Lifecycle Choices

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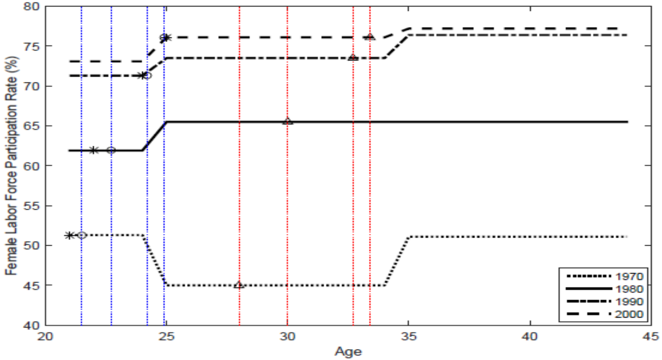
- The average age of a first-time home buyer was about 28 years old in the 1970s, about 30 in the 1990's, and is now about 32.5.
- This increase coincided with postponing marriage and fertility; the average age of mother at first birth rose from 22 forty years ago to 24 two decades ago, and is currently about 26.
- In contrast female labor-force participation rose from 48 percent in 1975, to 74 percent in 1995 and 76 percent in 2015, hours worked following a similar pattern.
- The median age of marriage and first birth practically coincide at each of the four census points (1970,. . . ,2000):
  - but age at first home purchase is several years older
  - and the gap between first birth and first home purchase widened a little and then stabilized.

Introduction

Figure 1 from Khorunzhina and Miller (2021)

Figure 1: Labor force participation rate by age for 1970 - 2000. "Star" denotes median age at first marriage, "circle" denotes average age at first birth, "triangle" denotes average age at first homeownership. Age at first marriage is taken from the US Census Bureau, age at first birth is taken from the National Vital Statistical Reports (Mathews and Hamilton, 2002), age at first homeownership is computed from the PSID, whereas labor force participation rates are taken from publications of the US Bureau of Labor Statistics (Toossi, 2002, 2012).



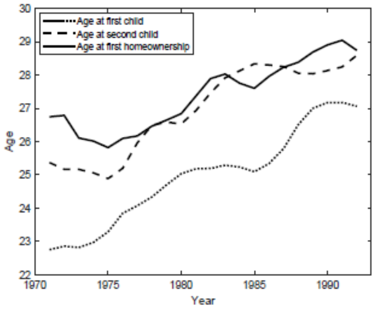
Introduction

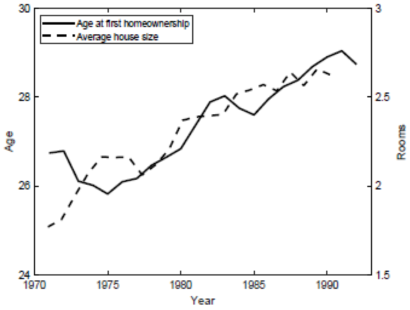
More detail on time trends

- Tracking over the decades, the median age at:
  - first home purchase, first birth and second birth have all increased.
  - second birth roughly tracks mean age at first home purchase.
- The trend to postpone buying the first house is matched by a trend to purchase a larger one:
  - Loosely speaking there is a quantity/quality trade-off.
  - Now larger houses are owned, but starting at a later age.
- The rate at which households sell houses and transition to renting did not change:
  - In other words declining home ownership is synonymous with the trend to purchase the first house later in life.

Introduction

Figure 3 and 4 from Khorunzhina and Miller (2021)

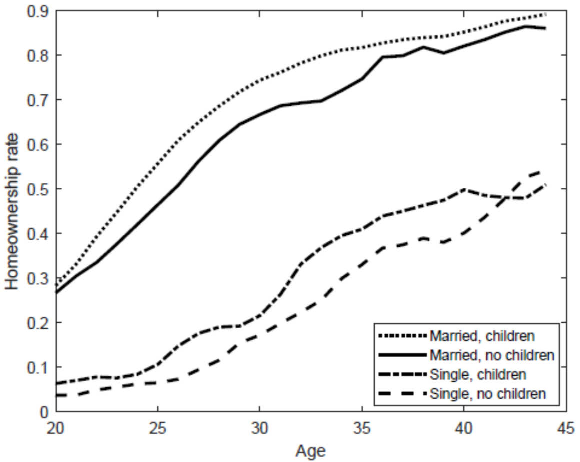




- At any given age home ownership ranks from lowest to highest by roughly tracking aggregate household weight:
  - married with children
  - married with no children
  - single with children
  - single with no children.
- With regards labor supply the ordering from the most to the least is:
  - single homeowners
  - single tenants
  - married females, whether they are homeowners or not.

