the 1995 PSID, the 1994 PSID data has the wealth supplement including the information on non-housing asset. Hence, there is no need for imputation strategy for this variable that is required to control for potential composition change. For the subsequent analysis, I take the weighted average between the values from the 1994 PSID and the 1995 SCF to represent the homeownership rates for 1995, with the weights proportional to the respective samples sizes.

## 2.3 Life-cycle profiles of homeownership in 1970 and 1995

I construct the life-cycle profiles of single and married households in 1970 and 1995 using the PSID and the SCF data. My aim is to provide the empirical facts on how the life-cycle profiles of homeownership changed across different marital statuses. Understanding how aggregate housing demand changed across marital statuses is important because many tax and subsidy policies are designed separately for single and married households.

An advantage of using the PSID and the SCF data is that I can control for potential composition changes from education and financial assets between 1970 and 1995. I conduct regression analysis that partials out changes in conditional mean accounted for by these factors. The regression results to control for composition effects are presented in Appendix A.3. After controlling for the composition effects, I obtain the life-cycle profiles of homeownership rates in Figure 1.

Figure 1 shows the changes in homeownership rates over time depending on marital status. Several papers (Koebel and Zappettini (1993); Fisher and Gervais (2011); Grinstein-Weiss et al. (2011); Fischer and Khorunzhina (2019)) have documented that married households are more likely to be homeowners than single households. In addition to this observation from the cross-section, I aim to account for the within-group change in homeownership by marital status.

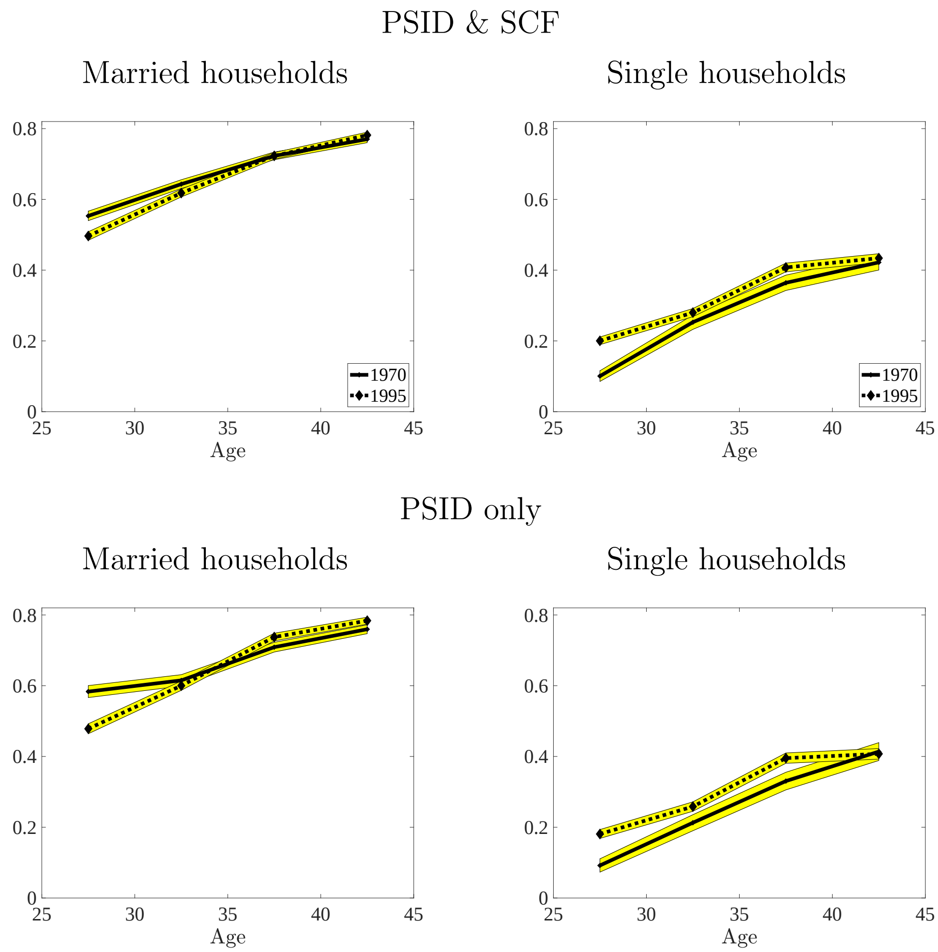


Figure 1: Homeownership rates

*Notes:* For PSID & SCF, the average homeownership rates across different age groups are obtained by taking the weighted average. The weight is set to be proportional to the sample size of each data set. The $x$-axis stands for the age of household head. The yellow shaded bands denote 90% confidence intervals.

I present the profiles constructed using both the PSID and the SCF data, along with the profiles exclusively constructed using the PSID. Regardless of the additional usage of SCF data, the overall qualitative nature of changes in homeownership rates between 1970 and 1995 remains consistent. In order to increase the number of observations, I use the PSID data in combination with the SCF data as the benchmark for my analysis. Through this approach, two key findings emerge. Firstly, there is an observed increase in homeownership rates among single households below the age of 40.[8] Secondly, for young married couples below the age of 35, the homeownership rate in 1970 is higher compared to 1995.

[8]The increase in homeownership is observed for both single men and women. I do not differentiate gender in this paper and pool all the observations together to study the increase in singles' homeownership rate.

## 2.4 Comparison to other data sources

I compare the homeownership rates from the PSID and the SCF data in Section 2.3 to the values constructed from other data sources. I consider two data sources, the American Housing Survey (AHS) and the decennial Census data.[9]

| Age | PSID & SCF | | | AHS | | | Census | | |
|---|---|---|---|---|---|---|---|---|---|
| | Early 70s | Mid 90s | Change | Early 70s | Mid 90s | Change | Early 70s | Mid 90s | Change |
| | | | | Married households | | | | | |
| 25-29 | 55.3 | 49.7 | -5.6 | 54.2 | 51.5 | -2.7 | 53.0 | 53.8 | 0.8 |
| 30-34 | 64.3 | 61.8 | -2.5 | 71.4 | 69.6 | -1.8 | 68.5 | 68.9 | 0.4 |
| 35-39 | 72.3 | 72.3 | 0.0 | 77.8 | 77.2 | -0.6 | 75.6 | 77.4 | 1.8 |
| 40-44 | 77.0 | 78.2 | 1.2 | 81.9 | 83.5 | 1.6 | 79.4 | 82.8 | 3.4 |
| | | | | Single households | | | | | |
| 25-29 | 10.1 | 20.0 | 9.9 | 16.5 | 20.3 | 3.8 | 16.0 | 20.3 | 4.3 |
| 30-34 | 25.3 | 28.0 | 2.7 | 27.5 | 33.0 | 5.5 | 25.4 | 32.0 | 6.6 |
| 35-39 | 36.4 | 40.8 | 4.4 | 37.3 | 40.6 | 3.3 | 33.5 | 41.1 | 7.6 |
| 40-44 | 42.2 | 43.4 | 1.2 | 41.9 | 48.5 | 6.6 | 40.5 | 48.2 | 7.7 |

Table 1: Homeownership rates from different data sources

*Notes:* Column PSID & SCF - (Early 1970s) based on the 1970 PSID and the 1970 SCF. (Mid 1990s) based on the 1994 PSID and the 1995 SCF data. Column AHS - (Early 1970s) based on the national public use file for 1973 and 1974, the earliest available years for this dataset. (Mid 1990s) based on the national public use file for 1995. Note that only the metropolitan public use files are available for 1994 and 1996. Column Census - (Early 1970s) based on the decennial census data for 1970. (Mid 1990s) based on the decennial census data for 1990 and 2000.

In Table 1, Column PSID & SCF delivers the same information as Figure 1. Column AHS relies on the AHS national public use files. I use the files for 1973 and 1974, the earliest available years for this dataset, to represent the early 1970s homeownership rates. For the mid 1990s, I use the AHS data for 1995 only as the national public use files are not available for year 1994 and 1996. For Column Census, I use the 1970 Census data for the early 1970s period, and use the data for 1990 and 2000 for the mid 1990s. For Column AHS and Census, the reported homeownership rates are without controlling for the composition effects due to unavailability for education or non-housing asset variables.

For married households, the change in homeownership rates between the early 70s and the mid 90s exhibits a similar pattern in both Column PSID & SCF and in Column AHS. The

[9]The AHS data is available at https://www.census.gov/programs-surveys/ahs/data.html and the decennial Census data is accessible via IPUMS USA (https://www.ipums.org/).

homeownership rates fall for couples aged 25-34. Based on the Census data, the homeownership rates show an increase across all age groups. However, couples aged 25-34 experience a relatively smaller increase in homeownership compared to those aged 35-44.[10] Hence, regardless of the data sources considered, there seems to be downward pressure on homeownership of couples younger than 35 years old.

For single households, the increase in homeownership rates is observed across all data sets. Though Column PSID & SCF shows a larger increase for the age group 25-29, the average increase over all age groups (4.6 percentage points) is of a similar magnitude to the average increase from the AHS data (4.8 percentage points). Column Census shows a greater average increase in singles' homeownership rates, possibly reflecting the effect of housing boom. From all the data sources considered, the homeownership rates of singles below the age of 45 are shown to increase between the early 70s to the mid 90s.

For the subsequent analysis, I utilize the empirical moments derived from both the PSID and SCF datasets. This allows me to account for the changes in composition attributed to education and non-housing assets, while also capturing the shifts in homeownership among young households that are largely consistent with observations from other data sources.

As homeownership rates have varied over time based on marital status, my argument is that the likelihood of household formation and dissolution is a significant factor in driving these changes. A single person, who is likely to marry soon, will wait to buy a house with a spouse because it is costly to sell or resize a house. This may explain why single households' homeownership rate increased, as they were less likely to marry. In addition, a married couple who is likely to get divorced may want to avoid owning a house due to the significant transaction costs associated with liquidating it during a divorce. To formalize this conjecture and quantify how much of the change in marital transition probabilities can account for the change in homeownership in comparison to other potential factors, I need a structural model.

# 3 Model

I develop a life-cycle model of single and married households that face age-dependent marital transition shocks. Similar to the approach of Cubeddu and Ríos-Rull (2003) and Fernández

[10] The increase in homeownership seems to come from using the data for 1990 and 2000 together, reflecting the housing boom started from the late 1990s. As a robustness check, Appendix A.4 reports the homeownership rates for the late 1990s using the SCF and the PSID data.

and Wong (2014), marital status is treated as exogenous in order to build a computationally tractable model of heterogeneous households and to conduct a decomposition analysis by feeding in the marital transition probabilities observed from the data.[11] When making decisions, households will take into account the probability of getting married or divorced.

Households decide how much to consume, rent, save in non-housing and housing assets, and how many hours to work. A finite number of housing sizes are available to own. Owning a house is advantageous, since it yields a higher service flow than renting and it serves as collateral for borrowing. However, it incurs substantial transaction costs whenever its size is adjusted. Housing is a highly idiosyncratic investment, so a change in status is likely to make the house owned prior to the change no longer suitable. For example, when you are single, you do not know what type of house your future spouse may like. When you get married, you learn how your spouse values the jointly owned home. The house you purchased when single is likely to be ill-suited for a married couple. Housing allocation rule in times of getting married or divorced is modeled to replicate housing transaction of individuals around marital transitions observed in the data.

Households face non-insurable idiosyncratic labor productivity shocks, and idiosyncratic housing depreciation or appreciation shocks. The framework is a partial equilibrium model in which households face the following given prices: wage, savings interest rate, borrowing interest rate, and house price.

**Preference - Single agent.** A single agent's utility is specified by

$$u(c,s,l) = \frac{(c^{\alpha}s^{1-\alpha})^{(1-\sigma)}}{1-\sigma} - B_s \frac{l^{1+\frac{1}{\gamma}}}{1+\frac{1}{\gamma}} - \phi \cdot I(l>0) + uhp(l),$$

where $c \geq 0$ is consumption and $s \geq 0$ is housing service. It is assumed that a household cannot be a homeowner and a renter at the same time. The service is defined as $s = (1-I^H)m + I^H\zeta(h')h'$, where $m$ is from rented housing, $\zeta(h')h'$ is from owned housing, and $I^H$ is the dummy indicator for homeownership status where $I^H = 1$ if $h' > 0$. $\zeta(h')$ is a size-dependent function of owned housing

$$\zeta(h') = \left(\zeta_1 + \zeta_2 \frac{h' - h_{min}}{h_{max} - h_{min}}\right),$$

[11] There are recent papers that endogenize households' marital decisions in different contexts (Mazzocco et al., 2013; Voena, 2015; Low et al., 2018; Reynoso, 2019). Modeling marriage and divorce as endogenous decisions goes beyond the scope of this paper. More discussion on the assumption of exogenous marital transitions is provided in Section 6.

where $h_{min}$ is the smallest non-zero size of owned housing and $h_{max}$ is the biggest size. $\zeta_1$ is the service gain of owning $h_{min}$-sized housing compared to renting. $\zeta_2$ reflects the marginal gain for larger houses. $\zeta(h')$ is assumed to be greater than 1 to reflect that owned housing is preferred to rented housing.[12] I use 5 different values for rented housing $m$ and 7 different values for owned housing $h'$ similar to Pizzinelli (2018) and Nakajima and Telyukova (2020).

On top of the change in marital transitions, there were substantial changes in earnings risk and in the labor market environment between 1970 and 1995. Since I want to incorporate these changes into the decomposition analysis in Section 5, I build a model with endogenous labor supply. This will allow me to study how housing decisions as lumpy investments change according to how agents adjust their labor supply in response to various idiosyncratic shocks. $l$ stands for labor supply associated with disutility from working $B_s$ and the fixed cost of labor market participation $\phi$. Also, there is utility from home production

$$uhp(l) = \begin{cases} 0 & \text{if one works} \\ \omega_{uhp} & \text{if one does not work.} \end{cases}$$

The utility from home production while working is normalized to be zero. The parameter $\omega_{uhp}$ does not serve the same purpose as $\phi$, since I employ a distinct functional form for the married agent's utility from home production.

**Preference - Married agents.** Within a married household, there is a head and a spouse. They differ in terms of labor productivity denoted by $y$ for the head and $\widetilde{y}$ for the spouse. This can be interpreted as each member of the household taking on a role depending on comparative advantage in house management.

