Family Composition and the Optimal Demand for Housing over the Life Cycle*

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Abstract

We study the impact of family composition on housing demand in a realistic life-cycle model. Our model predicts that in addition to their empirically documented instant effects, changes in family composition also have strong and long-lasting effects on housing demand. The current trend toward getting married and having children later in life alter the demand for housing over the life cycle. In addition to uncertainty in income, house prices, and financial assets, the possibility of divorce is another important risk factor.

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1 Introduction

Even though changes in family composition affect households' portfolio decisions (Love, 2010), the life-cycle literature has largely overlooked the implications of these changes for households' housing demand. This is surprising, given the potential for family composition to affect the demand for housing, which typically constitutes a household's largest asset. For instance, according to the 2009 Panel Study of Income Dynamics (PSID) data, 85% of married heads of households live in owner-occupied homes, whereas only 54% of unmarried heads do.

In this article, we extend life-cycle models with housing, such as Cocco (2005) and Yao and Zhang (2005), by explicitly taking family structure into account. Simultaneously, we extend the work of Love (2010) that focuses on how family structure affects portfolio decisions, but abstracts away from explicitly modeling housing decisions.

A growing literature empirically documents the instant impact of family composition on housing decisions.[1] Yet evidence on long-term effects is scarce. Our work contributes to the literature by setting up a realistically calibrated life-cycle model that allows us to study the long-term consequences of changes in family composition. Our results stress three key findings. First, our model predicts that besides instant effects, changes in family composition have a strong and long-lasting impact on household net worth and the demand for housing. Second, in addition to uncertainty in income, house prices, and financial assets, the possibility of divorce is another important risk factor that – despite its practical relevance – so far has received little attention in the life-cycle literature. Third, the current trend toward getting married and having children later in life alter the demand for housing over the life cycle.

Marriages not only instantly increase households' homeownership rates, but also result in a higher demand for homeownership over decades. This persistence in homeownership rates may reflect married households' labor income being typically less volatile than a single household's,

[1] Among the most recent examples, Öst (2012) documents that married are more likely to live in owner-occupied homes than singles, Khorunzhina and Miller (2014) show that childbearing decisions have an influence on housing choices, while Pericoli and Ventura (2012) show that family disruption risk generates precautionary savings.

thus reducing the risk of failing to meet financial obligations, such as mortgage payments. Simultaneously, marriages cause households to live in larger homes, reflecting the higher demand for living space that can be covered by the increase in household income and net worth resulting from the marriage. Our model predicts that these effects are typically of a long-lasting to permanent nature; that is, marriages result in a permanent increase in home sizes. Finally, marriages not only instantly affect household net worth; they also have a permanent positive effect on household net worth and welfare due to economies of scale from living together.[2]

Divorces decrease the demand for housing, and many of the effects from marriages are reversed. Specifically, divorces reduce homeownership rates not only instantly, but also in the long run, potentially due to the higher volatility of a single household's labor income. Likewise, divorces reduce family size, thereby also reducing households' net worth and labor income, and thus causing divorced individuals to live in smaller homes. Similarly, divorces not only have a negative instant impact on household net worth, but also a permanent one due to the loss of economies of scale from living together. Overall, divorces have a substantial impact on optimal household decisions and welfare. For instance, the average welfare costs for a female individual aged 30 are more than 10%. That is, these individuals are willing to give up 10% of their present net worth and future labor income to avoid the negative financial consequences of a divorce. Therefore, we argue that the possibility of divorce is an important risk factor along with uncertainty in labor income, house prices, and financial assets – the risk factors typically studied in the life-cycle literature with housing.

Throughout recent decades, family composition has experienced dramatic changes. First, individuals tend to get married and have children later in life. Second, they tend to have fewer children.[3] Our model predicts that these trends affect the demand for housing. More specifically, later marriages result in a lower demand for homeownership, reflecting singles' higher

[2]Similar effects hold for longterm cohabitation.

[3]According to the U.S. Census Bureau, from 1970 to 2009, the first-time marriage age in the United States increased from 23.2 (20.8) to 28.1 (25.9) years for males (females). During the same time period, the average age of first-time mothers increased from 21.4 to 25.4 years and the number of children per household (per household with children) decreased from 1.27 (2.28) to 0.84 (1.88).

income risk. The trend toward having children later in life and having fewer children, on the other hand, increases the demand for homeownership for middle-aged households, reflecting their higher savings.

Despite its practical relevance, theoretical work on how family structure affects optimal household decisions is scarce. Prior work on owner-occupied housing goes back to Grossman and Laroque (1990), who study the impact of transaction costs on trading in illiquid durable consumption goods. Damgaard, Fuglsbjerg, and Munk (2003) and Corradin, Fillat, and Vergara-Alert (2014) generalize their work by allowing for both perishable and durable consumption. Our work builds on Cocco (2005) and Yao and Zhang (2005), who were the first to study optimal housing, consumption, and portfolio decisions in a life-cycle context.[4] Their work has been extended along several dimensions, such as allowing for adjustable-rate mortgages (Van Hemert, 2010), costly mortgage refinancing and default (Hu, 2005; Yao and Zhang, 2008), tax-arbitrage (Marekwica, Schaefer, and Sebastian, 2013), or autocorrelation in residential house prices (Fischer and Stamos, 2013). However, how family structure affects the demand for housing has received little attention. We extend the work of Love (2010) that focuses on how family structure affects portfolio decisions, but abstracts away from explicitly modeling housing decisions. Given that owner-occupied homes typically constitute households' largest assets, understanding how family composition affects the demand for housing is an important step toward a more nuanced understanding of household behavior.

This paper proceeds as follows. In section 2, we provide empirical evidence on how family structure and changes in it affect the demand for housing. We formulate and calibrate our life-cycle model in section 3. In section 4, we show that our model predicts housing decisions to depend on family structure in a way that is commensurate with the empirical evidence from section 2. Section 5 explores the long-term effects of changes in family composition. In section 6, we demonstrate how the recent demographic trends towards getting married and having children later in life affect the demand for housing. Section 7 concludes.

[4] Another strand of literature studies housing in overlapping-generations models. Examples include Yang (2009) and Fernández-Villaverde and Krueger (2011).

Table 1
Summary statistics

Panel A: Marital Status and Housing Demand

	Full sample	Married	Single
Ownership rate	76%	85%	54%
H/W (owners)	1.93	1.93	1.91
Net worth (in 1,000)	311	363	185
Number of children	0.75	0.92	0.36
Number of observations	15,008	11,393	3,615

Panel B: Children and Housing Demand

	Full Sample	No Children	Any Children
Ownership rate	76%	74%	78%
H/W (owners)	1.93	1.49	2.52
Net worth (in 1,000)	311	357	246
Married	76%	61%	85%
Number of observations	15,008	8,823	6,185

This table provides summary statistics based on PSID data between 1999 and 2009. Panel A shows summary statistics depending on marital status, and Panel B shows summary statistics depending on the number of children living in a household. Net worth is expressed in thousands of 2008 dollars. H/W (owners) is home owners' average share of household net worth invested in their homes.

2 Empirical Evidence

In this section, we provide empirical evidence on the impact of family structure on housing decisions. More specifically, our goal is to answer two key questions. First, does household family structure affect the homeownership decision? Second, does the share of net worth invested in housing depend on family structure? To address these questions, we use micro-level data from the PSID along with its Wealth Supplements. Our data sample covers the time period in which data from the Wealth Supplements are available on a bi-annual basis, that is, the years 1999 to 2009. The details of the data-selection process and the construction of variables are outlined in Appendix A.

We begin the discussion of our empirical findings by presenting summary statistics in Table 1. Our findings in Panel A suggest three main conclusions about the impact of an individual's marital status.[5] First, married individuals are more likely to live in owner-occupied homes than

[5]With a slight abuse of wording, we refer to all long-term cohabiting partners, that is partners cohabiting for

singles. This could reflect that married individuals' household income is typically less volatile, thus making regular expenses such as mortgage payments easier to cover. Simultaneously, married individuals' household net worth is higher than singles'. Hence, financing a downpayment should be a lower hurdle to overcome for married individuals. Second, married individuals' household net worth is roughly twice as high as singles', suggesting marital status has little effect on the amount of net worth per partner living in a household. Third, the average number of children living in a married household is higher than in a single's.

The findings in Panel B suggest three main conclusions about the impact of children on housing decisions. First, households with children are slightly more likely to live in owner-occupied homes. Second, children have an effect on household net worth. Households without children have a higher household net worth than households with children. Third, conditional on living in an owner-occupied home, the share of household net worth invested in the home is higher for families with children. That is, home owners' house value-to-net-worth ratio (H/W) is higher for households with children than for those without, because of lower levels of household net worth and the higher demand for living space.

Though suggestive, our summary statistics in Table 1 do not control for other effects. We therefore turn to controlling for various effects the literature as documented as affecting housing demand in the regressions results reported in Table 2.

Panel A reports results of the estimation of a Heckman (1979) two-step sample selection model for households' decisions to acquire owner-occupied homes, and the share of net worth invested into these (H/W). In Panel B, we report results from a probit regression for the decision to rent a home. We control for the household head's marital status, whether the head of household got married within the last two years (just married), whether the head of household got divorced within the last two years (just divorced), the number of children living in the household, dummies indicating whether children in certain age groups are living in the household,

more than one year, as being married throughout. We also explored how treating only legally married individuals as married and all other as singles affects our findings. Because it does not significantly alter our findings, we do not report these results here in detail. They are, however, available from the authors upon request.