Introduction

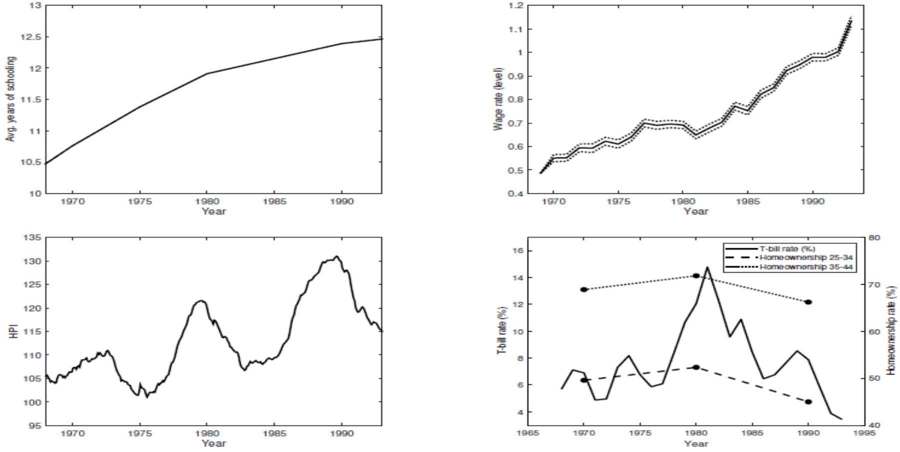
Figure 2 from Khorunzhina and Miller (2021)



- There are potentially four main economic factors driving these trends.
- Over these four decades:
  1. real wages rose.
  2. the real interest rate declined.
  3. housing prices rose and then fell.
  4. females became more educated.

Introduction

Figure 7 from Khorunzhina and Miller (2021)



Introduction

Agenda

- This data support a view widely acknowledged in the literature:
  - *Fertility, female labor supply and homeownership choices are related.*
- This lecture reports on a nonstationary dynamic model of household choices explaining:
  1. fertility
  2. female labor supply
  3. first home purchase decisions.
- The secular (nonstationary) drivers in this model include:
  1. educational attainment
  2. female wages (conditional on education)
  3. interest rates
  4. housing prices
- The model is:
  1. estimated with the PSID data.
  2. simulated to decompose the effects of the driving factors.

Data

PSID sample characteristics

- We use the PSID to conduct the analysis.
- Table 1 summarizes differences between owners and tenants.
- Compared to tenants, owners:
  - are older.
  - are more educated.
  - are more likely to be married.
  - have more children.
  - live in larger dwellings.
  - are less likely to be employed.
  - work fewer hours if they are employed.
  - earn more income if they are employed.

Data

Table 1 of Khorunzhina and Miller (2021)

	Full sample	Owners	Renters
Age	32.4	33.9	29.7
Education	13.0	13.0	12.9
Married	0.82	0.92	0.64
Number of children	1.53	1.67	1.28
Home ownership rate	0.64		
House value for home owners		66,381	
Annual rent for renters			2,956
Move to owned house	0.087		
own-to-own**		0.062	
rent-to-own***		0.064	
Move to rental house	0.126		
rent-to-rent***			0.329
own-to-rent***			0.041
Number of rooms in dwelling	5.8	6.4	4.7
Labor force participation	0.753	0.736	0.783
Hours worked*	1,497	1,479	1,527
Labor income*	11,070	11,504	10,341
Number of observations	43,504	27,871	15,633