A married head's utility $u^{\text{head}}$ and a married spouse's utility $u^{\text{spouse}}$ are specified below:

$$u^{\text{head}}(c, s, l, \widetilde{l}) = \varphi_j \frac{\left((\gamma_e c)^{\alpha} (\gamma_e s)^{1-\alpha}\right)^{1-\sigma}}{1-\sigma} - B_m \frac{l^{1+\frac{1}{\gamma}}}{1+\frac{1}{\gamma}} - \phi \cdot I(l > 0) + uhp(l, \widetilde{l})$$

$$u^{\text{spouse}}(c, s, l, \widetilde{l}) = \varphi_j \frac{\left((\gamma_e c)^{\alpha} (\gamma_e s)^{1-\alpha}\right)^{1-\sigma}}{1-\sigma} - \widetilde{B}_m \frac{\widetilde{l}^{1+\frac{1}{\gamma}}}{1+\frac{1}{\gamma}} - \widetilde{\phi} \cdot I(\widetilde{l} > 0) + uhp(l, \widetilde{l}),$$

where $c, s \geq 0$ is joint consumption and joint housing service. $\gamma_e$ is a parameter that transforms joint objects into per capita terms. If $\gamma_e$ is greater than 0.5, it captures economies

[12] One could modify the owned house more easily to cater to one's needs. Also, there could be a moral hazard issue with leasing agents, which makes renting less favorable, as pointed out in Postlewaite et al. (2008).

of scale in consumption and service flow provided by marriage. $\varphi_j$ allows for the marginal utility of consumption and housing service to differ over the life-cycle. $\varphi_j > 1$ could result from the joy of having a partner or children. Both the head and the spouse are constrained to enjoy equal consumption and housing service.

$l$ is labor supply of the head and $\widetilde{l}$ is labor supply of the spouse. Labor supply is associated with disutility from working $B_m, \widetilde{B}_m$ and the fixed cost of working $\phi, \widetilde{\phi}$. The married agent's utility from home production is defined as

$$uhp(l, \widetilde{l}) = \begin{cases} 0 & \text{if both work} \\ \frac{\omega_{uhp}}{n_\psi} & \text{if only one spouse works} \\ \omega_{uhp} & \text{if no one works,} \end{cases}$$

where $n_\psi$ reflects whether home production technology is increasing returns to scale or not.[13] In an extreme case where $n_\psi = 1.0$, having two people stay at home and do the housework generates the same utility as having one person do so.

## 3.1 Problem of the single household at the terminal age

This section describes the recursive formulation of the single household's problem at the terminal age $J$, which refers to the last working age prior to retirement. The value function depends on the following state variables: age $J$, total asset $a$, housing asset $h$, and labor productivity $y$. Households face an exogenously given wage $w$, a risk-free savings interest rate $r$, a borrowing interest rate $r^H$, and a common house price $P^H$. To simplify the notation, I denote the vector of all the state variables as $X_J^s = [J, a, h, y]$.

$$V^s(X_J^s) = \max_{c,m,b',h',l} u(c, s, l) + \beta V^{s,fin}(b', h')$$

$$s.t. \qquad c + (1 - I^H)m + b' + I^H P^H h' = wyl + a - \Phi(h', h)$$

$$c \geq 0, \quad s \geq 0, \quad b' \geq 0.$$

[13]This is different from leisure complementarity that induces couples to participate less in the labor force (to enjoy leisure together). For married households, with increasing returns to scale home production, wives with lower labor productivity tend to stay home whereas heads participate in the labor force.

$\Phi(h', h)$ is the asymmetric transaction cost associated with an illiquid housing asset. Similar to Yang (2009), it is defined as

$$\Phi(h', h) = \begin{cases} \kappa_b P^H h' + \kappa_s P^H h & \text{if } \ h' \neq h \\ 0 & \text{if } \ h' = h, \end{cases}$$

where $\kappa_b < \kappa_s$.[14] Households are borrowing-constrained at the terminal age, which is captured by non-housing asset $b'$ being non-negative.

The objective is to maximize the combination of current period utility and the discounted continuation value of the remaining life. $V^{s,fin}(b', h')$ is the continuation value after age $J$, for 4 more periods where the household consumes the constant amount of $A \equiv (b' + P^H h')\frac{1-\beta}{1-\beta^4}$. The amount $A$ is obtained by assuming that the discount factor during retirement is equal to $\frac{1}{(1+r)}$. This can be considered as submitting $(b' + P^H h')$ and entering a retirement community, which provides in return a constant flow of utility in the future. The continuation value in this case is written as

$$V^{s,fin}(b', h') = \frac{1-\beta^4}{1-\beta} \cdot \frac{A^{(1-\sigma)}}{1-\sigma}.$$

## 3.2 Problem of the married household at the terminal age

A married household's problem at age $J$ depends on one more state variable compared to their single counterparts, since we also need to consider the labor efficiency shock $\widetilde{y}$ of a spouse. Similarly, I denote the vector of all the state variables as $X_J^m = [J, a, h, y, \widetilde{y}]$.

A married household solves a joint problem that maximizes the average utility with equal weights. In other words, a marriage is a contract to obey the decision of a utilitarian social planner maximizing the average utility. The average utility at the current period is

$$u(c, s, l, \widetilde{l}) = \frac{u^{\text{head}}(c, s, l, \widetilde{l}) + u^{\text{spouse}}(c, s, l, \widetilde{l})}{2}$$

$$= \varphi_j \frac{\left((\gamma_e c)^{\alpha} (\gamma_e s)^{1-\alpha}\right)^{1-\sigma}}{1-\sigma} - \frac{1}{2}\left(B_m \frac{l^{1+\frac{1}{\gamma}}}{1+\frac{1}{\gamma}} + \widetilde{B}_m \frac{\widetilde{l}^{1+\frac{1}{\gamma}}}{1+\frac{1}{\gamma}}\right) - \frac{1}{2}\left(\phi \cdot I(l > 0) + \widetilde{\phi} \cdot I(\widetilde{l} > 0)\right) + uhp(l, \widetilde{l}).$$

[14]Gruber and Martin (2003) estimated the relocation cost of tax and agency costs from CEX, and found higher transaction cost associated with selling home compared to purchsase.

Then the problem solved by the married household is

$$V^m(X_J^m) = \max_{c,m,b',h',l,\widetilde{l}} u(c,s,l,\widetilde{l}) + \beta V^{m,fin}(b',h')$$

$$s.t. \quad c + (1-I^H)m + b' + I^H P^H h' = w(yl + \widetilde{y}\widetilde{l}) + a - \Phi(h',h)$$

$$c \geq 0, \quad s \geq 0, \quad b' \geq 0.$$

The household's labor income includes both the head's and the spouse's labor income. The choice variables are analogous to the single household's problem except that the married household also needs to decide the labor supply of the spouse $\widetilde{l}$.

The continuation value $V^{m,fin}(b',h')$ is analogous to the single household's case. The household does not face a marital transition shock at the terminal age $J$. Each member of the household is assumed to identically evaluate the joint consumption amount $A = (b' + P^H h')\frac{1-\beta}{1-\beta^4}$ provided by the retirement community. There is efficiency gain $\gamma_e$ in consumption from marriage. The continuation value then becomes

$$V^{m,fin}(b',h') = \frac{1-\beta^4}{1-\beta} \cdot \varphi_J \frac{(\gamma_e A)^{(1-\sigma)}}{1-\sigma}.$$

## 3.3 Problem of the single household at the non-terminal age

I denote the vector of all the state variables as $X_j^s = [j,a,h,y]$. The single household's problem at age $j < J$ is written as follows:

$$\begin{aligned} V^s(X_j^s) = \max_{c,m,b',h',l} \Big\{ u\big(c,s,l\big) \; + \beta \Big[ & q_{ss,j} \cdot \mathbb{E}V^s\big(j+1,a',h',y'\big) \\ & + q_{sm,j} \cdot p_{liquidate} \cdot \mathbb{E}V^m\big(j+1,(a'+\widetilde{a}') - \kappa_s P^H(h'+\widetilde{h}'),0,y',\widetilde{y}'\big) \\ & + q_{sm,j} \cdot (1-p_{liquidate}) \cdot \mathbb{E}V^m\big(j+1,(a'+\widetilde{a}') - \kappa_s P^H min\{h',\widetilde{h}'\}, max\{h',\widetilde{h}'\},y',\widetilde{y}'\big) \Big] \Big\} \end{aligned}$$

$$s.t. \qquad c + (1-I^H)m + b' + I^H P^H h' = wyl + a - \Phi(h',h)$$

$$a' = (1+r(b'))b' + P^H(1-\delta')h', \quad \text{where} \quad r(b') = \begin{cases} r & \text{if } b' \geq 0 \\ r^H & \text{otherwise} \end{cases}$$

$$c \geq 0, \quad s \geq 0, \quad b' \geq -\eta P^H h', \quad b' \geq -\nu wyl \quad \text{with} \;\; 0 \leq \eta \leq 1 \text{ and } 0 \leq \nu \leq 1.$$

A single person stays single with age-dependent probability $q_{ss,j}$. Then the expected value is based on the current period savings and housing choice in addition to future labor efficiency. The single household gets married with probability $q_{sm,j}$. This renders the continuation value equal to the average utility from the marriage arrangement. It is assumed that one gets married to a spouse of the same age group, in line with the average age differential of less than 5 years observed in the data. In addition to parsimonious marital transition probabilities that depend on age, a single agent takes into account the expectation about the potential spouse's distribution with respect to total asset $\widetilde{a}'$, housing asset $\widetilde{h}'$, and labor efficiency $\widetilde{y}'$.

To have random matching is computationally costly with rational expectation since consistency is required between the potential spouse's distribution of assets and the equilibrium distribution of assets of singles. Instead, I decide to model the expectation with bounded rationality as follows: assume that the potential spouse's housing asset distribution $\Omega_j(\widetilde{h})$ depends on age $j$. Since I know the homeownership rate of singles over the life-cycle from the data, I can incorporate this information to discipline $\Omega_j(\widetilde{h})$ such that

$$\begin{aligned}\Omega_j(\widetilde{h}=0) &= 1 - \text{homeownership rate at age } j\\ \Omega_j(\widetilde{h}=h_{min}) &= \text{homeownership rate at age } j,\end{aligned}$$

where $h_{min}$ is the minimum non-zero housing asset level. Since the model will be estimated with the moments including the life-cycle profile of the homeownership rate of single households, the potential spouse's housing asset distribution used to form expectation will be consistent with the ownership in equilibrium. However, the consistency over housing asset levels is not guaranteed. Even though I forgo some accuracy, the potential spouse's housing asset distribution captures the reality in that single homeowners tend to own a small house. Since the homeownership rate is increasing with age, a younger single is more likely to meet a spouse without housing assets.

Similarly, I use the age-dependent empirical distributions of non-housing assets $\widetilde{b}$ from the data of single households. This induces the distribution over total asset $\widetilde{a}$ coupled with $\Omega(\widetilde{h})$. Furthermore, I model one's labor efficiency $y$ and a potential spouse's labor efficiency $\widetilde{y}'$ as jointly normal random variables that have the empirical correlations across different age groups reported in Borella et al. (2021). For example, the correlation is set to be 0.33 for the age group 25-34 and 0.23 for the age group 45-54.

Housing allocation rule in times of marital transitions is modeled as follows: once a single person gets married, the couple have to sell either part or all of housing assets they accumulated while single and pay the associated transaction costs. The prohibitive transaction costs could also reflect potential moving or relocation costs associated with marriage. $p_{liquidate}$ denotes the probability of selling all home in the event of marital transitions. I calibrate $p_{liquidate}$ so that it reflects the empirical fact that most married households (80-90%) resize or buy a new house within 5 years after getting married (Speare, 1970; Speare and Goldscheider, 1987; Deurloo et al., 1994). With probability $(1 - p_{liquidate})$, the couple keep the bigger house between $h'$ and $\widetilde{h}'$. The smaller house is liquidated with transaction costs.

With the remaining wealth after combining two people's assets and selling off the houses owned before marriage, the married couple can choose a new level of housing asset in the next period to maximize the average utility. It is worth noting that there is no margin of disagreement when the couple solve a joint problem.

Households receive the idiosyncratic shock $\delta$ on top of the common house price $P^H$. Depending on the shock, the total asset a household carries to the next age differs. I assume that $\delta$ is uniformly distributed on $[\underline{\delta}, \bar{\delta}]$. If $\underline{\delta} < 0$ and $\bar{\delta} > 0$, the shock covers both depreciation and appreciation. Also, households at the non-terminal age have access to collateralized borrowing. $\eta$ captures the tightness of the collateralized borrowing constraint $b' \geq -\eta P^H h'$. That is, $(1 - \eta)$ reflects the downpayment constraint requirement. The borrowing interest rate $r^H$ is given to be higher than the savings interest rate $r$.[15] Lastly, households are subject to the loan-to-income (LTI) requirement in each period. It is assumed that households cannot borrow more than $\nu$ fraction of their labor income, i.e., $b' \geq -\nu wyl$.

## 3.4 Problem of the married household at the non-terminal age

The married household solves a joint problem that maximizes the average utility. The married household's problem with $X_j^m = [j, a, h, y, \widetilde{y}]$ is written as follows:

[15] This could be from financial intermediation or from default risk. I treat this borrowing rate to be exogenous instead of endogenizing it. For endogenizing the borrowing rate by explicitly modeling short-term or long-term mortgages, see Jeske et al. (2013) and Favilukis et al. (2017).

$$V^m(X_j^m) = \max_{c,m,b',h',l,\widetilde{l}} u\big(c,s,l,\widetilde{l}\big) \; + \beta\Big[q_{mm,j} \cdot \mathbb{E}V^m\big(j+1,a',h',y',\widetilde{y}'\big)$$

$$+ \, q_{ms,j} \cdot p_{liquidate} \cdot \mathbb{E}V^s\big(j+1, 0.5(a' - \kappa_s P^H h'), 0, y'\big)$$

$$+ \, q_{ms,j} \cdot (1 - p_{liquidate})\Big\{(1 - I^B) \cdot \mathbb{E}V^s\big(j+1, 0.5(a' - \kappa_s P^H h'), 0, y'\big)$$

$$+ \, I^B \cdot \frac{\mathbb{E}V^s\big(j+1, 0.5(1+r)b' + P^H(1-\delta')h', h', y'\big) + \mathbb{E}V^s\big(j+1, 0.5(1+r)b', 0, y'\big)}{2}\Big]\Big\}$$

$$s.t. \qquad c + (1 - I^H)m + b' + I^H P^H h' = w(yl + \widetilde{y}\widetilde{l}) + a - \Phi(h', h),$$

$$a' = (1 + r(b'))b' + P^H(1-\delta')h' \quad \text{where} \quad r(b') = \begin{cases} r & \text{if } b' \geq 0 \\ r^H & \text{otherwise} \end{cases}, \qquad I^B = \mathbb{I}(b' > 0),$$

$$c \geq 0, \quad s \geq 0, \quad b' \geq -\eta P^H h', \quad b' \geq -\nu(wyl + w\widetilde{y}\widetilde{l}) \text{ with } 0 \leq \eta \leq 1 \text{ and } 0 \leq \nu \leq 1.$$

The choice variables are analogous to the single household's problem except that the married household needs to make an additional decision on spousal labor supply $\widetilde{l}$ given the spouse's labor productivity $\widetilde{y}$. In addition, the LTI requirement is associated with household labor income. $\nu$ captures the tightness of LTI requirement $b' \geq -\nu(wyl + w\widetilde{y}\widetilde{l})$.