Table 2
Housing Decisions of Movers

	Panel A		Panel B
	Buy	H/W	Rent
Married	0.28***	-0.40	-0.46***
	(0.05)	(0.76)	(0.05)
Just married	0.30***		0.46***
	(0.09)		(0.10)
Just divorced	0.20		1.19***
	(0.14)		(0.13)
Number of children	0.01	0.40*	-0.04
	(0.02)	(0.23)	(0.03)
Child up to 3	0.43***		-0.19
	(0.12)		(0.13)
Child 4 to 6	0.24*		-0.32**
	(0.14)		(0.16)
Child 7 to 10	0.19		-0.17
	(0.14)		(0.15)
Child 11 to 15	0.14		-0.22
	(0.13)		(0.15)
Income-to-net-worth ratio	0.01	5.20***	0.68***
	(0.10)	(1.17)	(0.12)
Net worth / 1,000,000	0.08	-0.01	-0.09
	(0.08)	(1.13)	(0.12)
Net worth^2 / 1,000,000	-0.01	0.02	0.02
	(0.02)	(0.24)	(0.02)
Age	-0.04***	-0.17	-0.08***
	(0.01)	(0.12)	(0.01)
Age^2 / 1,000	0.17**	1.38	0.60***
	(0.09)	(1.09)	(0.10)
Owner at $t-1$	-0.28***	1.31*	-0.97***
	(0.06)	(0.70)	(0.06)
Other controls	Yes	Yes	Yes
Mills		-0.49	
		(1.99)	
Number of observations	8,090	948	8,090

This table reports results of the estimation of regressions documenting the impact of family structure and changes in it on households' housing decisions. Panel A reports results from a Heckman two-step estimation for households' decisions to acquire owner-occupied homes and the share of net worth invested into these (H/W). Panel B reports results from a probit regression for the decision to rent a home. "Child up to 3", "Child 4 to 6", "Child 7 to 10", and "Child 11 to 15" are dummy variables indicating whether children in the corresponding age group are living in the household. Education, race dummy, dummy for real estate other than main residence, time dummies, region dummies, and a constant are included as control variables but not reported here for space reasons. The income-to-net-worth ratio and net worth are the latest available observations prior to the household move. In Panel A the dummies for married within the last two years (just married), divorced within the last two years (just divorced), and dummies for ages of children are used as exclusion restrictions. ***, **, and * denote significance at the 1%, the 5%, and the 10% level, respectively. Standard errors are reported in parentheses.

and variables the literature (Yao and Zhang, 2005) has shown affecting housing decisions, such as age, the previous homeownership status, household net worth, and the income-to-net-worth ratio prior to moving.[6] We also include education, race dummies, a dummy for real estate other than the main residence, time dummies, region dummies, and a constant as control variables but do not report them for space reasons.

Changes in family composition may well trigger household moves. However, the family composition resulting from these changes is likely to determine the demand for living space. The dummies for just married, just divorced, and indicators for whether children in the given age groups live in the household are therefore used as exclusion restrictions in Panel A. Overall, our empirical findings in Table 2 show that family composition and changes in it are important determinants of housing decisions. More specifically, our findings in Table 2 allow us to draw four main conclusions.

First, confirming our findings from Table 1, married individuals are more likely than singles to move to owner-occupied homes and less likely to move to rented places. Simultaneously, our findings reveal that not only the marital status, but also changes in it affect the decision to move. More specifically, because of the increased demand for living space, newly married individuals are more likely to move. Even though being recently married also increases the likelihood of moving to rented homes, this decision is presumably short lived.

Second, being newly divorced substantially increases the likelihood of moving to a rented home. This finding reflects the typically sharp decline in household income and net worth following a divorce, which often makes serving a large owner-occupied home's running costs, such as maintenance and mortgage expenses, difficult. Simultaneously, singles' labor income is typically more volatile than married households' labor income stream, thus causing an additional incentive to avoid house-price risk.

Third, households with small children are more likely to move to an owner-occupied home.[7]

[6]The number of observations we can use in the regressions is somewhat smaller than in Table 1 due to the inclusion of lagged regressors.

[7]This finding might partly reflect parents' wish to see their children growing up in a good environment. For example, growing up in an owner-occupied home as opposed to a rented place positively affects childrens' future

More specifically, the dummy variable for children up to three years old living in the household has a statistically significant impact on the household decision to move to an owner-occupied home. Marginal effects for children beyond age seven, however, are insignificant. In other words and in line with the empirical evidence in Öst (2012), households are more likely to move to owner-occupied homes when giving birth to a new child or shortly thereafter.[8]

Fourth, supporting our findings from Table 1, the share of household net worth invested in housing increases in the number of children. More generally, the dual role of owner-occupied homes as both consumption and investment goods implies that housing demand is driven through two channels. The share of household net worth increasing in the number of children should be primarily driven by the consumption motive, and reflects the higher demand for living space. From an investment perspective, it simultaneously implies such households are forced to increase their exposure to house-price risk.

We summarize our stylized facts in three empirical findings that are testable in the model that we develop and solve throughout:

Empirical Finding 1. *Marital status affects the homeownership status: married individuals are more likely than singles to live in owner-occupied homes.*

Empirical Finding 2. *Households with children invest a larger share of their net worth in housing.*

Empirical Finding 3. *Changes in family composition affect the homeownership status: newly-married individuals are more likely to acquire owner-occupied homes, whereas newly divorced individuals are more likely to move to rented places.*

outcomes (Green and White, 1997; Haurin, Parcel, and Haurin, 2002).

[8] A dynamic feedback of homeownership on childbearing decisions can also be non-trivial (see Dettling and Kearney (2014), Khorunzhina and Miller (2014)).

3 The Model

We employ a discrete-time model. T denotes the maximum length of the household's life cycle, and t determines the household's adult age (computed as actual age minus 20).

3.1 Family Structure

Our work extends life-cycle models with housing, such as Cocco (2005) and Yao and Zhang (2005), by modeling family structure. Explicitly accounting for changes in family composition is important, because these events often trigger changes in housing decisions. Simultaneously, our work extends that of Love (2010) by explicitly modeling housing investment decisions. Our way of modeling family structure closely follows Love (2010), whose work focuses on how family structure affects portfolio decisions, but abstracts away from housing decisions. That is, we explicitly model the marital status of individuals and the number of children living in the household. Unmarried households face sex- and age-dependent probabilities of getting married. Marriages can be terminated by divorce or death. Again, we use sex- and age-dependent probabilities for both events. Similarly, the probability of giving birth to a child depends on the mother's age and marital status.

When getting married or divorced, households typically experience significant changes in both household net worth and income. Ideally, one would estimate these effects for each age and sex separately. However, as Love (2010) already noted, the PSID contains insufficient information to precisely estimate all these parameters. Yet research has extensively documented that marriage is assortative along age, education, net worth, and income (Mare, 1991; Schwartz and Mare, 2005; Bredermeier and Juessen, 2013). We therefore assume individuals marry a person of the same age and with the same education, income, and net-worth levels. This assumption also allows us to isolate the impact of marriage, because it keeps household income and net worth per adult constant.[9] In case of a divorce, we assume that household income

[9]In section 6.4 we study the case in which individuals marry richer partners.

decreases by 50%, an owner-occupied home is sold, and household net worth is split equally.[10] We allow for a 10% deduction to account for legal costs and inefficiencies resulting from the splitting of assets. We assume that children stay with their mothers, whereas fathers pay child support. We denote a change in household wealth due to marriage or divorce by ΔW^{MD}. Child support paid is denoted W^S.

Our way of modeling births of children closely follows Love (2010) and has the desirable feature of keeping the household's optimization problem numerically tractable. More specifically, we make four assumptions. First, we assume mothers beyond the age of 40 do not give birth to children. Empirically, the share of females beyond the age of 40 giving birth to children is small. According to Mathews and Ventura (1997), less than 1% of females beyond age 40 give birth to a child. Second, children born before the mother turns 30 are referred to as being born "early", whereas others are referred to as being born "late". We assume that females do not give birth to more than four children in either of these two periods. Third, we assume children born within each of these two periods are evenly spaced two years apart. Finally, we assume the age of the mother when the first child was born is determined by the number of children and whether the first child was born early or late.[11] The ages of the children are determined by the age of the mother at the first birth in both the "early" and the "late" period. The mother has the first child in the early period at 27 if only one child is born in that period, at 26 if two are born, at 25 if three are born, and at 24 if four are born. For children born late, the mother is 34 if one child is born, 33 if two are born, 32 if three are born, and 31 if four are born. Again following Love (2010), we assume children attend college from ages 18 to 22. The household's total annual college costs are denoted by Ξ.

[10] We also computed results under the assumption that the home goes to the custodial parent. Given that a family-size home is typically too large and expensive for a divorced individual, the household usually sells it anyway and results do not differ much from those reported throughout.

[11] These last two assumptions significantly reduce the number of state variables required to solve the life-cycle consumption, housing, and investment problem and thereby make solving the model possible. Essentially, they imply that the age of the children is determined by the mother's age and whether a child was born "early" or "late".

3.2 Preferences

To model preferences over both consumption and housing, we use a Cobb-Douglas utility function over consumption C_t and home size Q_t during each period t.[12] Growing up in an owner-occupied home as opposed to a rented home positively affects childrens' future outcomes (Green and White, 1997; Haurin, Parcel, and Haurin, 2002). Hence, households with children may have a preference for living in an owner-occupied home. Similar to Kiyotaki, Michaelides, and Nikolov (2011), who allow for higher utility from living in owner-occupied homes, we therefore allow households with children to enjoy the full utility of their home only when owning it. For that purpose, we multiply Q_t by a factor $1 - \zeta\chi$, where ζ determines the welfare loss from living in a rented home with children and χ is an indicator function that takes the value of 1 if children are living in the household and the household lives in a rented place.[13]

We assume individuals' preferences be of the CRRA type adjusted for household size and economies of scale. That is, an individual's utility at any point in time t can be expressed as

$$U\left(C_t, Q_t, M_t, N_t\right) = \frac{\left(\frac{C_t^{1-\psi}((1-\zeta\chi)Q_t)^{\psi}}{\eta(M_t,N_t)}\right)^{1-\gamma}}{1-\gamma}, \tag{1}$$

where γ is the individual's degree of risk aversion, M_t is the marital status at time t (we set $M_t = 1$ for a married individual and $M_t = 0$ for a non-married individual), N_t is the number of children at time t, and $\eta\left(M_t, N_t\right)$ is a function determining the household size adjusted for economies of scale.

Dying households with children gain utility from leaving a bequest, which their heirs use to finance consumption and housing services. We assume the beneficiaries have the same pref-

[12]Flavin and Yamashita (2002) show that rental markets enable the utility derived from a home to be split into a consumption and an investment part.

[13]Other work that allows for higher utility from owning includes Ortalo-Magné and Rady (1999, 2006) and Sinai and Souleles (2005).

erences as the bequeather, such that utility from leaving a bequest can be expressed as

$$B\left(W_t, N_t\right) = \begin{cases} \frac{b}{\sqrt{N_t}} \left(\frac{W_t \psi^{\psi} (1-\psi)^{(1-\psi)}}{b\sqrt{N_t}} \right)^{1-\gamma} & \text{if } N > 0 \\ 0 & \text{if } N = 0 \end{cases}, \tag{2}$$

where W_t is the household's net worth at time t, and b measures the strength of a bequest motive.