- Denote by:
  - $b_t \in \{0,1\}$, where $b_t = 1$ if a child is born at time t.
  - $c_t \in \mathcal{R}$ denotes nonhousing consumption, a continuous choice.
  - $l_t \in \{0,1\}$, where $l_t = 1$ means female works at time t.
  - $h_t \in \{0,1\}$, where $h_t = 1$ means first home is purchased at t.
- If $h_t = 1$ then $h_\tau = 0$ for $\tau \in \{t+1, \ldots, T\}$.
- Define homeownership by $h_t^* \equiv \sum_{\tau=1}^{t-1} h_\tau$. Then there are:
  - eight (b_t, l_t, h_t) discrete choices combinations if $h_t^* = 0$.
  - effectively four (b_t, l_t) combinations if $h_t^* = 1$.
- We label each possible choice permutation by $d_{jt} \in \{0,1\}$ where:
  - $j \in \{0, \ldots, 7\}$ and if $h_t^* = 1$ then $j \in \{0, \ldots, 3\}$.
  - $\sum_{j=0}^{7} d_{j\tau} = 1$ and $\sum_{j=0}^{3} d_{j\tau} = 1$ if $h_t^* = 1$.

Framework

Preferences

- We model household lifetime utility from t onwards as:

$$-\sum_{\tau=t}^{\infty}\sum_{j=0}^{7}\beta^{\tau-t}d_{j\tau}\exp\left(h_{\tau}u_{\tau}^{h}+b_{\tau}u_{j\tau}^{b}+l_{\tau}u_{\tau}^{l}-\rho c_{\tau}-\epsilon_{j\tau}\right)$$

where j indexes the discrete choices at τ and:

  - β denotes the subjective discount factor.
  - u_{τ}^{h} indexes expected lifetime utility from purchasing first home.
  - u_{τ}^{b} indexes net expected lifetime utility of raising a child.
  - u_{τ}^{l} indexes the current utility of current leisure.
  - ρ is the constant absolute risk aversion parameter.
  - $\epsilon_{j\tau}$ is a period τ choice-specific disturbance with *iid* density $g\left(\epsilon_{j\tau}\right)$.

- We parameterize the index functions as:

$$
\begin{aligned}
u_t^h &\equiv \theta_0 + l_t\theta_1 + b_t\theta_2 + x_t l_t\theta_3 + l_{t-1}\theta_4 \\
&\quad + s_t\left(\theta_5 + x_t'\theta_6 + s_t^2\theta_7 + s_{t-1}\theta_8 + l_t^*\theta_9 + l_{t-1}^*\theta_{10}\right) \\
u_t^b &\equiv \gamma_0 + l_t\gamma_1 + x_t'\gamma_2 \\
&\quad + h_t^*\gamma_3 + (1-m_t)\,h_t^*\gamma_4 + s_t\gamma_5 \\
u_t^l &\equiv \delta_0 + x_t'\delta_1 + h_t^*\delta_2 + (1-m_t)\,h_t^*\delta_3 + s_t\delta_4 + l_{t-1}\delta_5 \\
&\quad + l_t^*\left[\delta_6 + x_t'\delta_7 + h_t^*\delta_8 + (1-m_t)\,h_t^*\delta_9 + l_t^*\delta_{10} + l_{t-1}^*\delta_{11}\right]
\end{aligned}
$$

  where s_t measures house size in period t and:

  - x_t are fixed or time varying attributes (including marital status and ages plus education of both spouses) along with previous fertility outcomes.
  - $m_t \in \{0,1\}$ is marital status with $m_t = 1$ indicating married.
  - $l_t^* \in [0,1]$ is female labor supply in t where $l_t^* \in (0,1]$ *iff* $l_t = 1$.

- Assume future spot prices and interest rates are known.
- Denote by:
  - W_t household financial wealth at the beginning of period t.
  - y_t income from real wages paid to the female for work in period t.
  - $\widetilde{y}_t$ other income in period t.
  - i_t the period t interest rate.
  - $R(s_t, q_t)$ rent by tenants.
  - $H(s_t, q_t)$ the house price, which depends on house size, quality and aggregate factors.
- Defining gross flows before consumption as:

$$y_t^* \equiv y_t + \widetilde{y}_t - (1 - h_t^*) R(s_t, q_t) - h_t H(s_t, q_t)$$

the law of motion for disposable household wealth is:

$$(1 + i_t)^{-1} W_{t+1} \leq W_t + y_t^* - c_t$$

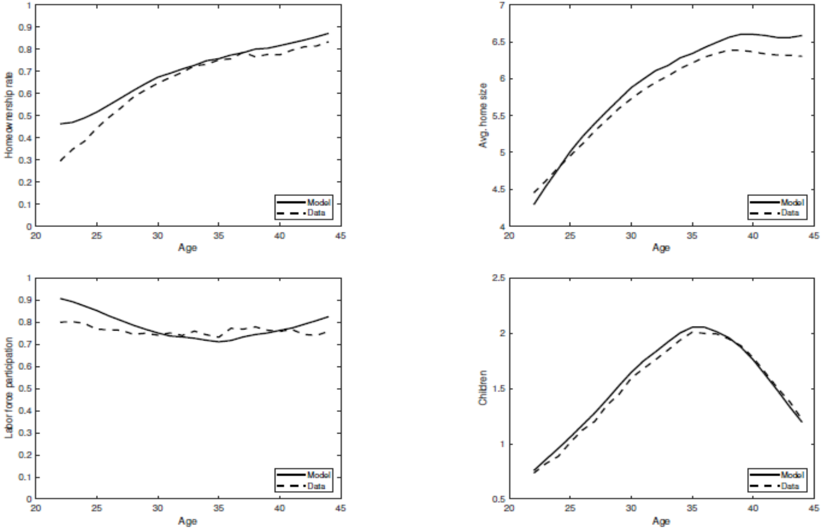
Model Fit

One period forecasts

- To check the model fit we:
  1. solve the optimal decision rule model for the estimated parameters.
  2. approximate PSID sample with an artificial population.
  3. simulate the artificial population one period forward using the first step.
- Note there is only one set of time dummies in the model, for estimating the base wage rate.
- The model simulates the life cycle quite well but predicts:
  - too much house ownership at both ends of the lifecycle.
  - homes too small at beginning of life cycle and too large at the end.
  - a slight U bend in labor force participation not in the data.
  - too many births in the household early in the lifecycle.
- The model also simulates calender time averages quite well, especially the trends, but predicts:
  - families are too large.
  - home ownership occurs too early and homes are too big.

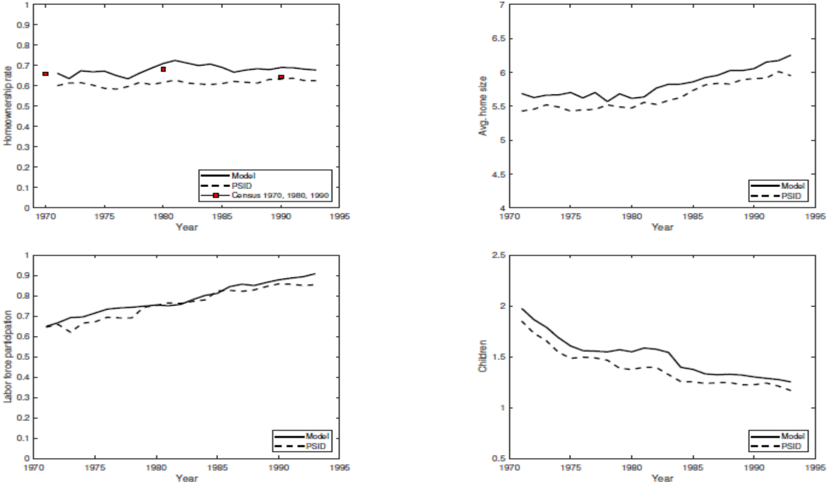
Female Labor Supply, Fertility and Home Ownership

Figure 5 from Khorunzhina and Miller (2021)



Female Labor Supply, Fertility and Home Ownership

Figure 6 from Khorunzhina and Miller



Structural Estimates

Table 2 of Khorunzhina and Miller (2021)