With probability $q_{mm,j}$, the married household stays married to the same spouse. It is not possible to be married to different spouses for two consecutive periods. With probability $q_{ms,j}$, the married household becomes divorced. With this status change, the divorcee becomes egoistic and the labor productivity is again distributed over the support of $y$.

With probability $p_{liquidate}$ of selling home in the event of marital transitions, the joint house $h'$ is sold and the associated cost is paid. This attempts to mirror the reality that over 80% of divorcees move within 5 years since divorce (South et al., 1998; Sullivan, 2007). After this transaction, the remaining joint assets are equally divided between the couple. If the couple is not affected by the liquidation shock with probability $(1 - p_{liquidate})$, there are two scenarios with different continuation values based on the non-housing asset $b'$. In the first scenario, the household has a positive amount of liquid asset $b'$ that can be split. Then one of the spouses keeps $h'$ after the divorce, and the non-housing asset $b'$ is split equally between the spouses.[16] The likelihood of receiving $h'$ after the divorce is the same for both spouses. In the second scenario, the household has mortgage ($b' < 0$). Regardless of whether the divorcee's LTI constraint would bind or not, the housing is liquidated if it was originally purchased with a mortgage. Each spouse has the same outlook on the future, which eliminates the margin of disagreement.

### 3.5 Shocks

A labor efficiency shock $y$ at age $j$ is modeled to be a combination of the age trend $\chi(j)$ from Hansen (1993) and an idiosyncratic shock $x$ of AR(1) after taking the log.

$$y = \chi(j)x, \quad \log(x') = \rho_x \log(x) + \epsilon^x, \quad \epsilon^x \sim N(0, \sigma_x^2) \quad \text{i.i.d.}$$

Idiosyncratic depreciation or appreciation shock $\delta$ is uniformly distributed with lower bound $\underline{\delta}$ and upper bound $\bar{\delta}$, $\delta \sim U[\underline{\delta}, \bar{\delta}]$. Additionally, households face the age-dependent marital transition shocks with the associated probabilities $q_{ss,j}, q_{sm,j}, q_{ms,j}$, and $q_{mm,j}$.

## 4 Estimation of model parameters

I set parameters of the model in two ways. First, some parameters are set by using parameter values in the literature or by using the estimates from the data without relying on the dynamic model. Then the remaining parameters are estimated using a limited information Bayesian approach, which matches the life-cycle profiles from the data and those generated from the model. I estimate the parameters for the baseline year 1970.

### 4.1 Externally set parameters

**Demographics and endowments.** Individuals start their lives at age 25 and retire at age 65. One model period corresponds to 5 years as in Fernández and Wong (2014), implying that non-retired individuals live for 8 periods. There is no mortality shock during these periods. Once they retire, households receive a fixed amount of payment for 20 more years

[16] The modification in the division rule for liquid assets does not significantly impact couples' homeownership rates. Under a division rule where 30% of liquid assets are allocated to the divorcee who retains the home, the model generates a marginal increase of 0.2 percentage points in the average homeownership rates.

before they die with certainty. I use the observed asset distribution of households aged 20 to 24 in the 1970 SCF data to determine initial asset distribution in the model.

**Preferences.** The discount factor $\beta$ is set to be 0.97 in annual terms. I set the coefficient of relative risk aversion $\sigma$ to 5 as in Chang et al. (2018) in order to better match the homeownership as well as the housing asset share by marital status.[17] The Frisch elasticity $\gamma$ is set to be 0.5 following the macro estimates of $\gamma$ as reviewed in Keane and Rogerson (2015).

**Labor productivity.** Labor productivity consists of two parts: a life-cycle component and an idiosyncratic shock. The life-cycle component $\chi(j)$ is set to match the estimates of Hansen (1993). The idiosyncratic shock follows AR(1) after taking the log. I set $\rho_x = 0.93$ and $\sigma_x = 0.3$ similar to the estimates from Iacoviello and Pavan (2013) for the early period (1952-1982). For the married spouse, the process is modeled with $\rho_{\widetilde{x}} = 0.92$ and $\sigma_{\widetilde{x}} = 0.32$. The spouse's process is less persistent with a higher standard deviation as reported in Chang and Kim (2006).

**Marriage-related parameters.** The scale parameter $n_\psi$ of home production is set to be 1.34 for the married household as in Fernández-Villaverde and Krueger (2007). To construct the life-cycle profile of $\varphi_j$, I rely on the OECD household member weight as in Pizzinelli (2018) and the average number of children across age groups in the 1970 Census of Population data.

The probabilities $q_{sm,j}$ of getting married at age $j$ are computed by a similar logistic regression as in Borella et al. (2021). The probabilities $q_{sm,j}$ of getting married at age $j$ are estimated as $q_{sm,j} = Prob(Married_{j+1} = 1 | Married_j = 0, Z_j) = F(Z_j'\beta_m)$ where $F$ denotes the standard logistic function and $Z_j$ denotes regressors including age $j$ and squared age.[18] Cohort or time effect is not controlled for.[19] The probability of getting divorced $q_{ms,j}$ is analogously defined. For the 1970 probabilities, the PSID data from 1970 to 1974 are

[17] Chang et al. (2018) note that this value is significantly lower than the conventional value commonly employed the finance literature to match the risky asset share.

[18] I do not control for geographic location which is not publicly available from the data. In the literature, Ziliak (2018) reports that marriage rates decreased from 1970 to 1995, and the decrease was steeper for those in rural areas. Divorce rates increased over the same time period, and the increase was slightly more steeper for those in urban areas. Despite the differences in terms of magnitude, people in both urban and rural areas became less likely to get married and more likely to get divorced from 1970 to 1995.

[19] I provide the marital transition probabilities with cohort effects considered in Appendix A.6. Also, I report the estimation uncertainty associated with marital transition probabilities in Appendix A.7.

used. For 1995, the data from 1995 to 1999 are used. Since there are fewer divorces than marriages, I also rely on the divorce probabilities computed from the Divorce Registration Area (DRA) data reported in Clarke (1995). For instance, the age-dependent probabilities of getting divorced $q_{ms,j}$ of 1995 are computed as the average of the probabilities in Clarke (1995) and the probabilities computed by a logistic regression using the PSID data from 1995 to 1999 with age and squared age controlled for.

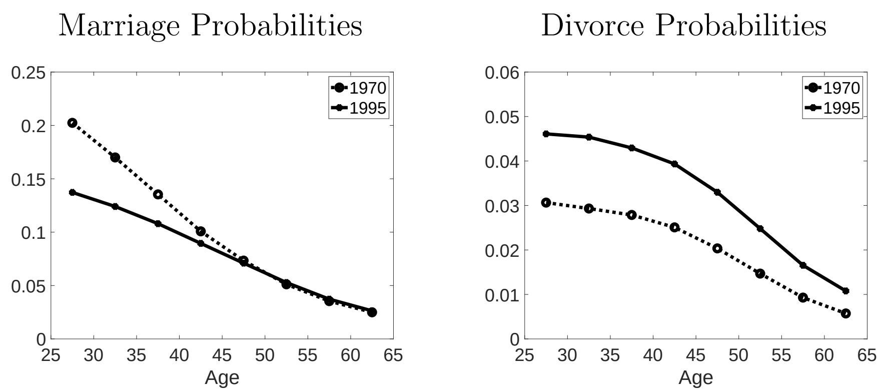


Figure 2: Marriage and divorce probabilities

**Borrowing constraint, loan-to-income requirement, and prices.** Households are subject to a collateralized borrowing constraint where the parameter $\eta$ captures how relaxed the constraint is. I set $\eta = 0.75$, the value used in Iacoviello and Pavan (2013) for the period 1952-1982. The loan-to-income (LTI) requirement is introduced to hold each period in the model. $\nu$ is calibrated to be 3.0, the same value as in Pizzinelli (2018), so that the average loan-to-income ratio is 0.66 as reported in Iacoviello (2008). The interest rate for savings is set to be 0.02 and the interest rate for borrowing is set to be 0.075 per annum. This borrowing rate is calibrated based on the 30-year fixed rate mortgage in the early 1970s reported by Freddie Mac.

**Housing-related parameters.** For the transaction cost of owned housing, similar to Gruber and Martin (2003) and Yang (2009), I set that 3% of the home value is paid when buying and 8% is paid when selling. The probability $p_{liquidate}$ of selling all home in the event of marital transitions is set to be 0.85 to reflect the empirical fact that over 80% of married couples and divorcees move within 5 years since marital transitions (Speare, 1970; Speare and Goldscheider, 1987; Deurloo et al., 1994; South et al., 1998; Sullivan, 2007).[20] Lastly,

[20] I provide some robustness analysis with home transaction frequency in Appendix A.12 and transaction costs having a fixed component in Appendix A.13.

housing depreciation/appreciation shock is modeled to be uniform between $\underline{\delta}$ and $\bar{\delta}$. I set $\underline{\delta} = -0.04$ in annual terms, which is close to the average price increase for 10 major US metropolitan areas (Composite 10) from the Case-Shiller house price index.[21] I set $\bar{\delta} = 0.03$ per annum, whose value is similar to the 2.5th percentile of price change for all states from 1987 to 1994. House price $P^H$ is calibrated to match the rent-price ratio of 5 percent as reported in Davis et al. (2008) for period 1960-1995.

Table 2 summarizes the externally set parameters in annual terms.

| Parameter | Description | Calibration |
|---|---|---|
| $\beta$ | discount factor | 0.97 |
| $\sigma$ | risk aversion coefficient | 5.0 |
| $\gamma$ | Frisch elasticity | 0.5 |
| $\rho_x$ ($\rho_{\tilde{x}}$) | AR(1) coefficient | 0.93 (0.92) |
| $\sigma_x$ ($\sigma_{\tilde{x}}$) | standard deviation of innovation | 0.3 (0.32) |
| $n_\psi$ | scale in home production | 1.34 |
| $\eta$ | collateralized borrowing constraint | 0.75 |
| $\nu$ | loan-to-income constraint | 3.0 |
| $(r,\ r^H)$ | savings/borrowing interest rate | (0.02, 0.075) |
| $(\kappa_b,\ \kappa_s)$ | buying/selling home transaction cost | (0.03, 0.08) |
| $p_{liquidate}$ | probability of selling home with marital transitions | 0.85 |
| $(\underline{\delta},\ \bar{\delta})$ | bounds on appreciation/depreciation | (-0.04, 0.03) |

Table 2: Externally set parameter values

## 4.2 Estimated parameters

**Estimation method.** I estimate the remaining parameters that are model-specific (hence hard to calibrate externally) and interact with key endogenous decisions on housing and labor supply. I use a limited information Bayesian approach (Kim, 2002; Christiano et al., 2010; Fernández-Villaverde et al., 2016). Structural estimation such as mine has advantages for several reasons. First, I can discipline estimation with various moments of interest. Since I want my model to be able to account for households' housing and labor supply decisions, I use the relevant life-cycle profiles of homeownership rates, housing asset share, and labor

[21] Given that major metropolitan areas tend to experience sharper housing price increases, I use the average of Composite 10 as the upper bound. Composite 10 includes Boston, Chicago, Denver, Las Vegas, Los Angeles, Miami, New York, San Diego, San Francisco, and Washington, D.C.

force participation rates across single and married households. Second, I am able to learn the uncertainty associated with the parameters in contrast to calibration. For instance, I can construct a credible set for each parameter of interest. I can also quantify the uncertainty in the life-cycle profiles induced from the parameter estimates. Lastly, one could incorporate prior beliefs to a limited information Bayesian procedure. I use uniform priors in order to be analogous to the simulated method of moments. Also, this is useful to check whether there is sufficient variation in the data to learn about parameters given diffuse uniform priors.

Let $\Theta$ denote the parameters of interest and $\hat{\mathbf{m}}$ denote the vector of $M$ empirical moments from the data for estimation. Kim (2002) shows that the likelihood of $\hat{\mathbf{m}}$ conditional on $\Theta$ is approximately

$$f(\hat{\mathbf{m}}|\Theta) = (2\pi)^{-\frac{M}{2}} |S|^{-\frac{1}{2}} \exp\left[-\frac{1}{2}\left(\hat{\mathbf{m}} - \mathbf{m}(\Theta)\right)' S^{-1}\left(\hat{\mathbf{m}} - \mathbf{m}(\Theta)\right)\right],$$

where $\mathbf{m}(\Theta)$ is the model-generated moments under parameter $\Theta$, and $S$ is the covariance matrix of $\hat{\mathbf{m}}$. The covariance matrix $S$ is often unknown but can be replaced by a consistent estimator of it, which can be obtained through bootstrap.

Bayes' theorem tells us that the posterior density $f(\Theta|\hat{\mathbf{m}})$ is proportional to the product of the approximate likelihood $f(\hat{\mathbf{m}}|\Theta)$ and the prior $p(\Theta)$:

$$f(\Theta|\hat{\mathbf{m}}) \propto f(\hat{\mathbf{m}}|\Theta)p(\Theta),$$

and we can then apply the standard Markov Chain Monte Carlo (MCMC) techniques such as the Metropolis-Hastings algorithm to obtain a sequence of random samples from the posterior distribution. More details on the algorithm are provided in Appendix A.8.

**Identification.** The moments used in the estimation include 1970's life-cycle profiles for homeownership rates, housing asset share, and labor force participation rates for single and married households, respectively. The intercept in the service gain of owned housing $\zeta_1$ is identified from the levels of homeownership rate whereas the slope $\zeta_2$ is identified from variation in housing asset share over the life-cycle. Without the utility from home production $\omega_{uhp}$, the model has difficulty in having married household heads to work more than singles on average. Hence, $\omega_{uhp}$ is identified from the gap in the labor force participation between married heads of households and singles. The economies of scale parameter $\gamma_e$ is identified from the gap in housing asset shares between married couples and singles. Preference parameter $\alpha$ that aggregates consumption and housing services is obtained from the overall levels of housing asset share and parameters on fixed cost of working $\phi, \widetilde{\phi}$ are from the overall levels of labor force participation. Lastly, parameters on disutility of working $B_s, B_m, \widetilde{B}_m$ are identified from how labor supply decreases over the life-cycle.