3.3 Income

Several studies, including Bodie, Merton, and Samuelson (1992), Viceira (2001), and Cocco, Gomes, and Maenhout (2005), for instance, highlight the importance of including labor income as a non-tradable asset in portfolio-choice frameworks. Because labor income is typically a regular stream of positive cash flow, its payment stream is similar to that of a coupon-bearing bond with stochastic coupon payments. Hence, households with labor income typically hold a higher proportion of risky assets when they are young, and shift to bonds as they get older and their human capital shrinks. We assume households earn unspanned labor income, L, which, during their working life, is subject to permanent shocks and a drift depending on age, sex, marital status, and the number of children living in the household. The replacement ratio, that is, the initial pension income divided by final labor income, depends on the individual's sex and marital status. We follow Cocco, Gomes, and Maenhout (2005) in assuming that real labor income is a constant fraction of final labor income during the retirement phase.

3.4 Capital and Housing Markets

Households can trade a representative risky stock market index, a risk-free bond, and owner-occupied homes. The growth in labor income, house-price risk, and stock market risk can be correlated, reflecting their tendency to depend on common risk factors, such as the state of the economy. We assume the representative stock market index and house prices are jointly lognormally distributed with expected returns of μ_S and μ_H and volatilities of σ_S and σ_H, respectively. We denote the return on the risk-free asset by r.

3.5 Rents, Maintenance, and Moving Costs

The consumption of housing services is associated with recurring expenses for both owners and renters. Renters periodically pay rental costs, $\delta^r QH$, with δ^r denoting the rate of renting costs, Q the size of the home measured in number of housing units, and H the price per housing unit. Owners pay maintenance costs, $\delta^m QH$, where δ^m is the rate of maintenance costs. That is, the rate of running housing costs, δ, can be expressed as

$$\delta\left(I_t\right) = \delta^r\left(1 - I_t\right) + \delta^m I_t, \tag{3}$$

where I_t is an indicator variable that takes the value of 1 if the household owns the home during period t, and 0 if the household rents it.

Non-recurring costs are realized if households move to owner-occupied homes, that is, if $I_t = 1$ and $I_{t-1} = 0$. As in Van Hemert (2010) and Fischer and Stamos (2013), a household acquiring a new home faces transaction costs of $\tau Q_t H_t$, where Q_t is the size of the new home. Transaction costs are also incurred if the household remains an owner, $I_t = I_{t-1} = 1$, but changes home size, that is, if $Q_t \neq Q_{t-1}$. Total non-recurring transaction costs, τ^t, can thus be summarized as follows:

$$\tau^t\left(Q_t, Q_{t-1}, I_t, I_{t-1}, H_t\right) = Q_t H_t \begin{cases} \tau & \text{if home purchase } (I_t - I_{t-1} = 1) \\ \tau & \text{if owner changes home size } (I_t = I_{t-1} = 1,\, Q_t \neq Q_{t-1}) \\ 0 & \text{otherwise.} \end{cases} \tag{4}$$

3.6 The Optimization Problem

The household maximizes expected lifetime utility by deciding each period, $t = 0, 1, \ldots, T$, upon consumption of the non-durable good, C_t; home size, Q_t; ownership status, I_t; exposure to stocks, π_t^s; and bonds, π_t^b. Individuals being married agree to maximize the sum of their equally-weighted respective utilities. That is, as long as they are married, they care as much about their partner's future well-being as they care about their own. Non-married individuals only maximize their own respective utilities. A household's evolution of net worth, W_t, is given by

$$W_t = \pi_{t-1}^s W_{t-1} R_{s,t} + \pi_{t-1}^b W_{t-1} R + L_t + H_t \cdot Q_{t-1} \cdot I_{t-1} + \Delta W_t^{MD}, \tag{5}$$

where $R_{s,t}$ and R are the gross returns on the stock and the bond position, respectively. The household's budget constraint is

$$W_t = C_t + \delta\left(I_t\right) \cdot H_t \cdot Q_t + H_t \cdot Q_t \cdot I_t + \tau^t\left(Q_t, Q_{t-1}, I_t, I_{t-1}, H_t\right) + W_t^S. \tag{6}$$

We impose the restriction that households cannot short-sell stocks, that is, $\pi_t^s \geq 0$, whereas bonds can only be shorted to finance homeownership. The minimum housing downpayment for home owners is $\kappa > 0$, implying the amount of debt, $-\pi_t^b W_t$, has to obey

$$-\pi_t^b W_t \leq \left(1 - \kappa\right) I_t \cdot H_t \cdot Q_t. \tag{7}$$

Hence, an individual's optimization problem is given by

$$
\begin{aligned}
V(X_t, Y, t) = & \sup_{\{C_t, Q_t, I_t, \pi_t^s, \pi_t^b\}} U\left(C_t, Q_t, M_t, N_t^e, N_t^l\right) \\
& + \beta \cdot \mathbb{E}\Bigg[M_t \Big\{ f_t \tilde{f}_t \left(\frac{1}{2} V(X_{t+1}, Y, t+1) + \frac{1}{2} V\left(X_{t+1}, \tilde{Y}, t+1\right) \right) \\
& + f_t \left(1 - \tilde{f}_t\right) V(X_{t+1}, Y, t+1) + (1 - f_t) \tilde{f}_t V\left(X_{t+1}, \tilde{Y}, t+1\right) + (1 - f_t)\left(1 - \tilde{f}_t\right) B(W_{t+1}) \Big\} \\
& + (1 - M_t) \Big\{ f_t V(X_{t+1}, Y, t+1) + (1 - p_t) B(W_{t+1}) \Big\} \Bigg], \qquad (8)
\end{aligned}
$$

and equations (1) to (7), where f_t is the probability of the individual surviving from time t to $t+1$, $\tilde{f}_t$ is the corresponding probability for a partner, Y is the individual's gender, $\tilde{Y}$ is a possible partner's gender, N_t^e and N_t^l are the number of children born "early" and "late," respectively, and

$$
X_t = \left[Q_{t-1}, I_{t-1}, L_t, W_t, H_t, M_t, N_t^e, N_t^l\right] \qquad (9)
$$

is the vector of state variables. The optimization problem is not solvable in closed form. We therefore solve the life-cycle consumption, housing, and investment problem numerically. The technical details are outlined in Appendix C.

3.7 Parameterization

In this section, we describe the parameterization of our model. We assume one period corresponds to one year. We estimate the evolution of real home prices, using the log-returns on the Case Shiller Home Price Index from 1953 to 2011.[14] The expected historical annual real house price return does not differ statistically from zero, reflecting that saved rent payments, rather than a high expected return, are the reward home owners receive for house-price risk. We therefore set the expected annual real house price return to $\mu_H = 0.0\%$. The historical annual volatility of the home price index is 5.4%. However, price changes for individual homes

[14] This home price index is publicly available on Robert Shiller's homepage: `http://www.econ.yale.edu/~shiller/data.htm`.

are far from perfectly correlated. The aggregation in the house price index therefore reduces house-price volatility, which we have to account for in our calibration. Case and Shiller (1989) argue that the annual volatility of individual house prices is close to 15%. Bourassa, Haurin, Haurin, Hoesli, and Sun (2009) find estimates of a similar magnitude. We therefore set house-price volatility to $\sigma_H = 15\%$. We set the risk-free rate to $r = 1.9\%$, the average real one-year Treasury Bill rate from 1953 to 2011.

We set the expected real stock return and its volatility to $\mu_S = 6.1\%$ and $\sigma_S = 16.4\%$, the empirical estimates using the S&P 500 index from 1953 to 2011. We set the correlation between stock returns, housing returns, and labor income to match the empirical evidence. More specifically, we set the correlation between log-stock returns and log-house returns to $\rho_{SH} = 0.22$, the historical correlation of the return on the S&P 500 and the Case Shiller Home Price Index from 1953 to 2011. We set the correlation between stock and labor income shocks to $\rho_{SL} = 0.2$, the empirical estimate of Cocco (2005), thus reflecting on the generally low correlation between the stock and the labor market for individual households, essentially making labor-income risk unspanned risk. We set the correlation between house price and labor income shocks to $\rho_{HL} = 0.55$, the empirical estimate of Cocco (2005). We set the home equity requirement to $\kappa = 20\%$. The rent rate, moving costs, and the costs of trading an owner-occupied home are set to $\delta^r = 6.0\%$, $\delta^m = 1.5\%$, and $\tau = 6.0\%$, respectively, as in Yao and Zhang (2005).

We estimate the income processes separately for single males, single females, and married individuals using the 1980 to 2009 waves of the PSID for high school graduates. Our estimation closely follows Cocco, Gomes, and Maenhout (2005) and Love (2010) and is outlined in detail in Appendix B. The coefficients reported in Table 3 are of a similar order of magnitude as those estimated by Love (2010), yet reflecting that our coefficients are estimated using the PSID data until 2009, thus also covering the recent financial crises.

At age 20 ($t = 0$), individuals are single and have no children. We normalize their initial net worth to one. We set the maximum household age to 95 ($T = 75$) because estimates for the

Table 3
Labor income process

Description	Male	Female	Married
Fitted age polynomials			
Constant	-1.6629	-0.8150	-0.9571
Age	0.1266	0.0607	0.0678
Age^2 / 100	-0.2131	-0.0540	-0.0450
Age^3 / 10,000	0.1013	-0.0064	-0.0314
Replacement rate	0.9512	0.9462	0.9482
Coefficient estimates			
Children age 0-1	-0.0699	-0.0312	-0.0261
	(0.1274)	(0.0281)	(0.0074)
Children age 2-4	0.0182	-0.0200	-0.0277
	(0.0846)	(0.0204)	(0.0062)
Children age 5-7	0.0230	0.0080	-0.0177
	(0.0613)	(0.0193)	(0.0063)
Children age 8-10	-0.0243	0.0320	-0.0070
	(0.0532)	(0.0195)	(0.0066)
Children age 11-12	-0.0568	0.0764	0.0122
	(0.0570)	(0.0216)	(0.0083)
Children age 13-15	-0.0530	0.0899	-0.0101
	(0.0501)	(0.0192)	(0.0077)
Children age 16-18	-0.0212	0.0994	0.0069
	(0.0608)	(0.0243)	(0.0100)
Constant	9.6312	9.3061	10.0316
	(0.0529)	(0.0466)	(0.0363)
N	4,852	6,848	25,752
R-squared	0.0761	0.1055	0.1119
Standard deviation permanent shock	0.0259	0.0122	0.0118
	(0.0040)	(0.0017)	(0.0012)

This table summarizes the estimated coefficients for the labor income process of single males, single females, and married couples for households whose head has a high school degree. Results are based on fixed-effects regressions described in detail in Appendix B. Standard errors are reported in parentheses.

probability of getting married become noisy thereafter. We set adult retirement age to $t_r = 45$, indicating households retire at the age of 65. Mortality rates are taken from the 2007 Period Life Table published by the US Social Security Administration. Birth rates are constructed as in Love (2010), using fertility data published in a US National Center for Health Statistics report (Mathews and Ventura, 1997, Table 5, page 13). The report publishes birth rates by race, education, and marital status for different age brackets. Fertility rates for ages 20 through 40 are estimated by fitting a third-degree polynomial (evaluated at the median age in each bracket) through the reported probabilities.