	Utility from:				
	home purchase	home size	birth	work	work hours
	$h_t \times$	$h_t s_t \times$	$b_t \times$	$d_t \times$	$d_t l_t \times$
	(1)	(2)	(3)	(4)	(5)
Constant	1.10 (0.47)	0.62 (0.08)	2.12 (0.19)	0.01 (0.17)	5.75 (0.91)
Work(d_t)	0.60 (0.50)		−4.05 (0.25)		
Birth(b_t)	−3.25 (0.49)				
Work*Birth$(d_t b_t)$	−22.77 (0.52)				
Demographic characteristics (x_t)					
Female age	−0.20 (0.01)	0.04 (0.01)	−0.42 (0.01)	−0.03 (0.01)	0.07 (0.02)
Female education	0.44 (0.03)	−0.07 (0.01)	0.14 (0.01)	0.13 (0.01)	−0.45 (0.05)
Husbands age	0.09 (0.01)	−0.01 (0.01)	−0.02 (0.01)	−0.01 (0.01)	0.07 (0.02)
Husbands education	−0.51 (0.03)	0.08 (0.01)	0.14 (0.01)	−0.08 (0.01)	0.26 (0.04)
Single	−10.26 (0.54)	0.41 (0.09)	−5.78 (0.22)	1.66 (0.20)	−11.62 (1.02)
Non-White	−8.94 (0.20)	0.48 (0.04)	−0.57 (0.08)	−1.33 (0.07)	9.52 (0.40)
Single*Non-White	−23.63 (0.50)	2.38 (0.09)	5.27 (0.17)	−1.13 (0.15)	13.61 (0.76)
Children at $t-1$	3.67 (0.14)	−0.15 (0.02)	4.29 (0.05)	−0.73 (0.04)	−2.99 (0.24)
Children sq. at $t-1$	−2.84 (0.04)	0.14 (0.01)	−2.47 (0.02)	0.08 (0.01)	−0.42 (0.06)
Age of last child	−0.34 (0.02)	−0.06 (0.01)	−1.48 (0.01)	0.12 (0.01)	−0.39 (0.03)
Homeowner at $t-1$ (h_{t-1})			2.65 (0.06)	−0.65 (0.04)	5.11 (0.21)
Single*Homeowner at $t-1$ (Single*h_{t-1})			−16.37 (0.15)	−1.00 (0.17)	8.33 (0.74)
Current home size (s_t)		−0.05 (0.01)	0.01 (0.01)	−0.01 (0.01)	
Prior home size (s_{t-1})		0.01 (0.00)			
Employed at $t-1$ (d_{t-1})	0.19 (0.04)			1.43 (0.03)	
Work time (l_t)		−2.11 (0.03)			−130.93 (0.85)
Work time at $t-1$ (l_{t-1})		−0.30 (0.03)			97.43 (0.58)

Structural Estimates

Utility from first home purchase

- The utility of purchasing a first house is:
  - increasing in lagged (female) employment and education.
  - declining in births, even more so when crossed with work.
  - concave increasing with the number of children.
  - declining with the age of the youngest child.
  - lower for nonwhites, singles, reinforced by an interaction term.
  - increasing in husband's age but decreasing in his education.
- Conditional on purchasing a home, utility from a larger home:
  - is concave increasing.
  - increases with age, but declines with her education.
  - declines with age of husband but increasing in his education.
  - greater for nonwhites and singles.
  - increases with the number of children beyond one.
  - increases with the size of previous home.
  - declines with amount of time spent at work.

Structural Estimates

Lifetime utility from giving birth

- The benefits of having another child decline with
  - age.
  - age of the youngest child.
  - education.
  - being employed.
  - house size.
  - owning a home the previous period.
- The benefits of having another child are greater for:
  - white if married.
  - nonwhite if not married.

Structural Estimates

Fixed utility cost of participation and utility from leisure time

- The current utility of leisure is concave increasing in leisure, and also increasing in past leisure, consistent with previous studies.
- The estimates pertaining to the effects of race, marriage education and family composition are also in line with previous work:
  - increasing in marriage, especially for nonwhites.
  - declining in age.
  - increasing in education.
  - higher for nonwhites.
  - increasing in family size and declining in the age of the youngest child.
- Homeowning and house size increase the benefit from leisure.

Counterfactuals

The problem of predicting the future

- If the time series process is stationary, the probability distribution characterizing the future is embodied in the past.
- Stationarity is not an attractive assumption when there is technological progress and secular demographic shifts.
- Except in special cases we cannot infer probability distributions characterizing the future from the data on nonstationary time series.
- We can nevertheless solve for hypothetical economies in which the unknown nonstationary processes generating the data are replaced with time series processes we specify.
- This study inoculates the counterfactual analysis against the unbalanced (PSID) sample and buffering from aggregate effects by comparing two steady state economies.
- Here we compare the long term differences of permanent shifts; we could also compute transitions from one steady state to the other.