**Estimation results.** Table 3 reports the posterior mean and the 90% credible intervals of parameters from the Bayesian estimation, together with the uniform priors. Uniform prior belief does not favor certain values over others within the support. This belief would be updated with the curvature provided by the difference between the moments from the data and those from the model. Given this prior specification, this procedure can be considered as pseudo-likelihood estimation in classical inference.

| | | Posterior Distribution | | Uniform Prior |
|---|---|---|---|---|
| Parameter | Description | Mean | 90% Interval | [Min, Max] |
| $\zeta_1$ | service flow from owned housing (intercept) | 1.054 | [1.034, 1.075] | [0.01, 1.5] |
| $\zeta_2$ | service flow from owned housing (slope) | 0.193 | [0.170, 0.221] | [0.0, 1.0] |
| $\omega_{uhp}$ | utility from home production | 12.609 | [12.079, 13.104] | [0.0, 100.0] |
| $\gamma_e$ | economies of scale within marriage | 0.535 | [0.516, 0.553] | [0.5, 1.0] |
| $\alpha$ | aggregator for consumption and housing | 0.653 | [0.633, 0.672] | [0.5, 0.999] |
| $B_s$ | disutility of working (single) | 20.227 | [19.293, 21.204] | [0.01, 50.0] |
| $B_m$ | disutility of working (married head) | 0.757 | [0.181, 1.488] | [0.01, 50.0] |
| $\widetilde{B}_m$ | disutility of working (married spouse) | 73.390 | [72.346, 74.421] | [50.0, 100.0] |
| $\phi$ | fixed cost of working (single, married head) | 45.599 | [43.964, 48.678] | [0.0, 100.0] |
| $\widetilde{\phi}$ | fixed cost of working (spouse) | 31.909 | [30.493, 33.325] | [0.0, 100.0] |

Table 3: Estimated parameters

One advantage of estimation is that I can characterize the uncertainty associated with each parameter. The parameter estimates inform me about interesting aspects in life, including economies of scale within marriage, utility from home production, and the cost of labor supply. The credible set for $\gamma_e$ is much narrower than the prior's and it does not include 0.5 (which means no economies of scale) supporting the existence of economies of scale within marriage. The utility from home production $\omega_{uhp}$ is estimated to be significantly positive. This gives incentive for some singles and married spouses (since they have lower productivity than married heads) not to work. With this in effect, married spouses' fixed cost of working $\widetilde{\phi}$ is estimated to be smaller than that of married heads. In Appendix A.8, the marginal distributions from posterior draws are shown to be non-uniform by combining the uniform prior with the data's variation.

## 4.3 Model fit

Figure 3 shows the model fit for the 1970 homeownership rates. The left figure includes the model-generated life-cycle profiles obtained by using the posterior mean estimates reported in Table 3 compared to the data counterparts. The model does a great job of matching the life-cycle profiles of homeownership rates.[22] The in-sample fit is also analyzed by the posterior predictive checks reported in the right figure of Figure 3. I simulate the life-cycle profiles for 100 different posterior draws that are equally distanced over the sampler. The hairlines generated from the predictive checks show the uncertainty associated with the estimated life-cycle profiles that one would not otherwise get with calibration.

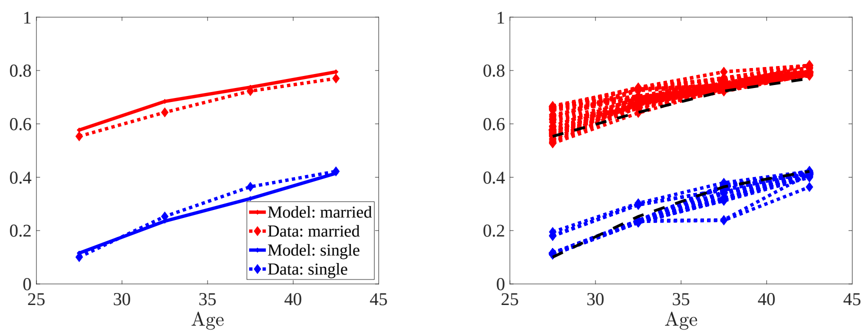


Figure 3: Life-cycle profiles of homeownership (data *vs.* model)

*Notes:* Life-cycle profiles of homeownership from the model and those from the data. (Left) The model-generated life-cycle profiles are obtained with the posterior mean estimates. (Right) The model-generated life-cycle profiles represented by the hairlines are with 100 different posterior draws that are equally distanced over the sampler. These predictive checks are compared to the black dashed lines that represent the data counterparts.

Lastly, the model is validated with some unmatched moments. The wealth-to-income ratio in the model is 2.1 which is close to the value 2.4 from Kuhn et al. (2020) for the year 1970. This moment is associated with both endogenous decisions regarding housing and labor supply. Hence, it is reassuring that the baseline model generates a sensible value for the wealth-to-income ratio. I target unconditional means of housing asset share over the life-cycle in the estimation. In Appendix A.9, the model is demonstrated to reasonably fit the life-cycle profiles of conditional housing asset share excluding zeros and the profiles of total assets.

[22]The model also matches the life-cycle profiles of housing asset share and labor force participation reasonably well. I provide the associated model fit and predictive checks in Appendix A.10.

# 5 Findings

Given the estimated model, I can study the impact of marital transition probabilities to account for the change in homeownership. In addition to this change in marriage and divorce probabilities, other structural changes that may be key drivers of households' housing decisions occurred. The goal of this section is to quantify the explanatory power of the main channel while controlling for other changes that affect housing decisions studied in the literature.[23] I first show the prediction of the model when all channels reflect the year 1995's changes and compare it to the data in Table 4. Then I apply structural changes between 1970 and 1995 one at a time to study each channel's effect on homeownership. These results are reported in Table 5.

## 5.1 Model prediction with the changes between 1970 and 1995

Starting from the baseline that reflects the year 1970's economy, I apply several structural changes that may have impacted homeownership rates from 1970 to 1995. The following changes are taken into consideration to generate the prediction of homeownership for the year 1995:

**Marital transition probabilities.** I use the age-dependent marriage and divorce probabilities as in Figure 2. The baseline life-cycle profiles are generated by using the marriage and divorce probabilities in 1970. In this decomposition exercise, I feed in the probabilities in 1995 instead, holding the other things fixed at the values of the baseline.

**Downpayment constraint.** The downpayment constraint was relaxed in 1995 compared to 1970. Fisher and Gervais (2011) point out the average downpayment in the 1990s was about two-thirds of the average value in the 1970s. I change the parameter $\eta$ accordingly that governs the tightness of the borrowing constraint $b' \geq -\eta P^H h'$.

[23]A simple back-of-the-envelope calculation is often useful, but ex ante it is difficult to tell whether the result remains the same in an environment with endogenous responses of agents and market interactions without building and solving a structural model. Even if it may turn out that the significance of a mechanism based on the counterfactual analysis is similar to the back-of-the-envelope calculation, it does not mean that having a structural model is not meaningful. For example, the model sheds light on endogenous reactions of households given a change, which cannot easily be captured by a regression analysis or simpler calculations.

**Labor market volatility.** The increase in labor market volatility is widely documented as in Fisher and Gervais (2011) and Santos and Weiss (2013). The parameters associated with earnings risk are $\sigma_x$ and $\sigma_{\widetilde{x}}$. The parameters for 1995 are set to reflect the 30% increase in volatility from 1970 to 1995 as reported in Fisher and Gervais (2011).

**Spousal labor force participation.** To generate the observed increase in spousal labor force participation from 1970 to 1995, I change the parameter $\widetilde{\phi}$ governing the fixed cost of working. $\widetilde{\phi}$ is set to be lower in 1995 so that the average spousal labor force participation rate matches 0.66 in 1995. This counterfactual experiment mimicking the increase in spousal labor participation also generates the fall in married heads' labor force participation as observed in the data.

**Fertility.** Fertility declined between 1970 and 1995. According to the UN World Population data, the fertility rate for the US was 2.33 births per woman in 1970 and it was 2.01 births per woman in 1995. In the model, $\varphi_j$ varies over the life-cycle to capture the changing size of married households. When calibrating $\varphi_j$, the average number of children across age groups from the 1970 Census data is used. For the decomposition analysis, I reduce it by 15% to reflect the fertility decline in 1995.

**Non-housing asset return.** In the model, I only model two types of assets: housing assets and non-housing assets (as safe assets).[24] In order to consider this change in non-housing asset return, I use the interest rate $r = 0.03$ for the year 1995 compared to the baseline value $r = 0.02$ per annum. $r = 0.03$ is close to the risk-free rate for the period 1980-1999 in Caballero et al. (2017) based on the real return on US treasuries.

**House price.** House price increases between 1970 and 1995. I consider the 5% increase in house price in the decomposition analysis that is consistent with the data pattern of the Shiller house price index.

Table 4 displays the homeownership rates for the age groups from 25 to 44 years who are single and married couples, both in the data and under the stationary equilibrium. From the model, Column 1970 is the baseline for the year 1970 and Column 1995 is generated by applying all structural changes listed above.

[24] I do not model risky financial assets since most of young households did not hold risky financial assets (Ameriks and Zeldes (2004)) and the associated return did not show an increasing trend over the period of study (Jordà et al. (2019)).

| Age group | Data 1970 | Data 1995 | Data Change | Model 1970 | Model 1995 | Model Change | Data 1970 | Data 1995 | Data Change | Model 1970 | Model 1995 | Model Change |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Single households | | | | | | Married households | | | | | |
| 25-29 | 10.1 | 20.0 | 9.9 | 11.5 | 17.2 | 5.7 | 55.3 | 49.7 | -5.6 | 57.6 | 53.9 | -3.7 |
| 30-34 | 25.3 | 28.0 | 2.7 | 23.5 | 26.8 | 3.3 | 64.3 | 61.8 | -2.5 | 68.4 | 67.0 | -1.4 |
| 35-39 | 36.4 | 40.8 | 4.4 | 31.9 | 33.9 | 2.0 | 72.3 | 72.3 | 0.0 | 73.7 | 73.5 | -0.2 |
| 40-44 | 42.2 | 43.4 | 1.2 | 41.4 | 45.3 | 3.9 | 77.0 | 78.2 | 1.2 | 79.4 | 77.3 | -2.1 |
| 25-44 | 28.5 | 33.1 | 4.6 | 27.1 | 30.8 | 3.7 | 67.2 | 65.5 | -1.7 | 69.8 | 67.9 | -1.9 |

Table 4: Homeownership in 1970 and 1995 (data *vs.* model)

When all channels reflect the year 1995's changes, the model successfully explains approximately 80% of the observed average rise in homeownership for single individuals aged 25-44.[25] This accounts for a 3.7 percentage point increase out of the total 4.6 percentage point increase observed in the data.

For married households, the model correctly predicts the decline in homeownership for the age groups 25-34 as observed in the data. Overall, the average decline in homeownership predicted by the model for couples aged 25-44 is close to the average decline observed in the data (-1.9 percentage points vs. -1.7 percentage points). However, the model's inability to explain the increase in homeownership for the age group 40-44 is a concern and is left for future research.

## 5.2 Effect of individual structural change on homeownership

Table 5 shows the effect of individual structural change presented in Section 5.1. I apply only one out of seven structural changes considered, and compute the homeownership rates by age and marital status from the associated stationary equilibrium.

Lower marriage probabilities of 1995 increase homeownership rate of young singles. It is because that the expected return on housing goes up as it is less likely to incur the transaction costs of selling or resizing associated with marital transitions. On the other hand, married

[25] My paper shares a close connection with the work of Fisher and Gervais (2011) but diverges in the following aspects. Firstly, Fisher and Gervais (2011) primarily address the decline in overall homeownership rates among young households attributed to a trend of delayed marriage, without generating the rise in singles' homeownership. Secondly, the focus of Fisher and Gervais (2011) was not on changing divorce behavior, and my study takes into account both the changes in marriage and divorce risks. Lastly, I expand upon their analysis by incorporating additional factors such as fertility and non-housing asset return.

households own home less with higher divorce probabilities of 1995. Younger households experience greater changes in homeownership rates resulting from shifts in marriage and divorce probabilities, both for single and married households. This captures the fact that the difference in marital transition probabilities between 1970 and 1995 is more conspicuous for those in their 20s or 30s.

| | Age group | | | | | Age group | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 25-29 | 30-34 | 35-39 | 40-44 | 25-44 | 25-29 | 30-34 | 35-39 | 40-44 | 25-44 |
| | Single households | | | | | Married households | | | | |
| Change (data) | 9.9 | 2.7 | 4.4 | 1.2 | 4.6 | -5.6 | -2.5 | 0.0 | 1.2 | -1.7 |
| Change (model, all channels) | 5.7 | 3.3 | 2.0 | 3.9 | 3.7 | -3.7 | -1.4 | -0.2 | -2.1 | -1.9 |
| Marital transitions | 7.0 | 6.5 | 3.9 | 1.4 | 4.7 | -3.8 | -3.3 | -2.4 | -1.7 | -2.8 |
| Downpayment constraint | 0.1 | 0.5 | 0.4 | 0.3 | 0.3 | 0.1 | 0.3 | 0.2 | 1.1 | 0.4 |
| Labor market volatility | -0.1 | -0.8 | -1.8 | -2.9 | -1.4 | -1.5 | -1.5 | -1.8 | -2.1 | -1.7 |
| Spousal labor participation | -0.4 | -0.7 | -0.7 | -0.7 | -0.6 | 0.6 | 1.4 | 1.4 | 2.1 | 1.4 |
| Fertility | 0.0 | 0.0 | 0.2 | 0.2 | 0.1 | -0.2 | -0.1 | 0.0 | -0.1 | -0.1 |
| Non-housing asset return | 0.0 | 1.2 | 2.2 | 2.7 | 1.5 | 0.9 | 0.7 | 1.3 | 1.3 | 1.1 |
| Housing price | -1.5 | -3.8 | -0.4 | 0.9 | -1.2 | -3.4 | -0.4 | -0.8 | -0.5 | -1.3 |

Table 5: Effect of structural changes on homeownership

*Notes:* The row labeled as "Change (data)" displays the observed changes in homeownership rates between 1970 and 1995, as derived from the data. The row labeled as "Change (model, all channels)" presents the predicted changes in homeownership rates from the model, incorporating all the structural changes. The remaining rows display the changes in homeownership rates from implementing individual structural changes in 1995. Each row corresponds to a specific structural change applied independently while keeping all other factors constant at their baseline values. All the changes in homeownership rates are reported in percentage points.

Relaxing the downpayment constraint has only a small positive effect on homeownership rates for both single individuals and married couples. The findings align with Fisher and Gervais (2011), which also suggests that loosening credit constraints has a limited impact on the homeownership rates of young households.

Increased income risk has two opposing effects on homeownership. On the one hand, it is valuable to delay buying a house until a household can afford it due to the large transaction cost and income risk. On the other hand, the increase in idiosyncratic risk raises precautionary savings. These savings can induce more transition from renting to home purchase, thereby increasing the homeownership rate. Homeownership of singles in their 20s show little change. Negative effect of income risk on homeownership is counteracted by precautionary savings motive that is stronger for young singles. However, at older ages, precautionary savings motive is dominated by the value of delaying the home purchase against labor market volatility. Homeownership rates for singles aged 30-44 exhibit a larger decrease. For married couples aged 25-44, elevated income risks generate a relatively uniform decline in homeownership rates.