We construct the probabilities of marriage and divorce using the 2001 Survey of Income and Program Participation. The survey publishes data on transitions into marriage for unmarried individuals and divorce transitions for married individuals by gender for the different age brackets. We estimate separately the probabilities of marriage and divorce for ages 20 through 95 for men and women by again fitting a third-degree polynomial through the reported probabilities (evaluated at the median age in each bracket).

For the payment of child support and college costs, we follow the modeling in Love (2010). That is, we model child support by adopting the income-sharing formulas prevalent in most US states. For children under 18, the noncustodial parent pays a constant share of income: 17% for one child, 25% for two children, 29% for three children, 31% for four children, and 33% for five or more children. The ratio for the male parent's income to the female parent's income is assumed to be given by the ratio of the expected incomes implied by our parameter estimates from Table 3 at the corresponding age. In case of a divorce, children typically stay with their mothers. We therefore assume the noncustodial parent is male, and focus our analysis on female investors.[15]

We assume children attend college from ages 18 to 22. Following the empirical estimates of Turly and Desmond (2011), we assume married couples spend 9% of income per year on each child's college eduction, whereas single parents spend only 7%. Following Love (2010),

[15]We also explored settings where we focused our analysis on male investors. Given that our model is able to match Empirical Findings 1 to 3 irrespective of the individual's sex, we do not report these results here in detail.

Table 4
Base-case parameter values

Description	Parameter	Value	Source
Degree of risk aversion	γ	5	Yao and Zhang (2005)
Housing preference	ψ	0.2	Yao and Zhang (2005)
Utility discount factor	β	0.96	Yao and Zhang (2005)
Strength of bequest motive	b	1	De Nardi (2004)
Maximum length of investment horizon	T	75	Own choice
Adult retirement age	t_r	45	Cocco (2005)
Risk-free rate	r	1.9%	Own estimation
Expected return stock	μ_S	6.1%	Own estimation
Volatility stock return	σ_S	16.4%	Own estimation
Expected housing return	μ_H	0.0%	Own estimation
Volatility housing return	σ_H	15%	Case and Shiller (1989)
Correlation stocks housing	ρ_{SH}	22%	Own estimation
Correlation stocks labor	ρ_{SL}	20%	Cocco (2005)
Correlation housing labor	ρ_{HL}	55%	Cocco (2005)
Minimum housing downpayment	κ	20%	Yao and Zhang (2005)
Renting costs rate	δ^r	6.0%	Yao and Zhang (2005)
Rate of maintenance costs	δ^m	1.5%	Yao and Zhang (2005)
Home purchasing costs	τ	6.0%	Yao and Zhang (2005)
Penalty children renters	ζ	6.08%	Kiyotaki et al. (2011)

we assume the function η, describing the household size adjusted for economies of scale, to be given by $\eta(M_t, N_t) = (1 + M_t + 0.7N_t)^{0.7}$, where M_t is the marital status and N_t is the number of children living in the household during period t. We set the penalty term for households with children living in a rented home to $\zeta = 6.08\%$, corresponding to the housing preference parameter used by Kiyotaki, Michaelides, and Nikolov (2011). We set the coefficient of relative risk aversion and the utility discount factor to $\gamma = 5$ and $\beta = 0.96$, respectively, as in Yao and Zhang (2005). We set the utility discount factor to $\psi = 0.2$, the empirical estimate of Yao and Zhang (2005). Hurd (1989) shows that the strength of the bequest motive is low. Yet the results in De Nardi (2004) suggest it should be positive. We therefore set it to $b = 1$. Table 4 summarizes our parameter choices.

4 Family Structure and Optimal Housing Decisions

In this section, we illustrate the impact of household family structure on optimal household decisions over the life cycle. Simultaneously, we demonstrate our model's ability to replicate the empirical evidence on the impact of family structure on housing decisions summarized in our Empirical Findings 1 to 3. In sections 4.1 and 4.2, we first show how the marital status and the number of children living in a household affect households' housing, consumption, and portfolio decisions. In section 4.3, we study the instant effects of changes in family structure on household decisions. The long-term effects are assessed in section 5. All results reported throughout are based on 10,000 simulations on the respective optimal paths. The initial distribution of the income-to-net-worth ratio, the homeownership status, and the housing-to-net-worth ratio at age 20 ($t = 0$) is drawn from its joint empirical distribution in the PSID data.

4.1 Marital Status

Individuals' marital status has important implications for their financial situation. First, married individuals' household net worth is usually higher than singles', thus better protecting the households against financial shocks. Second, married households' labor income is subject to lower volatility than singles', because individuals' labor income streams are typically far from perfectly correlated. In particular, in case of an individual's job loss, the partner's labor income provides a certain degree of financial protection. As a consequence, married individuals can better handle temporary periods of unemployment. Third, married individuals benefit from economies of scale. For example, married individuals usually share one kitchen, whereas two singles typically have one kitchen each. On the other hand, married individuals face divorce risk and the negative financial consequences resulting from divorce.

In Table 5, we illustrate the impact of the marital status on optimal household decisions. The table reports the homeownership rate (Ownership), the housing-to-net-worth ratio of homeowners (H/W), the consumption-to-net-worth ratio (C/W), the share of net worth invested in stocks

Table 5
Marital status and household decisions

Age	Ownership		H/W		C/W		S/W		Net worth	
	Mar	Sin	Mar	Sin	Mar	Sin	Mar	Sin	Mar	Sin
20-29	11%	8%	0.52	0.74	0.26	0.39	0.66	0.50	4.37	1.52
	(31%)	(28%)	(0.19)	(0.39)	(0.08)	(0.13)	(0.09)	(0.15)	(2.02)	(0.67)
30-39	38%	14%	0.51	0.51	0.17	0.22	0.74	0.70	9.72	4.11
	(49%)	(35%)	(0.13)	(0.15)	(0.05)	(0.06)	(0.05)	(0.06)	(6.40)	(2.72)
40-49	87%	57%	0.47	0.50	0.13	0.16	0.73	0.72	18.94	8.51
	(33%)	(49%)	(0.14)	(0.14)	(0.04)	(0.06)	(0.06)	(0.06)	(17.17)	(7.46)
50-59	94%	77%	0.44	0.48	0.12	0.14	0.70	0.70	25.73	12.80
	(23%)	(42%)	(0.14)	(0.14)	(0.04)	(0.06)	(0.07)	(0.07)	(26.47)	(14.16)
60-69	98%	93%	0.50	0.53	0.12	0.13	0.67	0.67	31.71	18.46
	(15%)	(26%)	(0.19)	(0.21)	(0.05)	(0.06)	(0.08)	(0.08)	(37.11)	(21.67)
$\geq$70	96%	83%	0.68	0.68	0.18	0.19	0.55	0.48	31.30	20.87
	(19%)	(38%)	(0.27)	(0.26)	(0.09)	(0.12)	(0.12)	(0.13)	(44.54)	(30.79)

The table shows the impact of marital status on household decisions for households with no children living at home. It reports the homeownership rate (Ownership), the housing-to-net-worth ratio of homeowners (H/W), the consumption-to-net-worth ratio (C/W), the share of net worth invested in stocks (S/W), and household net worth (Net worth) for married female individuals (Mar) and singles (Sin). All results reported are averages from 10,000 simulations on the optimal paths and conditional on the individual's survival. Standard deviations are reported in parentheses.

(S/W), and household net worth (Net worth) for married individuals (Mar) and singles (Sin). To isolate the impact of the marital status, we focus on households with no children. Our results show that optimal housing, consumption, and portfolio decisions of married and single individuals differ significantly.

First, matching Empirical Finding 1, homeownership is more prevalent among married than singles. In other words, the differences in the financial endowments of married and single individuals as well as the differences in the risks of their labor-income streams cause married individuals to invest more frequently than singles in owner-occupied homes.[16] For instance, 87% of married individuals aged 40 to 49 live in owner-occupied homes, whereas only 57% of singles do.

Second, married individuals tend to spend smaller shares of their net worth on housing. The housing-to-net-worth ratio (H/W) of homeowners is typically higher for single households, reflecting the economies of scale from living together.

Third, married individuals tend to spend a smaller share of household net worth on consumption than singles. Again, this result is affected by economies of scale from living together. However, the relative extent by which the consumption-to-net-worth ratio typically exceeds the housing-to-net-worth ratio is larger, thus suggesting additional causes. Indeed, given that married individuals are more likely to have children, they have a stronger precautionary savings motive. Simultaneously, they care about what their partners' well-being will be after their own death. Hence, they tend to build up larger savings and assign a higher weight to their home as an investment good. Finally, married individuals' higher shares of household net worth invested in stocks and lower shares invested in owner-occupied homes generally result in a higher degree of diversification.

[16]Our results also show that explicitly modeling family structure helps generate more dispersion in the share of households that own homes relative to models in which family size is fix. Yet ownership rates for older households in our model still exceed their empirical counterparts – a result that should be heavily driven by our simulations focusing on one representative individual with a given set of preferences. Empirical homeownership rates, however, aggregate over individuals that exert a high degree of heterogeneity in preferences. Vestman (2012) shows that allowing for such heterogeneity in preferences can generate a higher degree of dispersion in household savings and homeownership rates.

Table 6
Children and household decisions

	Ownership		H/W		C/W		S/W		Net worth	
Age	Chi	No	Chi	No	Chi	No	Chi	No	Chi	No
20-29	23%	11%	0.72	0.52	0.27	0.26	0.62	0.66	4.93	4.37
	(42%)	(31%)	(0.22)	(0.19)	(0.07)	(0.08)	(0.07)	(0.09)	(2.21)	(2.02)
30-39	72%	38%	0.62	0.51	0.20	0.18	0.67	0.74	9.87	9.72
	(45%)	(49%)	(0.18)	(0.13)	(0.06)	(0.05)	(0.07)	(0.05)	(6.61)	(6.40)
40-49	89%	87%	0.54	0.47	0.18	0.13	0.69	0.73	15.60	18.94
	(31%)	(33%)	(0.16)	(0.14)	(0.06)	(0.04)	(0.07)	(0.06)	(12.82)	(17.17)
50-59	93%	94%	0.52	0.44	0.16	0.12	0.69	0.70	19.97	25.73
	(25%)	(23%)	(0.16)	(0.14)	(0.06)	(0.04)	(0.07)	(0.07)	(19.20)	(26.47)

This table shows the impact children living at home have on household decisions for married female individuals. It reports the homeownership rate (Ownership), the housing-to-net-worth ratio of homeowners (H/W), the consumption-to-net-worth ratio (C/W), the share of net worth invested in stocks (S/W), and household net worth (Net worth) for households with children (Chi) and without children (No). All results reported are averages from 10,000 simulations on the optimal paths and conditional on survival. Standard deviations are reported in parentheses.