Counterfactuals

Two steady state economies

- One benchmark stationary economy somewhat resembles the (PSID) economy in 1971. We:
  - generate an artificial population of 23 year olds that approximates the population distribution of that age group within the PSID.
  - set their preference parameters to our estimates.
  - fix the wage premium from education, housing prices, and the interest rate at the 1971 values.
  - successively apply the optimal rule for 25 years to attain a steady state economy (when supplemented by immigration).
- Coincidentally the aggregate statistics for this benchmark stationary economy are remarkably close to the corresponding analogues:
  - for the PSID in 1971,
  - and for the U.S. economy at large at that time.
- The other benchmark economy replaces the 1971 wage rate, housing prices, and interest rate with their 1991 values, but leaves the demographic composition unchanged.

Counterfactuals

Changing wages, education, home ownership prices and interest rates

- We compare the benchmark 1971 stationary economy with a stationary economy where:

  1. *base wages increase to the 1991 level (almost double their 1971 level):*
     $\Longrightarrow$first home purchase postponed, labor force participation increases, births fall.
  2. *education attainment increases by 1.5 years:*
     $\Longrightarrow$first home purchase brought forwards slightly, labor force participation increases, births fall.
  3. *housing prices increase by 15 percent:*
     $\Longrightarrow$first home purchase postponed, labor force participation slightly increases, births barely affected.
  4. *the interest rate increases from 4.88% (1971) to 5.87% (1991):*
     $\Longrightarrow$first home purchase brought forwards, reduces labor force participation falls, births increase.

Counterfactuals

Table 4 of Khorunzhina and Miller (2021)

	Average age at		LFP (%)	
	first child	first homeownership	before age 35	after age 35
Benchmark in 1971	22.9	28.0	78	67
Benchmark in 1991	23.5	27.8	85	76
A. Wage as in 1991	21.6	29.3	87	85
B. Education level as in 1991	23.7	27.5	79	67
C. House prices as in 1991	22.9	28.4	78	68
D. Interest rate as in 1991	23.3	27.0	72	55

Concluding Remarks

Why was the American Dream delayed?

- *Rising housing prices* partly explains why homeownership was postponed.
- Two other factors played an indirect role:
  1. *Female wage rates increased* substantially over this period.
  2. *Females became more educated.*
- Time spent at home:
  - increases the value of homeownership.
  - is an input in raising children.
- These two factors increased the opportunity of raising children and staying home, reducing fertility and the value of homeownership.
- It remains to be seen whether future research incorporating the factors mentioned on the previous slide will overturn these basic findings.

Technical Details

State variables

- The household directly controls some state variables, including:
  - W_t current financial wealth.
  - $(b_t, \ldots, b_{t-18})$ family composition.
  - h_t^* (first) home ownership.
- The other state variables include:
  - s_t house size, a Markov process with transition density $f(s_t | s_{t-1})$ when the household rents, and when household owns, $s_t = s_{t-1}$.
  - $l_{t-1}^* \in [0, 1]$ female lagged labor supply.
  - q_t aggregate variables for housing prices.
  - Y_t wage rates.
  - B_t current price of a bond in t paying one consumption unit each period into perpetuity.
  - D fixed demographics for each woman including age and education.
- Summarizing the state variables are (z_t, W_t) where:

$$z_t \equiv (D, B_t, q_t, Y_t, b_t, \ldots, b_{t-18}, A_t, s_t, l_{t-1})$$

- In period t the household:
  - observes (z_t, W_t) and chooses c_t,
  - then observes $\epsilon_t \equiv (\epsilon_{0t}, \ldots, \epsilon_{7t})$, and takes action j, a (b_t, l_t, h_t) combination if $h_t^* = 0$ or a (b_t, d_t) combination if $h_t^* = 1$.
- Denote by (b_t^o, l_t^o, h_t^o) and (b_t^o, l_t^o) the discrete choices that along with the optimal consumption choices, c_t^o, solve the household's problem.
- Integrating over ϵ_t let $P_{jt}(z_t, W_t)$ denote the probability the optimal choice at year t conditional on (z_t, W_t) is j.
- The theorem below implies $P_{jt}(z_t, W_t)$ does not depend on W_t.
- We write the CCPs as $p_{jt}(z_t) = P_{jt}(z_t, W_t)$ for all W_t.
- It follows from assuming an interior solution for consumption given exponential utility.