As more spouses participate in the labor force, homeownership of married couples increases. The average increase in homeownership rate of couples aged 25-44 is 1.4 percentage points. The model suggests that an increase in spousal labor participation leads to a decrease in the labor supply of household heads. This could explain the lack of a substantial increase in homeownership rates despite the rise in spousal labor participation. Still, it remains the strongest positive factor among all the structural changes considered for married couples' homeownership. As expected, single households' homeownership changes little with the change in spousal labor participation.

Reduction in fertility decreases the marginal utility of housing services. It is shown that the homeownership rate of married households is not affected much by the 15% reduction in fertility. Even for the age group 25-29, the homeownership rate decreases by 0.2 percentage points only.

Increase in non-housing asset return has two opposing effects on housing decisions. Households change their portfolio decision to save more instead of buying houses. However, more savings could induce transition from renting to home purchase. My analysis indicates that an increase in non-housing asset returns is associated with higher homeownership rates among both single individuals and married couples. Moreover, the impact of this change is more noticeable among households aged 35 or older compared to their younger counterparts.

The increase in house price makes the smallest house to be owned more expensive. Keeping the same grid for housing, increased house price has a negative effect on homeownership of single and married households. The effect tends to be larger for younger households. As Fisher and Gervais (2011) mention, if I shift the grid for housing to the left by 5% by allowing for individuals to economize on the size of the house under a higher price, then the reduction in homeownership will be negligible since the housing expenditures will be the same regardless of the house price change.

The analysis reveals that the increase in homeownership rates among young singles can be attributed to the decreased likelihood of marriage and increased return on non-housing assets. Without accounting for changes in marital transitions, it becomes challenging to generate the observed rise in homeownership rates among young singles. On the other hand, when considering all factors including the increased likelihood of divorce, higher house prices, and labor market volatility, the model can predict the decline in homeownership rates among young married couples. However, if the changes in divorce risk are not accounted for, the predicted average decrease in homeownership rates is less than -1 percentage point. Therefore, incorporating the changes in marital transitions contributes to closely align the model's prediction with the observed decrease in homeownership among young married couples.

# 6 Discussion

I provide discussion on the assumptions adopted in this paper and some other potential alternative channels abstracted in the main analysis.

**Exogeneity of marriage and divorce.** I model marriage and divorce as exogenous shocks that households face, similar to the approach taken in Cubeddu and Ríos-Rull (2003) and Fernández and Wong (2014). An advantage of my approach is that, by keeping marital transitions exogenous, I can build a tractable dynamic life-cycle framework and conduct a straightforward decomposition analysis. However, this approach is subject to limitations as it does not account for reverse causality and does not explicitly incorporate the interconnectedness between marital transitions and other variables that can potentially affect homeownership.[26] For instance, if increased labor market risk influences the probability of marriage and divorce, my model may overestimate the impact of marriage and divorce by failing to separate and account for their interaction. This limitation highlights an area for further exploration to gain a more comprehensive understanding of the dynamics between marital transitions and homeownership.

I improve on previous literature by explicitly modeling marital transitions in a structural model with couples and singles to study their housing decisions although I do not endogenize marriage and divorce as in Mazzocco et al. (2013) and Voena (2015).[27] The presence of en-

[26]There has been some research on the effect of homeownership on marriage decisions (Wei et al. (2017); Farnham et al. (2011)). Analysis on how housing influences marital transitions is an intriguing possibility, but it is beyond the scope of this paper.

[27]Mazzocco et al. (2013) and Voena (2015) do not model the life-cycle aspect and do not separate savings in housing and non-housing assets. In addition, they do not attempt to study the effects of different mechanisms on household decisions over time. This may result from these models with limited commitment being computationally demanding and difficult to design a decomposition analysis of competing channels. Although these papers do not focus on explaining changes over time as my paper does, they provide valuable insights on the link between labor supply, savings, and marital decisions.

dogenous marriage and divorce is likely to mitigate the effects of marital transitions outlined in my paper. For example, if couples who opt for divorce possess greater resources and a better ability to liquidate their assets, the impact of divorce incidence on homeownership may be attenuated. However, as shown in Low et al. (2022), a model with endogenous marriage and divorce tends to have exogenous match quality or love shocks in order to match the likelihood of marital transitions. In other words, if I endogenize marriage and divorce, I will still need to model underlying structural shocks that affect marital decisions. What underlying shocks to add and how to design a decomposition analysis to study the link between time-varying marriage and divorce choices and homeownership are left for future research.

**Absence of cohort effects.** In the baseline analysis, the probabilities of getting married and getting divorced are estimated while abstracting cohort effects. I construct the marital transition probabilities with cohort effects in Appendix A.6. Compared to the baseline in 1970, the marriage probabilities with cohort effects are lower and the divorce probabilities are higher. With these marital prospects, homeownership rates increase for singles, while they decrease slightly for married households. In addition, in Appendix A.15, the changes in homeownership by marital status, while accounting for cohort effects, are shown to exhibit qualitatively similar patterns to those observed in the baseline analysis. It is left for future research to study the change in marital transition probabilities and its effect on housing decisions for different cohorts.

**Retirement.** Since the central focus of my paper is the effect of marital transition shock that mostly affects younger households, I keep the retirement period simple without having any shocks as in Fernández and Wong (2014). Certain elements of retirement may have changed to affect housing decisions over the life-cycle. Between 1970 and 1995, out-of-pocket medical expenses increased but pension payments increased even more. In Appendix A.16, I conduct a counterfactual analysis in which the increase in pension payments net of medical costs is reflected before computing a constant consumption amount during retirement. Housing demand falls slightly at the end of the working period but the magnitude of change in homeownership over the life-cycle turns out to be not so substantial. More thorough exploration for old-age housing decisions is left for future research.

**Mobility.** The previous literature on life-cycle models with housing has incorporated age-dependent moving probabilities in reduced form.[28] A potential reason for changes in housing

[28]In Appendix A.11, I postulate a simple model with moving probabilities and compare the outputs from

demand is that households' likelihood of mobility may have changed. If people move more frequently and each moving involves spending in home transaction costs, this will lower homeownership. However, the CPS Geographical Mobility reports (Long and Mills (1971); Hansen (1997)) documented that the probability that an individual moves did not change much between 1970 and 1995. To be specific, an individual's moving probability from the previous year was 18.4% in 1970 and 16.3% in 1995. That is why I do not consider the likelihood of mobility as one of key structural changes happened over the period of interest.

However, starting from late 1990s, interstate migration of working-age adults has declined as documented in Kaplan and Schulhofer-Wohl (2017) and Guler and Taşkin (2018). Guler and Taşkin (2018) report that the dual earner moving rate dropped by 50% whereas the drop in single earner moving was 39% from 1981 to 2012. How the change in mobility affects housing demand in more recent periods is left for future research.

**Confounding reforms.** Some important bills related to housing decisions were passed between 1970 and 1995 that are abstracted in the paper. First, the 1986 tax reform regarding mortgage interest deductibility shifted the incentives to take up mortgages. Other changes were also made to the tax code in 1986 that lowered incentive to own home. For example, Poterba (1992) states that the marginal tax rates declined substantially for high-income individuals which lowered the benefits to the mortgage interest tax deduction. In this regard, it is unclear how the tax reform in 1986 changed the housing demand. This issue is beyond the scope of this paper and I leave this question to future research.[29]

The Equal Credit Oppotunity Act (ECOA) was related to the relaxation of LTI constraint for married couples and may have improved labor supply incentives for spouses. In my model, the LTI constraint is written as $b' \geq -\nu(wyl + \widetilde{wyl})$ combining both spouses' labor income. When I conduct a counterfactual experiment to relax the LTI constraint by multiplying 2 in front of wife's labor income in the spirit of ECOA, this barely changes married couples' homeownership. For instance, homeownership rate increases by 0.2 percentage points for the age group 25-29. This result is in line with Bottazzi et al. (2007) where the simulated homeownership rates show only modest increases even with substantial relaxation in LTI constraint. Hence, I decide to abstract this reform from my analysis.[30]

this model to the results in the main text.

[29] Gervais (2002) shows that the removal of mortgage interest deductibility induces only a small change in aggregate homeownership rates. This is because mortgage interest deductions represent only a small fraction of one's tax burden.

[30] I do not have long-term mortgages in my model and they may have different implications for housing

**Inheritances or gifts from parents.** As discussed in Wolff (1999), the primary recipients of inheritances or gifts are of age from 45 years old. Since the 1980s with seminal papers such as Kotlikoff and Summers (1981) and Modigliani (1988), how much inheritance matters for wealth accumulation has been controversial. Recently, Alvaredo et al. (2017) study the evolution of the share of inherited wealth in aggregate private wealth in the US, and the share of inherited wealth is shown to change little over the 1970-1995 period. Hence, I abstract from these intergenerational gifts or transfers in my analysis.

# 7 Conclusion

This paper examines the contrasting changes in homeownership rates between young single households and married couples aged 25 to 44 years old from 1970 to the mid-1990s. During this period, there was a noticeable increase in homeownership rates among young singles, while homeownership rates among young couples declined. The paper demonstrates that these observed changes in homeownership can be accounted for by the decrease in marriage likelihood and the increase in divorce likelihood.

Using an estimated life-cycle model, this paper shows that the changes in marital prospects, along with non-housing asset returns, contribute to generate the observed increase in homeownership rates among young singles. Furthermore, the analysis reveals that the changes in divorce risks, combined with increased labor market volatility and house prices, help predict the observed decline in homeownership rates among young couples. My analysis sheds light on the quantitative significance of the change in marital prospects in accounting for the evolution of homeownership by marital status.

Since marital transitions and housing decisions are complex problems in life, my model abstracts from some interesting dimensions to explore. An advantage of my approach is that, by keeping marital transitions exogenous, I can build a tractable dynamic life-cycle framework and conduct a straightfoward decomposition analysis. This assumption has the limitation of not allowing for the reverse causality and for another factor to drive both housing decisions and marital status. It is beyond the scope of this paper and I leave it for future research.

decisions with the confounding reforms. I leave this as an open question to be explored in future research.

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# Online Appendix: Changing Marital Transitions and Homeownership Among Young Households

**Minsu Chang**

# A Data – Further Details

## A.1 Variable construction

### (1) Year 1995

**Survey of Consumer Finances (SCF).** I use the 1995 SCF data available on the Federal Reserve's website. I drop the observations if the age of the head is less than 25 and more than 65. Since its redesign in 1983, the SCF consists of two samples. The first sample is drawn using area probability sampling of the entire U.S. population based on Census information. The second sample is drawn based on tax information used to identify households at the top of the wealth distribution. This two-frame sampling scheme yields a representative coverage of the entire population, including wealthy households. To get rid of outliers, I drop the observations with total asset level greater than 95% percentile. The following shows how each variable is constructed using the SCF data.

- checking account = X3506 + X3510 + X3514 + X3518 + X3522 + X3526
- savings account = X3804 + X3807 + X3810 + X3813 + X3816
- mutual funds = X3824 + X3826 + X3828 + X3822 + X3830
- stocks = X3915 + X7641
- bonds = X3902 + X3906 + X3908 + X3910 + X7633 + X7634
- life insurance = X4006
- IRA = X3610 + X3620
- certificate of deposit = X3721

- value of housing = X513 + X526 + X604 + X614 + X623 + X716 + X1706 + X1806 + X1906
- mortgages and HELOCs = X1715 + X1815 + X1915 + X805 + X905 + X1005 + X1044 + X1108 + X1119 + X1130 + X1136
- non-housing asset = checking account + savings account + mutual funds + stocks + bonds + life insurance + IRA + certificate of deposit
- net value of housing = value of housing - mortgages and HELOCs
- total asset = non-housing asset + net value of housing
- homeownership dummy = 1 if value of housing > 0
- housing asset share = $\begin{cases} \text{net value of housing/total asset} & \text{if total asset} > 0 \\ 0 & \text{if total asset} = 0 \end{cases}$

**Panel Study of Income Dynamics (PSID).** The Panel Study of Income Dynamics (PSID) data is the longitudinal household survey. I use the 1994 PSID data instead of using the 1995 PSID data for two reasons. First, between 1994 and 1995, the homeownership rates for young households did not change much. Second, in contrast to the 1995 PSID, the 1994 PSID data has the wealth supplement including the information on non-housing asset or total asset. Hence, there is no need for imputation strategy for these variables. The following shows how each variable is constructed using the PSID data.

- savings[31] = ER3742
- stocks and mutual funds = ER3811
- life insurance = ER3748
- value of housing = ER2033 + ER3722
- mortgages and HELOCs = ER2037 + ER2038

[31] Any money in checking or savings accounts, money market funds, certificates of deposit, government savings bonds or Treasury bills, including IRAs.

- net value of housing = value of housing - mortgages and HELOCs
- total asset = savings + stocks and mutual funds + life insurance + net value of housing
- Homeownership dummy, non-housing asset, housing asset share are analogously defined as with the 1995 SCF.

**(2) Year 1970**

**SCF.** I use the 1970 Survey of Consumer Finances (SCF) that was conducted by the Economic Behavior Program of the Survey Research Center at the University of Michigan. The raw data can be downloaded from the Inter-University Consortium for Political and Social Research (ICPSR), at the Institute for Social Research in Ann Arbor. The historical survey contains the variables that are used to construct housing asset share and homeownership rate. It also includes demographic information including age, sex, marital status, and educational attainment. The historical SCF sample before 1983 is not supplemented by the second sample, so wealthy households are likely to be under-represented. Similar to the re-weighting procedure described in Kuhn et al. (2018), I identify the observations belonging to the top 5% of the total asset distribution. Then I increase the survey weights for these households so that 2% of wealthy households are added to the original sample. The remaining weights are adjusted. Once this is done, I drop the observations with a total asset level greater than 95% percentile under the new weights. The following shows how each variable is constructed with this data.

- checking account = V334
- savings account = V333
- mutual funds = V335
- stocks = V336
- bonds = V337 + V338
- life insurance = V275

- certificate of deposit = V332

- net value of housing = V150 + V339 - V340

- total asset[32], homeownership dummy, non-housing asset, housing asset share are analogously defined as with the 1995 SCF.

**PSID.** Unlike PSID in the 90s where the wealth supplement is available, the 1970 PSID data does not provide a detailed breakdown of households' portfolios into different assets. However, the net value of housing can be constructed as V1122-V1124 and a homeownership dummy can be set to 1 if V1122> 0.

In order to construct non-housing asset, I use the cross-imputation strategy as described in Section 2.1. Using the 1970 SCF data, I run the following regression whose result is reported in Table A-1.

$$\log(\textit{net value of housing}_{i,SCF}) = X'_{i,SCF}\beta + \gamma \log(\textit{non-housing asset}_{i,SCF}) + u_{i,SCF}.$$

The control variables $X_i$ include marital status, age of head, education of head, labor supply of head, homeownership status, and whether a household has children. Education is a categorical variable taking one of the three values (1: less than high-school degree, 2: complete high school, 3: some college or more). By using the estimated coefficients $(\widehat{\beta}, \widehat{\gamma})$ and assuming that the relation between variables will be the same between the different data sets, I can obtain the cross-imputed value of non-housing assets in the PSID.