4.2 Children

Having studied how an individual's marital status affects optimal household consumption, housing, and portfolio decisions, we next turn to studying how children affect these decisions. Even though having a child and moving in together when getting married both result in an increase in family size, the financial consequences are quite different. Specifically, whereas marriages positively affect household net worth and income, births do not have direct wealth or income effects. Hence, marital status and children should affect optimal household decisions through different channels.

In Table 6, we illustrate how optimal household decisions differ between households with and without children. We report the homeownership rate (Ownership), the housing-to-net-worth ratio of homeowners (H/W), the consumption-to-net-worth ratio (C/W), the share of net worth invested into stocks (S/W), and household net worth (Net worth) for households with children (Chi) and without children (No). To control for the impact of marital status on household decisions, all results reported are for married households only.[17] Our results in Table

[17]The assumption that mothers beyond age 40 are not giving birth to children, combined with the assumption that children are leaving home at age 18, implies that households in the 60-69 and 70 and older age groups have

6 stress that children significantly affect optimal household decisions.

Households with children are more likely to be homeowners, reflecting the well-documented positive externalities of growing up in an owner-occupied home on childrens' future outcomes (Green and White, 1997; Haurin, Parcel, and Haurin, 2002). For instance, our model predicts that 72% of married individuals aged 30 to 39 with children optimally live in owner-occupied homes, whereas only 38% of those without children do. In the 50-59 age group, however, homeownership rates are slightly lower for families with children, reflecting the significant costs of raising them and the thereby implied lower level of household savings.

Matching Empirical Finding 2, households with children invest a larger share of their net worth in owner-occupied homes due to the higher demand for living space. To avoid a too high overall level of risk, they invest a smaller share of their net worth in stocks. Simultaneously, the larger family size causes households with children to spend a larger share of their net worth on consumption. As a consequence, older households with children have lower levels of net worth than their counterparts without.

4.3 Changes in Family Composition and Homeownership Status

Changes in family composition are events that typically affect the demand for living space. In particular, singles getting married and moving in together, as well as births of children, generally increase the demand for living space, whereas divorces typically decrease it. As a consequence, newly married, households with newly-born children, and newly divorced households should be more likely to move than others. More specifically, Empirical Finding 3 suggests that newly married households and households with newly-born children are more likely to acquire homeownership, whereas newly divorced individuals are more likely to abandon it. Table 7 illustrates how changes in family composition affect the propensity to change homeownership status. We show how marriage affects the probability of becoming a homeowner (Panel A), how divorce affects the likelihood of abandoning homeownership (Panel B), and how the birth

no children living at home.

Table 7
Changes in homeownership status

	Panel A: Become owner		Panel B: Become renter		Panel C: Become owner	
Age	Just married	Others	Just divorced	Others	Newly-born	Others
20-29	8.34%	1.95%	15.68%	0.17%	5.19%	1.96%
30-39	33.41%	5.06%	47.94%	0.21%	12.30%	5.77%
40-49	21.31%	2.46%	47.84%	0.24%	—	—
50-59	6.44%	1.76%	18.03%	0.16%	—	—
60-69	2.07%	1.04%	4.98%	0.15%	—	—
≥70	0.00%	0.09%	2.96%	2.64%	—	—

This table shows the impact of changes in family structure on the (annual) probability of a female individual to change homeownership status. Panel A depicts the impact of being married within the last year (Just married) on the probability of becoming a homeowner. Panel B reports the impact of being divorced within the last year (Just divorced) on the probability of moving from an owned to a rented home. Panel C depicts the impact of having a child within the last year (newly-born) on the probability of becoming a homeowner. All results reported are conditional on the individual's survival.

of a child affects the probability of becoming homeowner (Panel C).

Our results in Table 7 confirm Empirical Finding 3 that newly married individuals and households with newly-born children are more likely to acquire homeownership, whereas newly divorced individuals are more likely to abandon it. For example, more than 33% of newly married households aged 30 to 39 acquire an owner-occupied home, whereas less than 6% of other households do. Our results further show that households with newly-born children are more likely to move to owner-occupied homes than their counterparts without. For example, in the 30-39 age group, 12% of households with newly-born children move to owner-occupied homes, whereas only 6% of other households do. For households getting divorced, we observe that divorces for younger and middle-aged households significantly increase the probability of abandoning homeownership. For instance, in the 30-39 age group, 47% of the just-divorced individuals abandon homeownership, whereas less than 1% of other households do. Effects for older households are smaller, reflecting that these households typically have higher savings that enable them to repurchase smaller homes after a divorce. As individuals age, their levels of household net worth tend to increase, thus enabling them to remain homeowners even after a divorce. This can also help us understand why homeownership rates increase over the life cycle.

Overall, our results in sections 4.1 to 4.3 show that family structure and changes in it heavily affect optimal housing decisions. Simultaneously, our results demonstrate our model's ability to replicate the empirical evidence summarized in Empirical Findings 1 to 3.

5 The Long-Term Effects of Changes in Family Composition

Having demonstrated our model's ability to replicate important features of the data – namely, the impact of family composition on households' instant housing, consumption, and portfolio decisions, we next turn to studying the long-term effects of changes in family composition. More specifically, we assess how marriage, divorce, and birth affect the long-term demand for homeownership, consumption levels, and household net worth.

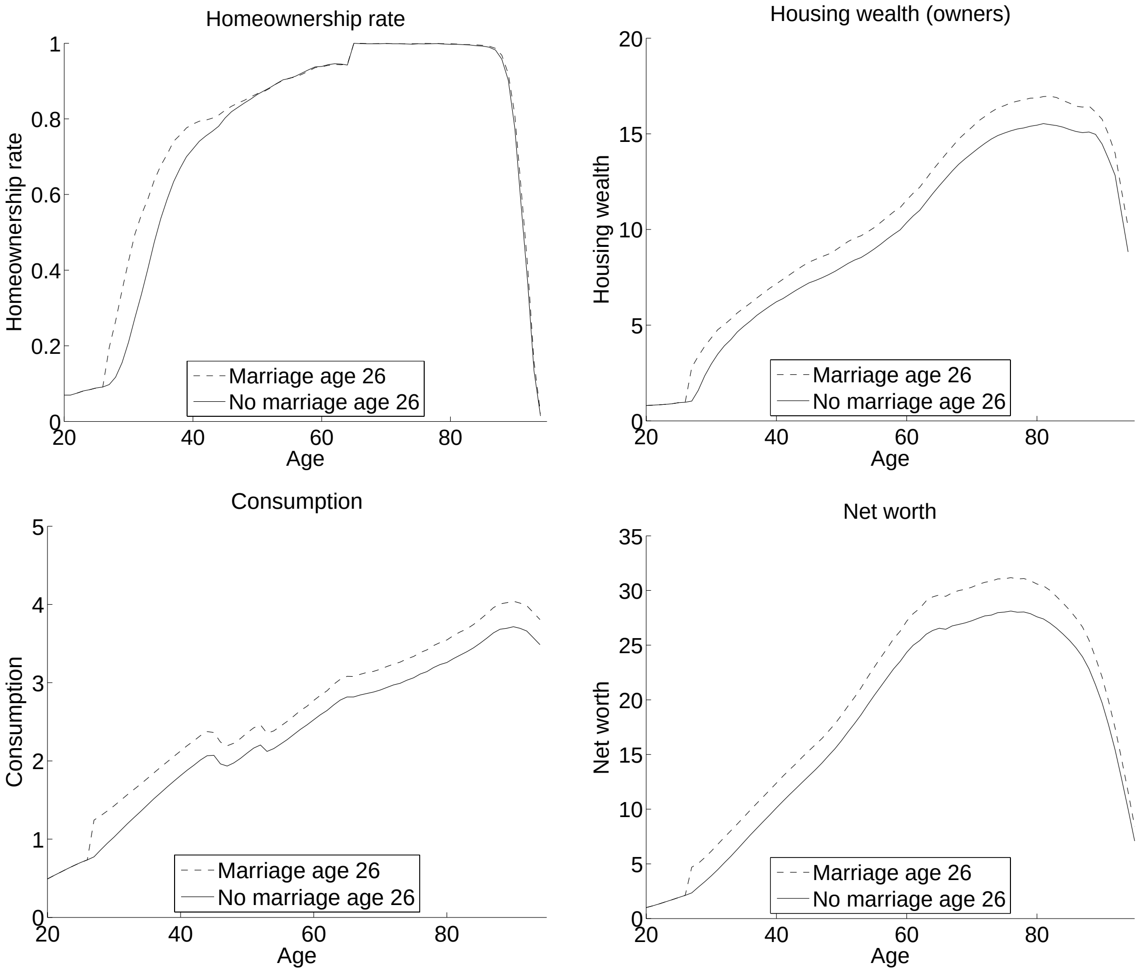
Whereas our empirical evidence in section 2 and Öst (2012) show that changes in family structure affect instant household decisions, evidence on the long-term effects of changes in family composition on the demand for housing is scarce. In this section, we employ our model to investigate these long-term consequences.

5.1 Marriages

We explore the long-term effects of marriage on homeownership decisions, housing wealth, consumption, and household net worth. More specifically, we explore the long-term impact of marriage at age 26, the median first-marriage age of females (Elliott, Krivickas, Brault, and Kreider, 2012).[18] In Figure 1, we therefore focus on the subsample of our 10,000 simulated paths where the individual is single when turning 26 and compare the evolution of homeownership rates (upper left panel), housing wealth of homeowners (upper right panel), consumption (lower left panel), and household net worth (lower right panel) when individuals get married at age 26 (dashed lines) with results when they do not (solid lines). Our results point to three key effects.

[18] We also explored the impact of shocks to the marital status at other ages. The results do not differ qualitatively. We therefore do not report them here. They are, however, available from the authors upon request.

Figure 1
Impulse-response analysis: Marriage at age 26



This figure depicts the impact of getting married at the age of 26 on homeownership rates (upper left panel), housing wealth of homeowners (upper right panel), consumption level (lower left panel), and household net worth (lower right panel) for a female individual. All results reported are averages from the simulated paths, where the individual is single when turning 26. The dashed lines show results when the individual get married at age 26; the solid lines show results when the individual does not.