Appendix: Technical Details

Consolidating the notation

- Define y_{jt}, gross flows before consumption, as:

$$y_{jt} \equiv y_t + \widetilde{y}_t - (1 - h_t^*) R(s_t, q_t) - h_t H(s_t, q_t)$$

  for choice j matching (b_t, l_t, h_t).

- Let $\alpha_{jt}(z_t)$ denote choice specific log utility:

$$\alpha_{jt}(z_t) \equiv h_t u_t^h + b_t u_t^b + l_t u_t^l$$

- Finally let $z_{t+s}^{(j)}$ denote the value of the state vector at $t + s$ from following the decision sequence $(d_{jt}, d_{0,t+1}, \ldots, d_{0,t+s})$ applied to z_t.

- The optimal discrete choices maximize:

$$\sum_{j=0}^{7} d_{jt} \left[\rho y_{jt} - \alpha_{jt}(z_t) - (B_t - 1) \ln A_{t+1}(z_{t+1}^{(j)}) + \epsilon_{jt} \right]$$

where:

- $A_t(z_t)$ is an index of household capital defined as:

$$A_t(z_t) = \sum_{j=0}^{7} p_{jt}(z_t)\, e^{\left[\alpha_{jt}(z_t) - \rho y_{jt}\right]/B_t}\, E_t\left[e^{-d_{jt}^{o}\epsilon_{jt}/B_t} \right] A_{t+1}\left(z_{t+1}^{(j)}\right)^{1-\frac{1}{B_t}}$$

$$A_{T+1}(z_{T+1}) \equiv \prod\nolimits_{\tau=T+1}^{\infty} \alpha_{j\tau}\left(z_{\tau}^{(0)}\right)^{1/B_{T+1}}$$

- Note $A_t(z_t) > 0$ and $A_t(z_t) \downarrow$ as $y_{jt} \uparrow$ (higher income & lower rent).

Appendix: Technical Details

Identification (Arcidiacono and Miller, J. of Econometrics 2020)

- The parameters are identified given a *pdf* for $\epsilon_t \equiv (\epsilon_{0t}, \ldots, \epsilon_{7t})$ and normalizing constants for each (t, z_t).
- We assume ϵ_{jt} is independently and identically distributed as a T1EV with location and scale parameters $(0, 1)$.
- It is well known that in this case:

$$\ln\left[\frac{p_{jt}\left(z_t\right)}{p_{0t}\left(z_t\right)}\right] = \rho\left(y_{jt} - y_{0t}\right) - \alpha_{jt} - \left(B_t - 1\right)\ln\left[\frac{A_{t+1}\left(z_{t+1}^{(j)}\right)}{A_{t+1}\left(z_{t+1}^{(0)}\right)}\right]$$

- The model exhibits finite dependence: if any two choices j and k are both followed by the zero choice for as long it it takes for a child to grow up, the state variables are equalized, implying:

$$A_{t+1}\left(z_{t+18}^{(j)}\right) = A_{t+1}\left(z_{t+18}^{(0)}\right)$$

Appendix: Technical Details

Finite dependence (Arcidiacono and Miller, Quantitative Economics 2019)

- Estimation is based on successively telescoping $\ln\left[A_{t+1}\left(z_{t+1}^{(j)}\right)\Big/A_{t+1}\left(z_{t+1}^{(0)}\right)\right]$ into the future out to $T=18$.
- For each $j\in\{1,\ldots,7\}$ and $t\in\{1,\ldots,T\}$ we prove:

$$
\ln\left[\frac{p_{jt}\left(z_t\right)}{p_{0t}\left(z_t\right)}\right]=\rho\left(y_{jt}-y_{0t}\right)-\alpha_{jt}
$$

$$
+\sum_{s=t+1}^{18}\prod_{r=t+1}^{s}\left(\frac{1}{1+i_r}\right)\left[\rho\left(y_s^{(j,t)}-y_s^{(0,t)}\right)-\ln\frac{p_{0s}\left(z_s^{(j)}\right)}{p_{0s}\left(z_s^{(0)}\right)}\right]
$$

- This is a linear estimation problem (with a closed form solution):
  - Obtain cell (or smoothed kernel) estimators for $p_{jt}\left(z_t\right)$.
  - Use a minimum distance estimator for the $(\theta,\gamma,\delta,\rho)$ vector.