Table A-2 provides the comparison of some summary statistics across the data sets and different time periods. The housing asset share variable for the 1970 PSID is constructed using the imputed non-housing asset.

[32]There is no IRA variable for 1970. Traditional IRA was introduced with the Employee Retirement Income Security Act of 1974 (ERISA) and made popular with the Economic Recovery Tax Act of 1981.

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| marital status dummy | 0.168*** | 0.166*** | 0.170*** | 0.168*** |
| | (0.062) | (0.064) | (0.062) | (0.064) |
| age | 0.022*** | 0.022*** | 0.022*** | 0.022*** |
| | (0.002) | (0.002) | (0.002) | (0.002) |
| education (2: complete high school) | 0.156*** | 0.156*** | 0.160*** | 0.160*** |
| | (0.060) | (0.060) | (0.060) | (0.060) |
| education (3: some college or more) | 0.246*** | 0.246*** | 0.249*** | 0.250*** |
| | (0.065) | (0.065) | (0.065) | (0.065) |
| hours worked | 0.002* | 0.002* | 0.003** | 0.003** |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| homeownership dummy | 3.767*** | 3.766*** | 3.770*** | 3.769*** |
| | (0.055) | (0.056) | (0.055) | (0.056) |
| log(non-housing assets) | 0.126*** | 0.126*** | 0.127*** | 0.127*** |
| | (0.011) | (0.011) | (0.011) | (0.012) |
| children dummy | — | 0.008 | — | 0.008 |
| | — | (0.057) | — | (0.057) |
| employment dummy | — | — | -0.083 | -0.083 |
| | — | — | (0.092) | (0.092) |
| adjusted $R^2$ | 0.804 | 0.803 | 0.803 | 0.803 |

Table A-1: Regression Analysis (SCF 1970)

*Notes:* * p-value $< 0.10$, ** $< 0.05$, *** $< 0.01$. Standard errors in parentheses and constants omitted.

| variables | 1970 PSID | 1970 SCF | 1994 PSID | 1995 SCF |
|---|---|---|---|---|
| fraction of married households | 0.74 | 0.77 | 0.54 | 0.55 |
| age of head (mean) | 44.01 | 43.95 | 42.02 | 42.61 |
| homeownership rate (mean) | 0.65 | 0.66 | 0.64 | 0.66 |
| housing asset share (mean) | 0.53* | 0.54 | 0.49 | 0.49 |
| housing asset share (standard deviation) | 0.44* | 0.41 | 0.43 | 0.40 |
| Number of observations | 3304 | 1764 | 5951 | 2408 |

Table A-2: Summary statistics

*Notes:* The value with asterisk(*) is obtained from cross-imputation similar to Blundell et al. (2006).

## A.2 Whether to use PSID together with SCF

I examine whether it is preferable to use PSID alone or to augment it with information from the SCF, especially for the year 1970 when the number of observations is relatively small for single households. Table A-3 reports the average homeownership rates for the year 1970 by marital status, age groups, and different data sources. I compare the following four data sources: PSID, PSID & SCF, American Housing Survey (AHS), and Census.[33] For the column PSID & SCF, I report the weighted average of the summary statistics from the two data sources. The weight is set to be proportional to the sample size of each data source. The weight given to PSID is about 0.65. As shown in Table A-3, augmenting the PSID data with the SCF data allows me to obtain the average homeownership rates that are closer to the values from the AHS data or the Census data. For this reason, I use the PSID data together with the SCF data in the main text securing more observations.

| | All (age 25-65) | | Young (age 25-44) | |
|---|---|---|---|---|
| Data source | Married households | Single households | Married households | Single households |
| PSID | 74.7 | 37.2 | 67.8 | 25.4 |
| PSID & SCF | 75.0 | 40.5 | 68.3 | 27.5 |
| AHS | 76.9 | 42.3 | 70.8 | 28.7 |
| Census | 74.3 | 42.6 | 69.0 | 28.7 |

Table A-3: Homeownership rates of married and single households for 1970

*Notes:* Column PSID and Column PSID & SCF are based on the sample constructed according to Appendix A.1 using the Panel Study of Income Dynamics (PSID) and Survey of Consumer Finances (SCF) data for the year 1970. Column AHS is based on the American Housing Survey National Public Use File for 1973 and 1974, the earliest available years for this dataset. Column Census is based on the 1970 Census data.

[33] I used the AHS data available at https://www.census.gov/programs-surveys/ahs/data.html, and the decennial census data available at https://usa.ipums.org/usa/index.shtml.

## A.3 Regression analysis to control for composition changes

I control for potential composition changes from education and non-housing assets by regression analysis. I use the homeownership dummy as the dependent variable, and the following as the independent variables: marital status, education of head, and logged non-housing assets. Education is a categorical variable (1: less than high-school degree, 2: complete high school, 3: some college or more).

| Depedent variable: homeownership | PSID | | SCF | |
|---|---|---|---|---|
| | 1970 | 1994 | 1970 | 1995 |
| marital status dummy | 0.344*** | 0.342*** | 0.231*** | 0.205*** |
| | (0.016) | (0.011) | (0.025) | (0.017) |
| education (2: complete high school) | 0.082*** | 0.041** | 0.035 | 0.020 |
| | (0.017) | (0.016) | (0.024) | (0.026) |
| education (3: some college or more) | 0.026 | 0.027* | -0.031 | -0.041 |
| | (0.018) | (0.015) | (0.026) | (0.026) |
| log(non-housing assets) | 0.033*** | 0.020*** | 0.029*** | 0.032*** |
| | (0.001) | (0.001) | (0.002) | (0.002) |

Table A-4: Regression results

*Notes:* * p-value < 0.10, ** < 0.05, *** < 0.01. Standard errors in parentheses and constants omitted. As described in the main text, the 1994 PSID data with the wealth supplement is used to get the information on non-housing assets without imputation.

## A.4 Life-cycle profiles of homeownership in the late 1990s

Figure A-1 shows the life-cycle profiles of homeownership rates based on the PSID and the SCF data for the mid 1990s and for the late 1990s. The mid 1990s is the period analyzed in Section 2.3 of the main text. In comparison, for the late 1990s, I use the 1998 SCF data and the 1999 PSID data with the wealth supplement that includes the information on non-housing assets.

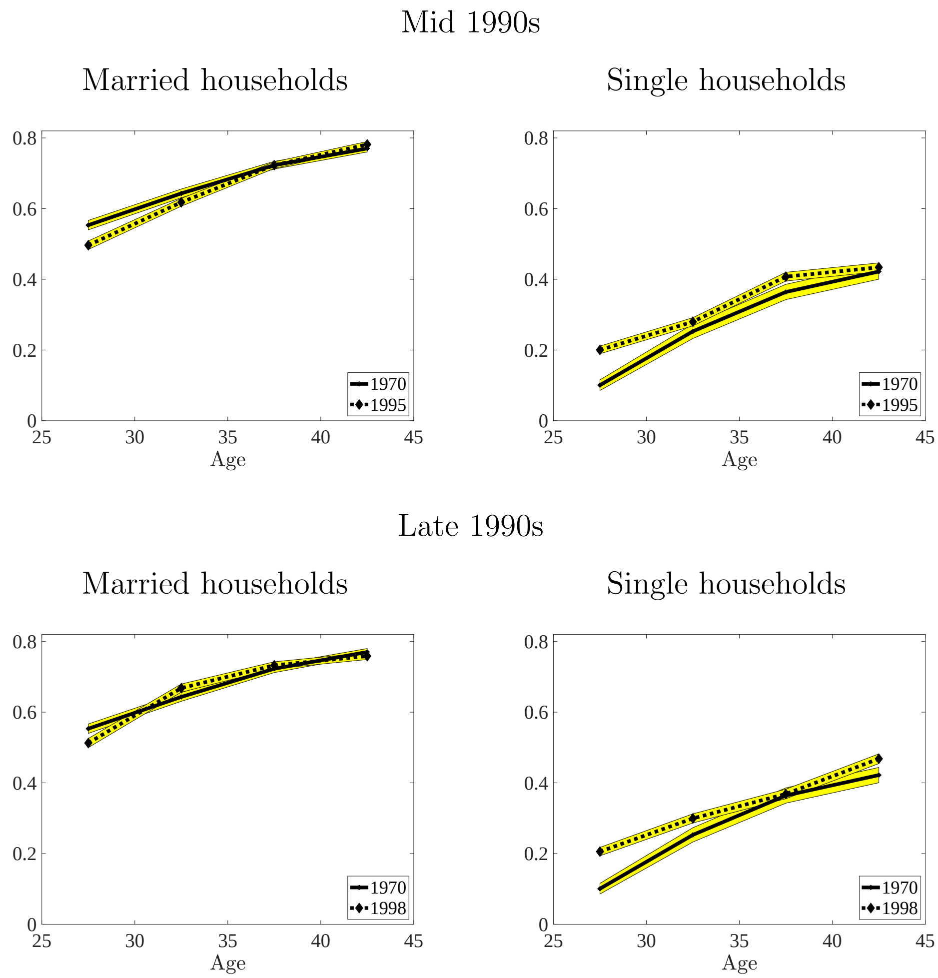


Figure A-1: Homeownership rates (mid 1990s *vs.* late 1990s)

*Notes:* Using the PSID and the SCF data, the average homeownership rates across different age groups are obtained by taking the weighted average. The weight is set to be proportional to the sample size of each data set. (Mid 1990s) based on the 1995 SCF data and the 1994 PSID data with the wealth supplement. (Late 1990s) based on the 1998 SCF data and the 1999 PSID data with the wealth supplement. The $x$-axis stands for the age of household head. The yellow shaded bands denote 90% confidence intervals.

Married households' homeownership rates slightly increase from the mid 1990s to the late 1990s. The increase in homeownership seems to reflect the housing boom started from the late 1990s. Even with the late 1990s data, the average homeownership rate of couples younger than 30 years old is smaller compared to the year 1970's value. I conjecture that the increased divorce risk still puts downward pressure on homeownership of young couples but its effect is counteracted by upward pressure from housing boom. For single households, the homeownership rates increase from 1970 to the late 1990s. This pattern is qualitatively similar to what is observed from 1970 to the mid 1990s. In the main text, I choose the mid-1990s as a representative period of analysis in comparison to 1970, in an effort to mitigate the potential confounding influence of the housing boom.

## A.5 House price index

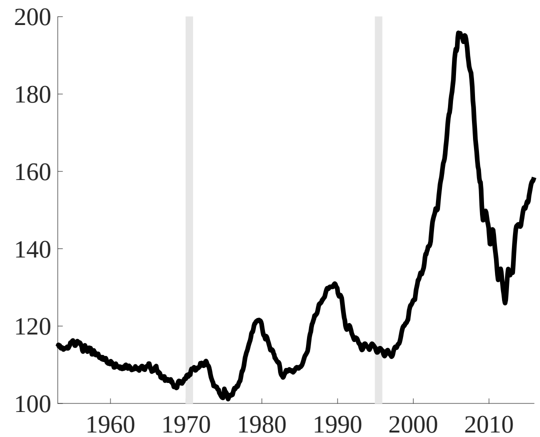


Figure A-2: Real home price index

*Notes:* The solid line is the real home price index from Shiller (2015). The data is available at http://www.econ.yale.edu/ shiller/data.htm. The gray areas stand for the year 1970 and the year 1995.

Figure A-2 shows the real home price index by Shiller (2015). Despite some swings from 1970 to 1995, the real home price index seems to be mean-reverting when we look at a longer history from the 1950s.[34] In addition, the index on rent-price ratio stayed quite stable between 1970 and 1995 as reported in Gallin (2008). Hence, I choose 1970 and 1995 as two periods with similar house prices, but with substantially dissimilar likelihood of marital transitions. In the decomposition analysis of Section 5, I consider the slight increase in house price by 5% as one structural change for the year 1995 compared to 1970.

[34] This reasoning is in line with Corbae and Quintin (2015): the real home price is approximated with three-point process where the 1940-1998 time spans as periods with the intermediate price value. The period between 1999 and 2006 is with the high price and the period between 1920 and 1939 is with the low price.

## A.6 Marital transition probabilities with cohort effects

I construct marriage and divorce probabilities taking into account cohort effects using data until the year 1995. From Figure A-3, the marriage probabilities with cohort effects considered are lower than the baseline probabilities. In contrast, the divorce probabilities are higher when cohort effects are considered. I conduct a sensitivity analysis by feeding in these probabilities (with cohort effects) to the model.[35]

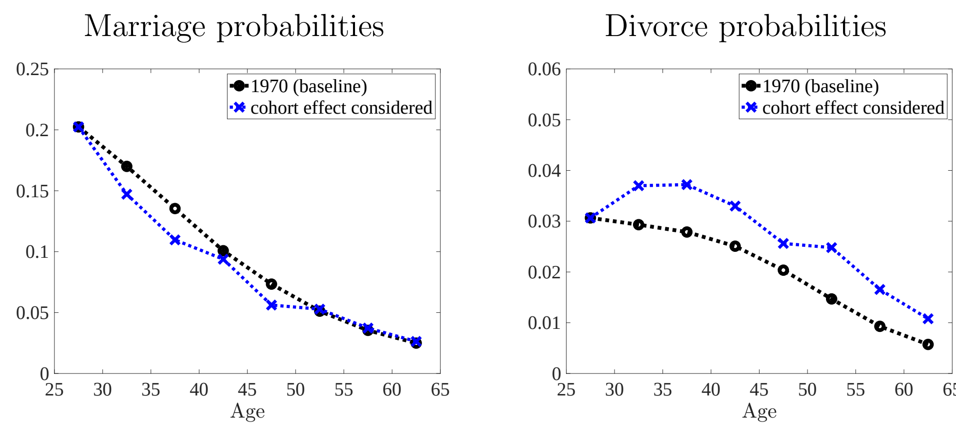


Figure A-3: Marriage and divorce probabilities

*Notes*: The black dotted lines are the same as the baseline where the cohort effect is abstracted. The blue lines with x-mark denote the probabilities where the cohort effect is considered. In other words, a single individual of the age group 25-29 in 1970 faces the year 1995's marriage probability at the age group 50-54.

| | Age group | | | | | Age group | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 25-29 | 30-34 | 35-39 | 40-44 | 25-44 | 25-29 | 30-34 | 35-39 | 40-44 | 25-44 |
| | Single households | | | | | Married households | | | | |
| Baseline | 11.5 | 23.5 | 31.9 | 41.4 | 27.1 | 57.6 | 68.4 | 73.7 | 79.4 | 69.8 |
| Prob. with cohort effects | 11.5 | 24.7 | 33.6 | 43.6 | 28.4 | 57.6 | 68.0 | 73.4 | 79.2 | 69.6 |

Table A-5: Homeownership from the baseline and from the model with marital transition probabilities with cohort effects

[35]Since I use the data until the year 1995, I use the age-dependent probabilities from the 1995's cross-section for age groups 50-64.