First, confirming Empirical Finding 1, married individuals are more likely to live in owner-occupied homes, reflecting that married individuals are endowed with higher household net worth and income but lower labor-income risk. Our results show a strong, long-lasting relationship between marital status and homeownership. Homeownership rates of individuals who get married at age 26 and of those who stay single take more than a decade to reach similar levels. Furthermore, the quantitative impact of getting married on homeownership rates is substantial. For instance, 42% of individuals who got married at age 26 are homeowners at the age of 30, whereas only 21% of those who stayed single are. These significant differences in homeownership rates combined with individuals getting married later in life can also help explain the declining homeownership rates among younger households (Fisher and Gervais, 2011).

Second, households of married individuals own larger homes and consume more, because the increase in family size resulting from marriage increases the demand for both consumption and home size. Simultaneously, marriage results in an increase in household net worth and income, thus making higher consumption levels and larger home sizes attainable.

Third, marriage has a positive and permanent impact on household net worth, despite the fact that marriages may end in divorce and that individuals who are single at the age of 26 can get married at a later point in time. That is, the shares of households being married under the two different scenarios converge as age increases. For example, 92% of individuals who got married at the age of 26 are married at age 30, whereas only 27% of those who stayed single at 26 are. At the age of 60, however, these shares have converged to 70% and 66%, respectively. Yet households getting married at the age of 26 happen to permanently have higher wealth levels, reflecting that married individuals living together benefit from economies of scale that enable them to attain the same level of welfare at a lower level of expenses per individual than singles. As a consequence, marriage not only has a positive effect on household net worth at the moment of marriage, but also has a permanent positive impact on household net worth for which getting married at a later point in time cannot compensate.

5.2 Divorces

In this section, we investigate the long-term consequences of divorces for housing demand, consumption, and household net worth. More specifically, we investigate the impact of getting divorced at age 30, the median age at the first divorce for females in 2009 according to the US Census Bureau.[19] We therefore focus on the subsample of our 10,000 simulated paths where the individual is married when turning 30, and compare the evolution of homeownership rates (upper left panel), homeowners' housing wealth (upper right panel), consumption (lower left panel), and household net worth (lower right panel) when individuals get divorced at age 30 (dashed lines) and when they do not (solid lines). Our results in Figure 2 show that many of the effects for marriages are reversed and quantitatively enhanced.

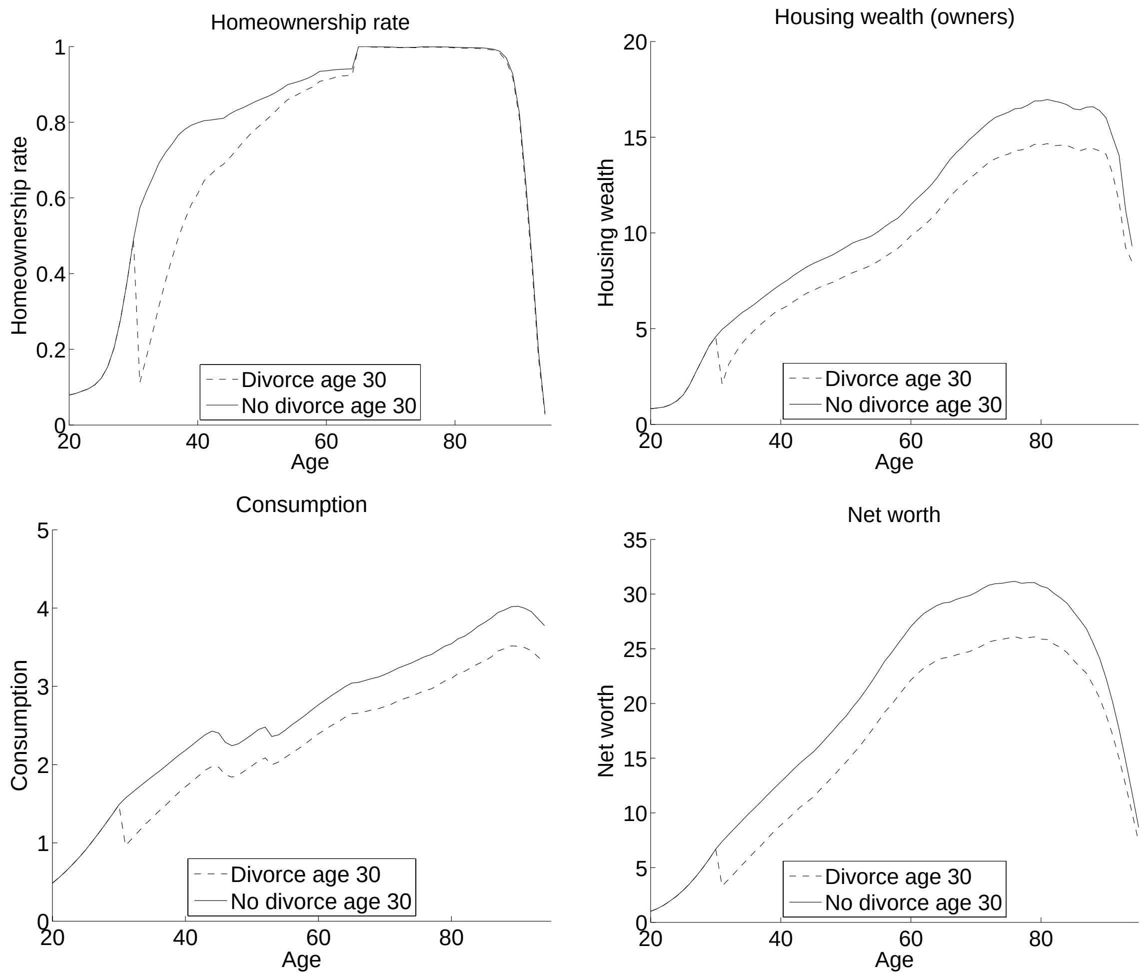
First, whereas our results in section 5.1 show that marriage increases homeownership rates, our results in Figure 2 show that divorce heavily decreases the demand for homeownership. This results is in line with Empirical Finding 3 and reflects that divorce implies a rapid decrease in household net worth and income. Simultaneously, a single's labor income is typically subject to higher volatility than a household's. As a consequence, homeownership rates drop significantly when individuals get divorced. For instance, 38% of individuals getting divorced at age 30 are homeowners at age 35, whereas 72% of those not getting divorced are. Furthermore, our results show that divorce has long-lasting effects on homeownership rates. Specifically, homeownership rates take more than three decades to return to the level that would have been attained without a divorce.

Second, divorced individuals live in smaller homes and consume less. Similar to our results for marriages in section 5.1, the changes in household net worth and income at the time of divorce heavily drive these results. Specifically, divorces reduce both household net worth and income, thus making high consumption levels and home sizes unattainable.

Third, divorces have a negative and permanent impact on household net worth. Even though

[19]We also explored the impact of divorces at other ages. Given that these did not qualitatively affect our results, they are not reported here. They are, however, available from the authors upon request.

Figure 2
Impulse-response analysis: Divorce at age 30



This figure depicts the impact of getting divorced at the age of 30 on homeownership rates (upper left panel), housing wealth of homeowners (upper right panel), consumption level (lower left panel), and household net worth (lower right panel) for a female individual. All results reported are averages from the simulated paths, where the individual is married when turning 30. The dashed lines report results when the individual gets divorced at the age of 30, the solid lines when the individual does not.

divorced individuals may end up remarrying and individuals not getting divorced at the age of 30 may get divorced at a later point in time. Married individuals living together benefit from economies of scale that enable them to attain the same level of welfare at a lower level of expenses than singles. Hence, divorces affect household net worth at the time of the divorce not only negatively but also permanently, because they prevent individuals from benefiting from economies of scale.

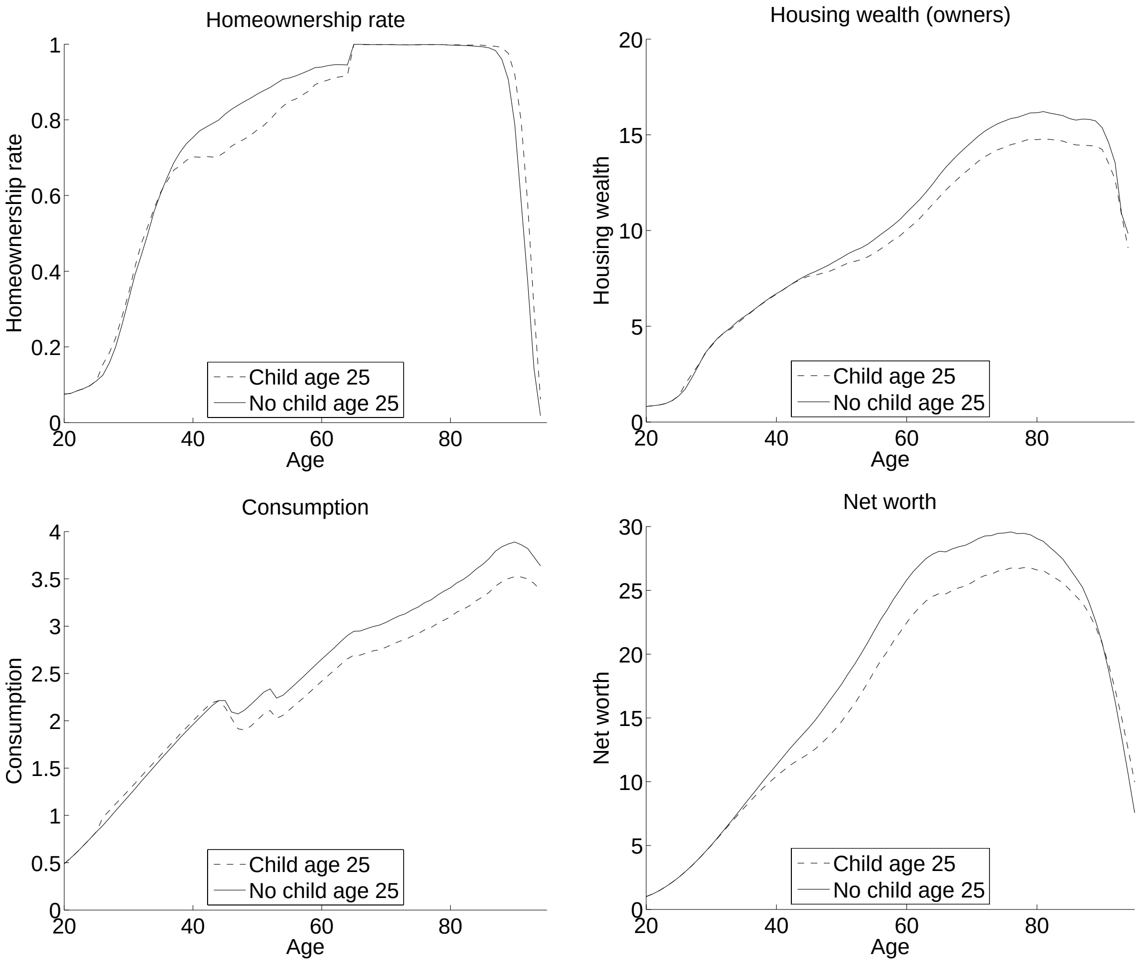
The welfare effects of divorce are substantial. The average certainty equivalent welfare loss from getting divorced at age 30 is as high as 13% of present net worth and permanent income. That is, individuals getting divorced at age 30 require an average increase of 13% in net worth and permanent income to attain the same level of expected present discounted utility as individuals staying married. In other words, the possibility of divorce is an important risk factor.

Divorce risk is unique in the sense that it is only of direct relevance for married individuals. That is, married individuals are subject to an additional risk factor. On the other hand, they face economies of scale and a lower volatility in their labor income stream. These benefits are accumulating while one is married. The costs of getting divorced, however, are one-time costs. Hence, even if married individuals get divorced after having been married for many years, they may be better off financially than individuals who never married. More specifically, individuals who get married at the age of 26 have to remain married until at least age 31 to attain a higher level of expected utility than individuals who do not get married until that age.

5.3 Children

In this section, we investigate the long-term financial consequences of the births of children. Specifically, we investigate the impact of giving birth to a child at age 25, the average age of first-time mothers in 2009 as reported by the National Center for Health Statistics. To do so, we compare results from our 10,000 simulated paths under the assumption that a child is born when the mother is 25 (dashed lines) with results under the assumption that the mother did not

Figure 3
Impulse-response analysis: Child at age 25



This figure depicts the impact of having a child at the age of 25 on homeownership rates (upper left panel), housing wealth of homeowners (upper right panel), consumption level (lower left panel), and household net worth (lower right panel) for a female individual. All results reported are averages from 10,000 simulated paths. The dashed lines show results for households when a child is born while the mother is 25, the solid lines when no child is born at that age.

have a child at that age (solid lines).[20] The upper left graph in Figure 3 reports the impact on the homeownership rate, the upper right graph on homeowners' housing wealth, the lower left graph on consumption expenses, and the lower right graph on household net worth. Our results in Figure 3 point to two main findings.

First, the births of children have a slightly positive instant effect on homeownership rates, reflecting on the empirical evidence that households generally prefer to see their children grow up in a good environment. In the long run, however, our model predicts that homeownership

[20]We also explored the impact of births of children at other ages. Given that these births did not qualitatively affect our results, we do not report them here. They are, however, available from the authors upon request.

rates of households giving birth to a child are somewhat lower, a result of the high costs of raising children and the thereby implied lower household savings.

Second, we find no significant immediate impact on consumption levels and homeowners' housing wealth while children are small. However, the high costs of raising children and the thereby implied lower levels of savings cause households to choose lower consumption levels and home sizes once children have left home.

Overall, our results in sections 5.1 to 5.3 show that changes in family structure have important long-term effects on the demand for housing. In particular, marriage increases homeownership rates over decades and permanently increases home sizes and household net worth. For divorce, these effects are reversed and quantitatively enhanced, whereas births of children have a slightly positive instant but a negative long-term effect.

6 Robustness Analysis

Having demonstrated the long-term effects of changes in family structure on consumption, household net worth, and the demand for housing, in sections 6.1 and 6.2, we next turn to demonstrating how the recent trend toward getting married and having children later in life affect households optimal housing decisions. Understanding how these trends affect the demand for owner-occupied homes is important given that owner-occupied homes are typically households' largest assets. In section 6.3, we investigate the impact of changes in divorce rates. In section 6.4, we demonstrate how getting married to a significantly richer partner affects the evolution of housing demand over the life cycle. All results reported are based on 10,000 simulated paths and are summarized in Table 8.

6.1 Later Marriages

Over the last several decades, we have observed a trend toward getting married later. For instance, from 1970 to 2009, the median first-time marriage age of females increased from

Table 8
Robustness results

Age	Observation	Base case	Marriage	Divorce	Children	Richer
20-29	Ownership	13%	13%	12%	11%	19%
		(33%)	(33%)	(32%)	(31%)	(39%)
	H/W	0.70	0.70	0.67	0.69	0.71
		(0.29)	(0.29)	(0.29)	(0.30)	(0.26)
	C/W	0.36	0.36	0.35	0.37	0.35
		(0.13)	(0.13)	(0.13)	(0.13)	(0.14)
	S/W	0.56	0.57	0.58	0.55	0.57
		(0.14)	(0.14)	(0.14)	(0.15)	(0.14)
	Net worth	2.48	2.27	2.52	2.38	2.85
		(1.84)	(1.61)	(1.88)	(1.77)	(2.53)
30-39	Ownership	56%	52%	51%	55%	66%
		(50%)	(50%)	(50%)	(50%)	(48%)
	H/W	0.61	0.61	0.58	0.60	0.59
		(0.17)	(0.18)	(0.16)	(0.17)	(0.18)
	C/W	0.22	0.22	0.21	0.21	0.21
		(0.07)	(0.07)	(0.06)	(0.06)	(0.07)
	S/W	0.69	0.70	0.71	0.70	0.70
		(0.07)	(0.06)	(0.06)	(0.07)	(0.07)
	Net worth	7.81	7.23	7.83	7.86	9.10
		(6.08)	(5.71)	(6.07)	(6.18)	(7.56)
40-49	Ownership	80%	79%	77%	84%	84%
		(40%)	(41%)	(42%)	(37%)	(37%)
	H/W	0.53	0.53	0.52	0.52	0.52
		(0.17)	(0.17)	(0.16)	(0.16)	(0.16)
	C/W	0.18	0.18	0.18	0.17	0.17
		(0.08)	(0.08)	(0.08)	(0.07)	(0.08)
	S/W	0.70	0.70	0.70	0.71	0.70
		(0.08)	(0.07)	(0.07)	(0.07)	(0.07)
	Net worth	13.81	13.27	13.54	14.56	15.93
		(13.27)	(12.83)	(13.08)	(13.77)	(15.67)
50-59	Ownership	90%	90%	88%	92%	92%
		(30%)	(30%)	(32%)	(27%)	(27%)
	H/W	0.46	0.46	0.46	0.46	0.45
		(0.15)	(0.15)	(0.15)	(0.15)	(0.15)
	C/W	0.13	0.13	0.13	0.13	0.13
		(0.06)	(0.06)	(0.06)	(0.06)	(0.06)
	S/W	0.69	0.70	0.70	0.69	0.68
		(0.07)	(0.07)	(0.07)	(0.07)	(0.07)
	Net worth	20.97	20.44	20.24	21.86	24.16
		(23.37)	(22.97)	(22.77)	(23.93)	(27.00)
60-69	Ownership	97%	97%	97%	97%	98%
		(17%)	(17%)	(18%)	(16%)	(14%)
	H/W	0.51	0.51	0.51	0.51	0.49
		(0.20)	(0.19)	(0.20)	(0.19)	(0.19)
	C/W	0.12	0.12	0.13	0.12	0.12
		(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
	S/W	0.67	0.67	0.67	0.67	0.66
		(0.08)	(0.08)	(0.08)	(0.08)	(0.08)
	Net worth	27.18	26.55	26.01	28.04	31.64
		(33.26)	(32.77)	(31.96)	(33.99)	(38.82)
≥ 70	Ownership	87%	87%	87%	86%	87%
		(33%)	(34%)	(34%)	(35%)	(33%)
	H/W	0.68	0.69	0.69	0.69	0.66
		(0.26)	(0.26)	(0.26)	(0.26)	(0.25)
	C/W	0.18	0.18	0.19	0.19	0.17
		(0.11)	(0.11)	(0.11)	(0.12)	(0.11)
	S/W	0.51	0.50	0.51	0.50	0.50
		(0.13)	(0.13)	(0.13)	(0.13)	(0.13)
	Net worth	25.37	24.72	24.19	25.75	30.11
		(37.28)	(36.62)	(35.14)	(37.75)	(45.45)

This table reports the evolution of households' homeownership rates (Ownership), homeowners' housing-to-net-worth ratios (H/W), consumption-to-net-worth ratios (C/W), stocks-to-net-worth ratios (S/W), and net worth over the life cycle. Results are shown for our base-case parameter setting (Base case), a setting where individuals tend to get married later (Marriage), a setting with higher divorce rates (Divorce), a setting where individuals tend to have children later in life (Children), and a setting where individuals marry a richer partner (Richer). Standard deviations are reported in parentheses.

20.8 to 25.9 years. In this section, we investigate how getting married later in life affects the demand for homeownership over the life cycle. More specifically, following the recent demographic trend, we increase the median first-time marriage age to 30 years.[21]

Our results in Table 8 point to two key effects of getting married later. First, homeownership rates of younger households tend to be lower given that single individuals' labor income is subject to higher volatility than married individuals'. For instance, only 52% of households aged 30 to 39 live in owner-occupied homes, whereas 56% do in our base-case parameter setting. Second, levels of attained net worth tend to be slightly lower, reflecting that singles do not benefit from costs of scale from living together.

6.2 Higher Divorce Rate

From 1960 to 1980, the ratio of divorces to marriages increased from 26% to 49%. Since then, this divorce rate has not changed much. Yet our results in the previous sections show that the possibility of divorce is an important risk factor driving optimal household decisions. In this section, we therefore investigate how a further increase in divorce rates affects the demand for housing over the life cycle. Specifically, we investigate how a further increase in the ratio of divorces to marriages by 50%, namely, a ratio of about three quarters, affects the demand for housing over the life cycle.[22]

Our results in Table 8 show that an increase in divorce risk significantly affects household decisions. Because of the significant costs involved with trading owner-occupied homes, homeownership rates at young ages, where divorce rates are highest, are smaller than in our base case parameter setting. For instance, in our base-case parameter setting, 56% of households aged 30 to 39 are homeowners, whereas only 51% are once we allow for higher divorced rates. Also, conditional on owning, these households invest a smaller share of their net worth in their

[21]Technically, this increase is achieved by decreasing marriage rates by 40% for individuals below age 30. We also explored the impact of marrying even later. Given that this does not qualitatively affect our findings, we do not report these results here. They are, however, available from the authors upon request.