Table A-5 compares the homeownership rates from the baseline abstracting cohort effects to those from the model with cohort effects. With lower marriage probabilities with cohort effects, singles' homeownership rates increase. On the other hand, with higher divorce probabilities with cohort effects, married couples' homeownership rates slightly decline.

## A.7 Marital transition probabilities with confidence bands

Figure A-4 shows the estimated age-dependent marriage and divorce probabilities. The black lines are the mean probabilities used in the main analysis (baseline), and the blue lines show the 90% confidence bands. Still, the decline in marriage probabiltiies for young singles and the increase in divorce probabilities hold with uncertainty in the estimates taken into account.

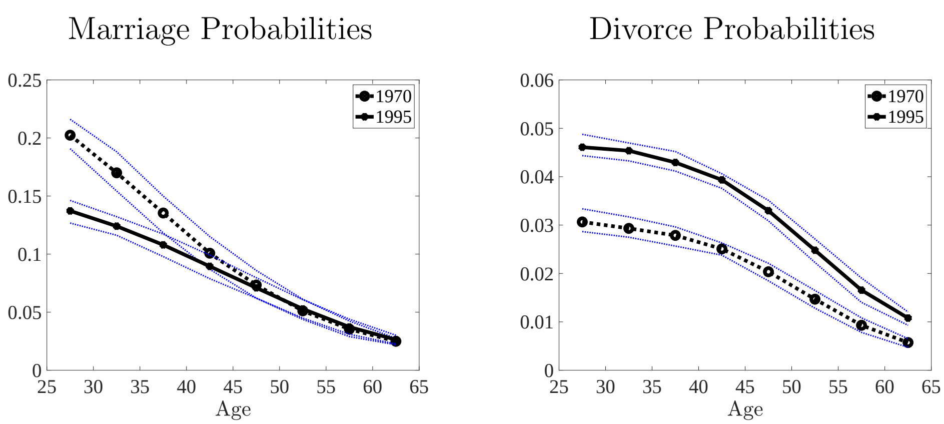


Figure A-4: Marriage and divorce probabilities

*Notes*: Marriage probability at age $t$ is constructed from $Pr(Married_{t+1} = 1|Married_t = 0, Z_t)$ where $Z_t$ include age and squared age similar to Borella et al. (2021). Divorce probability at age $t$ is from $Pr(Divorced_{t+1} = 1|Married_t = 1, Z_t)$ where $Z_t$ include age and squared age. The blue dotted bands represent 90% confidence bands.

As robustness check, I use the lower bound values in the confidence bands to represent marriage and divorce probabilities (smaller risks faced by households). The baseline homeownership rates for the year 1970 increase for both singles and married couples only slightly. Also, the decrease in marriage probabilities and the increase in divorce probabilities are shown to increase singles' homeownership rate whereas putting the downward pressure for married couples' homeownership. The effects of marital transition channel turn out to be similar in magnitude regardless of whether I use the mean probabilities or the lower bounds from the confidence bands.

| | Age group | | | | | Age group | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 25-29 | 30-34 | 35-39 | 40-44 | 25-44 | 25-29 | 30-34 | 35-39 | 40-44 | 25-44 |
| | Single households | | | | | Married households | | | | |
| Baseline | 11.8 | 24.0 | 35.6 | 43.1 | 28.6 | 58.2 | 68.9 | 74.1 | 80.0 | 70.3 |
| Marital transitions | 7.7 | 7.3 | 3.9 | 0.9 | 5.0 | -4.0 | -3.4 | -2.4 | -1.9 | -2.9 |

Table A-6: Effect of marital transition probabilities using lower bound values

*Notes*: The rows named "Baseline" show the values of homeownership rate generated from the model to represent the year 1970. The row named "Marital transitions" show the incremental changes from the baseline when only the marital transitions probabilities are changed to the year 1995's values, holding everything else as the baseline. The marital transition probabilities used are the lower bound values from the 90% confidence bands (blue dotted lines) in Figure A-4.

## A.8 Bayesian Estimation

Let $\Theta$ denote the parameters of interest and $\hat{\mathbf{m}}$ denote the vector of $M$ empirical moments from the data for estimation. The goal is to choose $\Theta$ to make the model-simulated moments $\mathbf{m}(\Theta)$ be as close as possible to $\hat{\mathbf{m}}$. The approximate likelihood is written as

$$f(\hat{\mathbf{m}}|\Theta) = (2\pi)^{-\frac{M}{2}} |S|^{-\frac{1}{2}} \exp\left[-\frac{1}{2}\left(\hat{\mathbf{m}} - \mathbf{m}(\Theta)\right)' S^{-1} \left(\hat{\mathbf{m}} - \mathbf{m}(\Theta)\right)\right],$$

where $S$ is the covariance matrix of $\hat{\mathbf{m}}$. The covariance matrix $S$ is replaced by a consistent estimator $\bar{S}$, which can be obtained through bootstrap. With $N_B$ bootstrap samples,

$$\bar{S} = \frac{1}{N_B} \sum_{b=1}^{N_B} (\hat{\mathbf{m}}_b - \bar{\mathbf{m}})(\hat{\mathbf{m}}_b - \bar{\mathbf{m}})',$$

where $\hat{\mathbf{m}}_b$ stands for the moments from the $b$-th bootstrap sample and $\bar{\mathbf{m}}$ is the mean of $\hat{\mathbf{m}}_b$ for $b = 1, \ldots, N_B$. The Bayesian posterior of $\Theta$ conditional on $\hat{\mathbf{m}}$ is derived as

$$f(\Theta|\hat{\mathbf{m}}) = \frac{f(\hat{\mathbf{m}}|\Theta)p(\Theta)}{f(\hat{\mathbf{m}})},$$

where $p(\Theta)$ denotes the priors on $\Theta$ and $f(\hat{\mathbf{m}})$ denotes the marginal density of $\hat{\mathbf{m}}$, where $f(\hat{\mathbf{m}}) = \int f(\hat{\mathbf{m}}|\Theta)p(\Theta)d\Theta$. Then I characterize the posterior density using the Random-Walk Metropolis Hastings sampler with the objective function $g(\Theta) \equiv \log f(\hat{\mathbf{m}}|\Theta) + \log p(\Theta)$.

The proposal covariance-variance matrix $\Omega_{\text{proposal}}$ is obtained by multiplying a constant $c$ to the diagonal matrix $\Omega$ whose elements are equal to prior variances, $\Omega_{\text{proposal}} = c \times \Omega$. As the chain runs, $c$ is updated as in Herbst and Schorfheide (2019) so that the acceptance rate $x$ gets closer to the target 0.25:

$$c' = c \times \left(0.95 + 0.1 \times \frac{e^{16(x-0.25)}}{1 + e^{16(x-0.25)}}\right).$$

Figure A-5 shows the marginal density of each parameter constructed from posterior draws. I use uniform priors in this paper so that the non-uniform shape of posterior density clearly illustrates that data variations are informative of the estimated parameters.

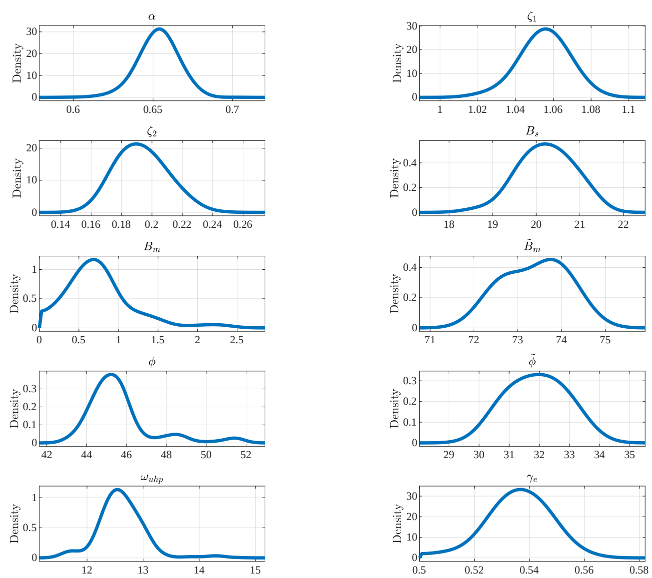


Figure A-5: Posterior density for each parameter

Even with non-informative priors, the parameter estimates inform me about interesting aspects including economies of scale within marriage, utility from home production, and the cost of labor supply. More informative priors would sharpen the inference. I leave for future research what informative priors to impose for different parameters in a life-cycle model.

## A.9 Model Fit

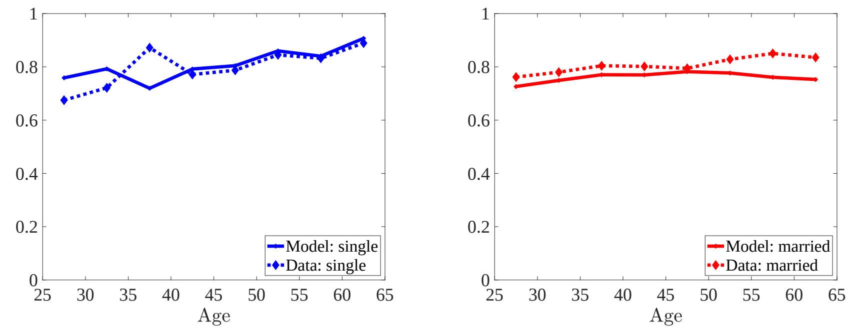


Figure A-6: Model fit for conditional housing asset share

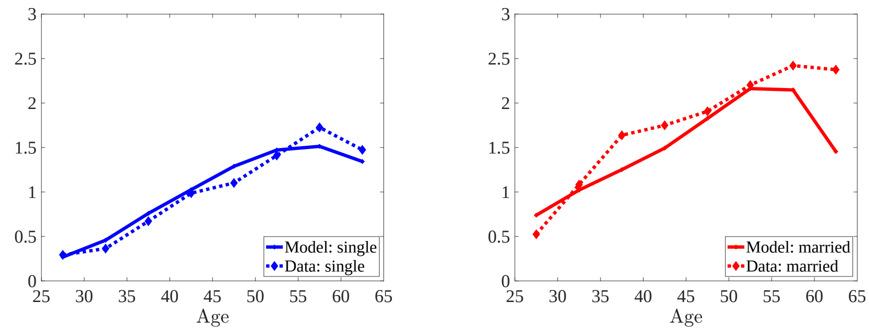


Figure A-7: Model fit for total assets

*Notes:* The vertical axis is in $10,000 in 1970.

## A.10 Predictive checks for life-cycle profiles

From Figure A-8 based on the posterior mean, I observe some gaps between the model-generated life-cycle profiles and the data's. The hairlines generated from the predictive checks allow me to see whether these discrepancies are big or not given the uncertainty involved.

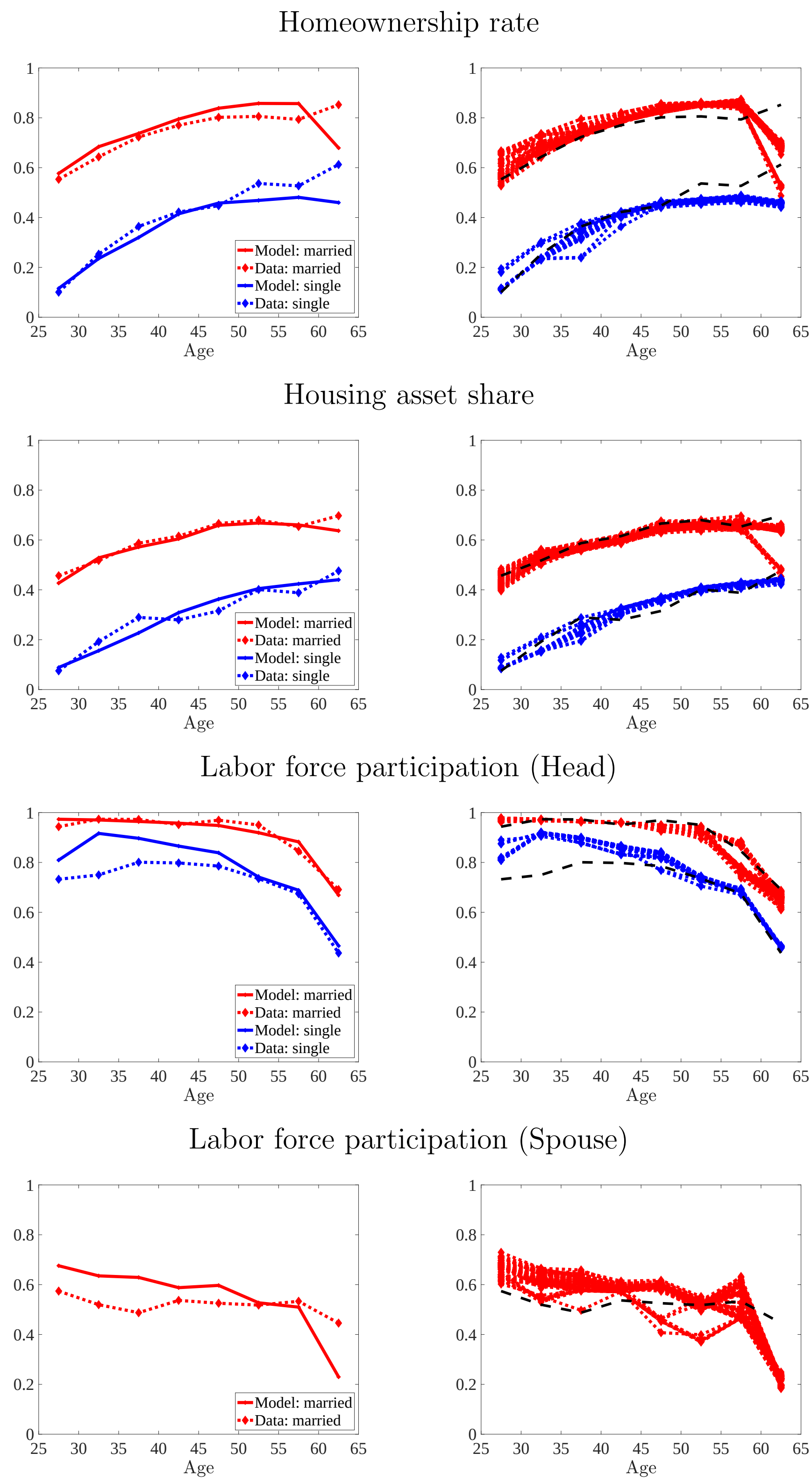


Figure A-8: Life-cycle profiles (data *vs.* model)

*Notes:* Life-cycle profiles of homeownership, housing asset share, and labor force participation from the model and those from the data. (Left column) The model-generated life-cycle profiles are obtained with the posterior mean estimates. (Right column) The model-generated life-cycle profiles represented by the hairlines are with 100 different posterior draws that are equally distanced over the sampler. These predictive checks are compared to the black dashed lines that represent the data counterparts.