[22]We also explored the effects of decreases in divorce rates. Given that these settings essentially reverse the results reported here for increases in divorce rates, we do not report them here. They are, however, available from the authors upon request.

homes. To keep their overall portfolios diversified, these households substitute housing market with stock market risk. That is, they slightly increase their exposure to stocks. This finding is in contrast to the results in Love (2010), who finds that in the absence of owner-occupied homes as an asset class, female investors optimally decrease their equity exposures.

The costs of getting divorced also result in households' levels of attained net worth being slightly smaller in the long run, whereas they are slightly higher at young age due to a higher precautionary savings motive resulting from the increased divorce risk (González and Özcan, 2013). However, quantitatively, these effects are relatively small.

6.3 Having Children Later in Life

Simultaneously with getting married later in life, individuals have fewer children and tend to have them later. For instance, from 1970 to 2009, the median age of first-time mothers increased from 21.4 to 25.4 years. In this section, we analyze how the trend toward having children later in life affects the demand for housing over the life cycle. More specifically, we decrease birth rates of mothers below age 30 by 40% and increase birth rates of mothers aged 30 and older by the same rate, thus increasing the median age of first-time mothers to 29 and decreasing the average number of children per mother to 1.30.[23]

Our results in Table 8 show that the trend toward having children later in life has two main implications for the evolution of optimal household behavior over the life cycle. First, households acquire higher levels of net worth. Simultaneously, the housing-to-net-worth ratio is essentially unaffected, implying the demand for living space increases. Second, middle-aged households' homeownership rates increase. For instance, the homeownership rate of households aged 40 to 49 increases to 84% compared to 80% in our base-case parameter setting. This increase in homeownership rates is mainly driven through two channels. First, it reflects the generally higher levels of household net worth. Second, the number of children living in

[23]We also explored larger and smaller changes in birth rates. Given that these settings do not qualitatively alter our results, we do not report them here. They are, however, available from the authors upon request.

the households tends to be smaller, thus relaxing the households' financial constraints.

6.4 Marriage with Richer Partner

In our base-case parameter setting, we assumed individuals marry a partner with the same level of net worth as them. In this section, we demonstrate the robustness of our results to this assumption. More specifically, we assume individuals marry a partner twice as rich as them.[24]

Our results in Table 8 show that marrying a richer partner affects the evolution of optimal housing, consumption, and portfolio decisions. Probably the most important effect is the impact on household net worth. As a consequence, homeownership rates tend to be higher, especially for younger households for whom the richer partner's level of net worth can help relax the generally tightly binding borrowing constraints.

7 Conclusion

In this article, we set up a realistically calibrated life-cycle model that extends models with housing by explicitly taking family structure into account. Our model predicts that family composition significantly affects household decisions. Accounting for heterogeneity in life-cycle models is therefore important for a more nuanced understanding of household behavior, especially in a world of constantly changing demographics.

Our robustness analysis predicts that the current trend toward getting married and having children later in life alters the demand for homeownership over the life cycle. Later marriages result in lower homeownership rates, especially among younger households. Having children later in life, on the other hand, increases the demand for homeownership for middle-aged households.

A growing literature documents significant instant effects of changes in family composition on household decisions. Our model contributes to that literature by showing that changes in

[24]We also explored the effects of marriage to poorer partners. Given that this exercise essentially reverses the reported effects, we do not report these results here. They are, however, available from the authors upon request.

family composition also have significant long-term consequences. Specifically, marriage positively affects homeownership rates over several decades and leads to permanent increases in household net worth and home sizes. For divorce, these effects are reversed.

Welfare effects from getting divorced are significant, reflecting that marital status and homeownership are closely related to each other. Hence, the literature should take divorce risk as seriously as other risk factors, such as uncertainty in income, house prices, and financial assets. Integrating divorce risk in other life-cycle models is therefore an important avenue that we leave for further research.

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A Data Details

In our empirical analysis in section 2, we use micro-level data from the PSID along with its Wealth Supplements. Our data sample covers the time period in which data from the Wealth Supplements are available on a bi-annual basis, that is, the years 1999 to 2009. We exclude households in the Latino sample, the poverty sample, and the immigrant sample to keep our sample representative. We define household income as the sum of labor income and public transfers after taxes.[25] We do not include financial income or private transfers, because we explicitly model these in our work. That is, income includes wages, bonus payments, overtime payments, tips, commissions and earnings, pensions, working compensation, unemployment compensation, value food stamp benefits, TANF and other state program transfers, Supplemental Security Income payments, as well as other public welfare payments. Net worth is the sum of all assets (including the values of homes) minus all household debt. All monetary values reported are in 2008 dollars.

Similar to Love (2010), we restrict household income to be between \$3,000 and \$3,000,000 and household net worth to be positive. We further remove households with loan-to-net-worth ratios beyond 0.95, reflecting that these households are more likely to default on their mortgages (Mayer, Pence, and Sherlund, 2009). Likewise, we remove households with substantial debt relative to their net worth. Such households' behavior is likely to be significantly affected by their debt, which goes beyond the scope of our work.[26] Specifically, we remove households with a debt-to-net-worth ratio exceeding 20. We also remove observations with top-coded values, wild codes, and refused or ambiguous answers, such as households reporting they neither own nor rent the home in which they are living.

We construct the income-to-net-worth ratio as household income divided by the sum of household income and household net worth. This construction is in line with the income-to-net-worth ratio in our model, which is measured right after the receipt of income. Also, for the empirical analysis, our income-to-net-worth ratios have the desirable feature of being bounded from below and above by 0 and 1, respectively.

B Estimation of Labor-Income Process

Income data are available in the PSID beyond the waves with the Wealth Supplement. For estimating the income process, we use panel data from the 1980-2009 waves of the PSID. We split our sample of high school graduates into three groups: single males, single females, and married couples. The estimation of income-process characteristics closely follows the procedure outlined in Cocco, Gomes, and Maenhout (2005) and subsequently used by Love (2010). Income profiles for each group are constructed in two steps. First, we run a fixed-effects regression of the natural logarithm of income on a full set of age dummies and the number of children in different age brackets living in a household. Second, a polynomial of order three is fitted to the age-dummy coefficients.

We compute the replacement ratio for each group in two steps as in Cocco, Gomes, and Maenhout (2005). First, we run fixed-effects regressions of log income on age dummies for

[25] Taxes are not available in the PSID data for the time period considered in our analysis. We therefore use the TAXSIM software developed by Feenberg and Coutts (1993) to compute taxes. The TAXSIM software is publicly accessible on the NBER's homepage: `http://users.nber.org/~taxsim/`.

[26] This issue is, for instance, studied in more detail in Koijen, Van Hemert, and Van Nieuwerburgh (2009), Campbell and Cocco (2012), and Cocco (2013).

each demographic group separately. Second, based on these estimated dummies, we compute the average implied income for individuals aged 55-62 as a proxy for labor income prior to retirement. Likewise, we compute the average implied income for individuals aged 67-80 as a proxy for the first retirement income. The ratio between the latter and the former defines our replacement ratio. We estimate the variances of income shocks, using the procedure proposed by Carroll and Samwick (1997) and used in Cocco, Gomes, and Maenhout (2005) and Love (2010), among others.

C Solution of Model

We reduce the state space of the optimization problem by exploiting the homogeneity of the Cobb-Douglas function in C and Q. Defining $v = V/\left(W_t/H_t^{\psi}\right)^{1-\gamma}$, it holds that

$$
\begin{aligned}
& v\left(x_t, Y, t\right) \\
= & \sup_{\{c_t, q_t, I_t, \pi_t^s, \pi_t^b\}} U\left(c_t, q_t, M_t, N_t\right) \\
& + \beta \cdot \mathbb{E}\Bigg[M_t \Bigg\{ f_t \tilde{f}_t \left(\frac{\frac{W_{t+1}}{W_t}}{\left(\frac{H_{t+1}}{H_t}\right)^{\psi}}\right)^{1-\gamma} \left(\frac{1}{2} v\left(x_{t+1}, Y, t+1\right) + \frac{1}{2} v\left(x_{t+1}, \tilde{Y}, t+1\right)\right) \\
& + f_t\left(1-\tilde{f}_t\right) \left(\frac{\frac{W_{t+1}}{W_t}}{\left(\frac{H_{t+1}}{H_t}\right)^{\psi}}\right)^{1-\gamma} v\left(x_{t+1}, Y, t+1\right) + \left(1-f_t\right) \tilde{f}_t \left(\frac{\frac{W_{t+1}}{W_t}}{\left(\frac{H_{t+1}}{H_t}\right)^{\psi}}\right)^{1-\gamma} v\left(x_{t+1}, \tilde{Y}, t+1\right) \\
& + \left(1-f_t\right)\left(1-\tilde{f}_t\right) \left(\frac{\frac{W_{t+1}}{W_t}}{\left(\frac{H_{t+1}}{H_t}\right)^{\psi}}\right)^{1-\gamma} B(1) \Bigg\} \\
& + \left(1-M_t\right) \Bigg\{ f_t \left(\frac{\frac{W_{t+1}}{W_t}}{\left(\frac{H_{t+1}}{H_t}\right)^{\psi}}\right)^{1-\gamma} v\left(x_{t+1}, Y, t+1\right) + \left(1-p_t\right) \left(\frac{\frac{W_{t+1}}{W_t}}{\left(\frac{H_{t+1}}{H_t}\right)^{\psi}}\right)^{1-\gamma} B(1) \Bigg\} \Bigg], \qquad (10)
\end{aligned}
$$

where $c_t = C_t/W_t$ is the consumption rate, $q_t = Q_t/W_t$ is the household's normalized home size for which we have normalized H_t to 1, and

$$
x_t = \left[\frac{Q_{t-1} H_t}{W_t}, I_{t-1}, \frac{L_t}{W_t}, M_t, N_t^e, N_t^l\right] \qquad (11)
$$

is the normalized vector of state variables. Hence, the policy functions c_t, q_t, I_t, π_t^s, π_t^b, and the value function, v, depend on six state variables: (1) the normalized size of the home; (2) the ownership status; (3) the income-to-net-worth ratio; (4) the marital status; (5) the number of children born "early;" (6) the number of children born "late;" and (7) age. That is, in line with the empirical evidence in section 2, in our model, the optimal policies do not depend on household net worth.

We numerically compute the optimal policy function using backward induction in the discretized six-dimensional state space. We discretize the continuous state variables: normalized value of the home, the labor income-to-net-worth ratio, and time. We employ parallel computation to expedite the optimization.