## A.11 Comparison to a simple model with moving probabilities

One could model moving probabilities to capture a potential reason for changes in housing demand. If people move more frequently and each moving involves substantial home transaction costs, this could lower homeownership. In this section, I conduct a counterfactual analysis with moving probabilities: the goal is to compare the outputs from a simple model with moving probabilities to those from the baseline model.

The problems for singles and married couples at the terminal age are the same as the baseline. Likewise, the preferences of singles and married households are specified the same way as the baseline as well as the budget constraint, the borrowing constraint, and the LTI constraint. Hence I only state the changes made to the value functions at the non-terminal ages: the expected value should take into account the age-dependent shock of moving with probability $q_{move,j}$ for age $j$. For both singles and married couples, it is assumed that a household hit by the moving shock sells the owned home and pays the associated transaction costs. The value function of the single household with the state variables $X_j^s = [j, a, h, y]$ is written as follows:

$$\begin{aligned} V^s(X_j^s) = \max_{c,m,b',h',l} \Big\{ u\big(c, s, l\big) \; + \beta\Big[(1 - q_{move,j}) \cdot \mathbb{E}V^s\big(j+1, a', h', y'\big) \\ + q_{move,j} \cdot \mathbb{E}V^s\big(j+1, a' - \kappa_s P^H h', 0, y'\big)\Big]\Big\}. \end{aligned}$$

Likewise, the married household's value function with $X_j^m = [j, a, h, y, \widetilde{y}]$ is written as follows:

$$\begin{aligned} V^m(X_j^m) = \max_{c,m,b',h',l,\widetilde{l}} \Big\{ u\big(c, s, l, \widetilde{l}\big) \; + \beta\Big[(1 - q_{move,j}) \cdot \mathbb{E}V^m\big(j+1, a', h', y', \widetilde{y}'\big) \\ + q_{move,j} \cdot \mathbb{E}V^m\big(j+1, a' - \kappa_s P^H h', 0, y', \widetilde{y}'\big)\Big]\Big\}. \end{aligned}$$

When solving this simpler model, I plug in the same parameter estimates used in the 1970's baseline. For the age-dependent moving probabilities for single households, I use the same values as age-dependent marriage probabilities. It is known that married couples move less compared to singles. Hence, I set the age-dependent moving probabilities for married couples by multiplying 1/3 to the singles' moving probabilities. This gap is in a similar magnitude to the reported values in Guler and Taşkin (2018) and Alonzo (2022).

| | Age group | | | | | Age group | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 25-29 | 30-34 | 35-39 | 40-44 | 25-44 | 25-29 | 30-34 | 35-39 | 40-44 | 25-44 |
| | Single households | | | | | Married households | | | | |
| Baseline | 11.5 | 23.5 | 31.9 | 41.4 | 27.1 | 57.6 | 68.4 | 73.7 | 79.4 | 69.8 |
| Moving probabilities | 10.3 | 19.3 | 26.9 | 33.2 | 22.4 | 76.9 | 78.1 | 79.0 | 80.6 | 78.7 |

Table A-7: Homeownership from the baseline and from the model with moving probabilities

Table A-7 shows the life-cycle profiles of homeownership rates for the age groups from 25 to 44 years. Singles' homeownership rates from the simple model with moving probabilities are lower than those from the baseline. Under the simpler model without marital transitions, singles are subject to moving shock that involves costly liquidation of home for sure and there is no buffer provided by pooled assets with a potential spouse. In this regard, investing in home while being single is less attractive under the simpler model. In contrast, the model with moving probabilities deliver higher homeownership rate for married couples. Assets are not destructed as in the case of divorce and the economies of scale within marriage is still kept with moving. In this regard, homeownership rates turn out to be higher compared to the baseline.

## A.12 Robustness check with $p_{liquidate}$

The higher $p_{liquidate}$ could amplify the riskiness of marriage and divorce when it comes to housing decisions. With $p_{liquidate} = 0.9$, the housing demand is only slightly lower compared to the baseline. The opposite is the case for $p_{liquidate} = 0.8$ that is close to the lower bound value of empirical frequency.

| | Age group | | | | | Age group | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 25-29 | 30-34 | 35-39 | 40-44 | 25-44 | 25-29 | 30-34 | 35-39 | 40-44 | 25-44 |
| | Single households | | | | | Married households | | | | |
| $p_{liquidate} = 0.85$ (Baseline) | 11.5 | 23.5 | 31.9 | 41.4 | 27.1 | 57.6 | 68.4 | 73.7 | 79.4 | 69.8 |
| $p_{liquidate} = 0.9$ | 11.5 | 23.3 | 31.7 | 41.1 | 26.9 | 57.4 | 68.0 | 73.4 | 79.2 | 69.5 |
| $p_{liquidate} = 0.8$ | 11.6 | 23.6 | 32.1 | 41.8 | 27.3 | 57.9 | 68.6 | 74.0 | 79.7 | 70.1 |

Table A-8: Homeownership from the baseline and from the model with different $p_{liquidate}$

## A.13 Robustness check with transaction costs

I conduct a counterfactual analysis with the alternative specification of transaction costs that also entail a fixed component.

| | Age group | | | | | Age group | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Single households | 25-29 | 30-34 | 35-39 | 40-44 | 25-44 | 25-29 | 30-34 | 35-39 | 40-44 | 25-44 |
| | Transaction costs (proportional only) | | | | | Transaction costs (proportional+fixed) | | | | |
| Baseline | 11.5 | 23.5 | 31.9 | 41.4 | 27.1 | 10.6 | 20.1 | 31.3 | 40.9 | 25.7 |
| Marital transitions | 7.0 | 6.5 | 3.9 | 1.4 | 4.7 | 7.3 | 6.1 | 3.0 | 1.3 | 4.4 |
| | Age group | | | | | Age group | | | | |
| Married households | 25-29 | 30-34 | 35-39 | 40-44 | 25-44 | 25-29 | 30-34 | 35-39 | 40-44 | 25-44 |
| | Transaction costs (proportional only) | | | | | Transaction costs (proportional+fixed) | | | | |
| Baseline | 57.6 | 68.4 | 73.7 | 79.4 | 69.8 | 56.3 | 65.8 | 71.5 | 76.6 | 67.6 |
| Marital transitions | -3.8 | -3.3 | -2.4 | -1.7 | -2.8 | -6.9 | -2.7 | -2.3 | -1.8 | -3.4 |

Table A-9: Effect of marital transition probabilities on homeownership with different specifications for transaction costs

*Notes:* The rows named "Baseline" show the homeownership rates under the 1970 baseline. The rows "Marital transitions" show the effect (incremental change in percentage points) of changing marital transition probabilities from the 1970's values to the 1995's values, holding everything else the same as the baseline.

Let's begin by revisiting the results obtained using proportional transaction costs, as discussed in the main text. The results are presented under the heading "Transaction costs (proportional only)" in Table A-9. In contrast, the counterfactuals are reported under the heading "Transaction costs (proportional+fixed)". This refers to the alternative specification where, in addition to the proportional transaction costs, a fixed component equivalent to 3% of the smallest house's value must be paid.[36]

Under the baseline with 1970's marital transition probabilities, the homeownership rates are lower when there is a fixed component to be paid for home transactions. The effect of increased divorce risk on housing decisions seems to be amplified with an additional fixed component in transaction costs. The effect of decreased marriage risk on homeownership remains relatively similar regardless of the presence of a fixed component in transaction costs.

## A.14 Housing decisions with different risk aversion parameters

In the main text, I set the risk aversion parameter $\sigma = 5$ as in Chang et al. (2018) in order to better match the homeownership as well as the housing asset share by marital status.

| Single households | Homeownership | Housing asset share |
|---|---|---|
| Data for 1970 | 0.28 | 0.20 |
| Model ($\sigma = 5$) | 0.27 | 0.19 |
| Model ($\sigma = 4$) | 0.11 | 0.08 |
| **Married households** | **Homeownership** | **Housing asset share** |
| Data for 1970 | 0.67 | 0.54 |
| Model ($\sigma = 5$) | 0.69 | 0.53 |
| Model ($\sigma = 4$) | 0.73 | 0.56 |

Table A-10: Housing decisions with different risk aversion parameters

The decrease in the risk aversion parameter has two contrasting effects on homeownership rates. Firstly, a decrease in risk aversion can lead to households saving less, thereby making it relatively less affordable for them to purchase a home. However, in terms of portfolio allocation, as households become less risk-averse, there may be an inclination to invest more

[36]For instance, buying the smallest house will incur 6% of the house value as the total transaction costs. This value is close to costs of employing estate agents, lawyers, surveyors, and other specialists reported in Bottazzi et al. (2007) for the United Kingdom.

in housing compared to risk-free assets. To examine which effect dominates, I conduct an experiment by reducing $\sigma$ from 5 to 4. The outcomes are presented in Table A-10, which reports the average homeownership rates among households aged 25-44. For single households, the average homeownership rate exhibits a substantial decline. Conversely, the average homeownership rate for married households aged 25-44 increases. Similar patterns are also observed when examining the unconditional housing asset share.

## A.15 Homeownership with cohort effects

In Table A-11, the homeownership rates are constructed with the PSID data taking cohort effects into account.

| | Age group | | | | | Age group | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Single households | 25-29 | 30-34 | 35-39 | 40-44 | 25-44 | 25-29 | 30-34 | 35-39 | 40-44 | 25-44 |
| | Baseline (data, main text) | | | | | With cohort effects | | | | |
| 1970 | 10.1 | 25.3 | 36.4 | 42.2 | 28.5 | 10.1 | 28.3 | 39.6 | 49.7 | 31.9 |
| 1995 | 20.0 | 28.0 | 40.8 | 43.4 | 33.1 | 20.0 | 33.1 | 47.7 | 46.0 | 36.7 |
| Change | 9.9 | 2.7 | 4.4 | 1.2 | 4.6 | 9.9 | 4.8 | 8.1 | -3.7 | 4.8 |
| | Age group | | | | | Age group | | | | |
| Married households | 25-29 | 30-34 | 35-39 | 40-44 | 25-44 | 25-29 | 30-34 | 35-39 | 40-44 | 25-44 |
| | Baseline (data, main text) | | | | | With cohort effects | | | | |
| 1970 | 55.3 | 64.3 | 72.3 | 77.0 | 67.2 | 55.3 | 72.8 | 83.6 | 85.1 | 74.2 |
| 1995 | 49.7 | 61.8 | 72.3 | 78.2 | 65.5 | 49.7 | 69.6 | 79.7 | 83.5 | 70.6 |
| Change | -5.6 | -2.5 | 0.0 | 1.2 | -1.7 | -5.6 | -3.2 | -3.9 | -1.6 | -3.6 |

Table A-11: Homeownership from the baseline and from the PSID data with cohort effects

*Notes:* The columns named “Baseline (data, main text)” show the homeownership rates constructed according to Section 2 of the main text. The columns “With cohort effects” show the homeownership rates constructed using the PSID data to control for the cohort effects. In order to obtain the homeownership rates with the cohort effects, I additionally use the PSID in the years 1975, 1980, 1985, 1999, 2005, 2009. The life-cycle profiles are adjusted with a constant so that the age group 25-29 values are matched with the baseline values.

The life-cycle profiles for the year 1970 are constructed as if the cohort aged 25-29 in 1970 is tracked over time. For example, I use the 1980 data in order to obtain the average homeownership rate of the age group 35-39. To construct the life-cycle profiles with cohort effects, I additionally use the PSID data from the years 1975, 1980, 1985, 1999, 2005, and 2009. Then the homeownership rates with cohort effects are adjusted with a constant so that the age group 25-29 values are matched with the baseline values.[37]

The changes in homeownership by marital status, while accounting for cohort effects, exhibit qualitatively similar patterns to those observed in the baseline analysis. This similarity may be attributed to the fact that the baseline analysis addresses composition differences coming from education and non-housing assets, which are partially linked to varying cohort effects. The magnitude of changes over time is larger with cohort effects considered. It is worth noting that the time effects are not controlled by tracking a specific cohort. For example, when constructing profiles for the cohort aged 25-29 in 1995, data from the housing boom periods is necessary. It is left for future research to study the change in marital transition probabilities and its effect on housing decisions for different cohorts.

## A.16 Counterfactual with medical costs and pension payments

Certain elements of retirement may have changed between 1970 and 1995. I conduct a counterfactual experiment to incorporate the change in out-of-pocket medical expenditures and pension payments and compare what differs from the baseline results. Pension payments increased from \$7141.7 to \$9462.6 (both in 1995 dollars) as reported in Purcell and Whitman (2006). Out-of-pocket medical expenses increased from \$792.6 to \$1188.99.[38] Combining these two changes, there was \$1918.6 increase in the pension payments net of medical expenses. Accordingly, I experiment with the model so that this increase is reflected to the constant amount of consumption for the continuation value in the terminal period. Table

[37]For instance, the average homeownership rate of couples aged 25-29 from the 1970 PSID data is 57.2%. In order to match the value from the baseline (55.3% for the age group 25-29 with composition change controlled with the regression analysis), I subtract 1.9 percentage points from couples' homeownership rates with cohort effects.

[38]Medical spending for people older than 65 increased from \$1981.6 to \$5284.4 (both in 1995 dollars) as reported in Dickman et al. (2016). The reported out-of-pocket expenses were calculated based on the fraction paid out-of-pocket out of total medical spending reported in De Nardi et al. (2016).

A-12 shows the results from this counterfactual analysis. The homeownership rates over the life-cycle seem not to change substantially from the baseline. More thorough exploration for old-age housing decisions is left for future research.

| | Age group | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Single households | 25-29 | 30-34 | 35-39 | 40-44 | 45-49 | 50-54 | 55-59 | 60-64 |
| Baseline | 11.5 | 23.5 | 31.9 | 41.4 | 45.7 | 46.8 | 48.0 | 46.0 |
| Change in medical costs + pension payments | 11.5 | 23.4 | 34.5 | 41.6 | 45.6 | 47.3 | 47.6 | 45.5 |
| | Age group | | | | | | | |
| Married households | 25-29 | 30-34 | 35-39 | 40-44 | 45-49 | 50-54 | 55-59 | 60-64 |
| Baseline | 57.6 | 68.4 | 73.7 | 79.4 | 83.8 | 85.7 | 85.6 | 67.9 |
| Change in medical costs + pension payments | 57.6 | 68.4 | 73.7 | 79.5 | 83.8 | 85.8 | 87.3 | 67.5 |

Table A-12: Homeownership from the baseline and from the model with the change in medical costs and pension payments