Education, Marriage, and Social Security

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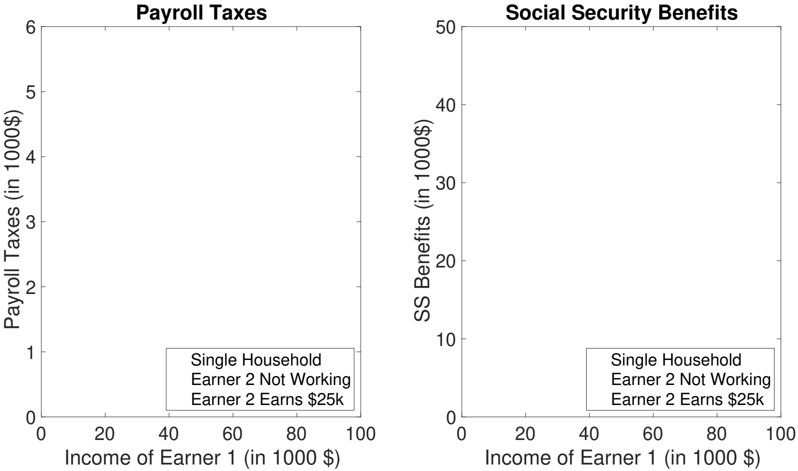
Motivation and Research Question

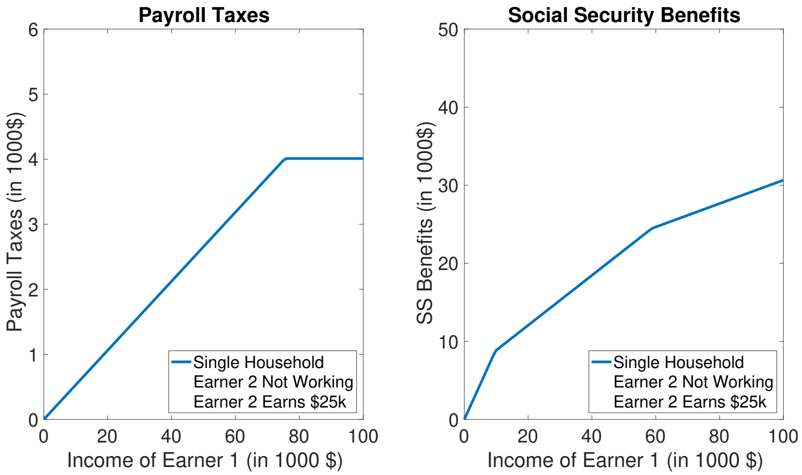
- Social security system biased towards married couples

Social Security: Payroll Taxes and Benefits



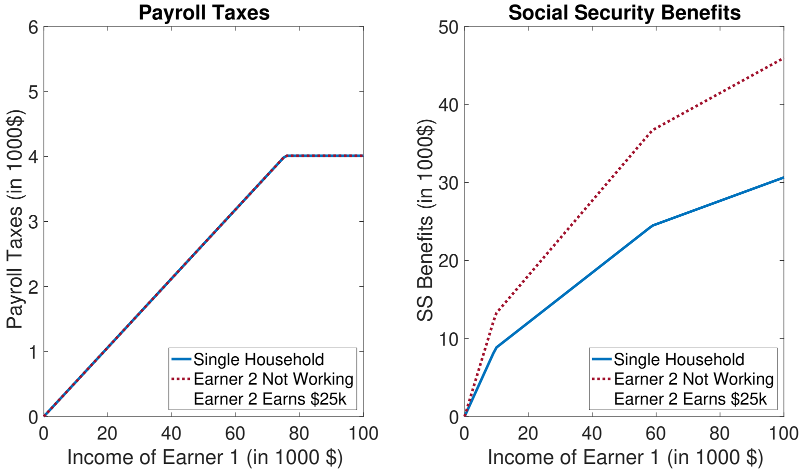
- Payroll taxes fund the SS system

Social Security: Payroll Taxes and Benefits



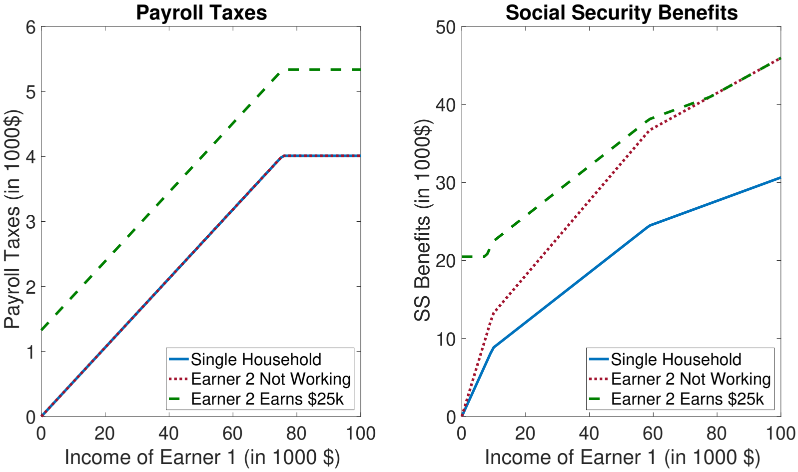
- Higher income individuals: Higher taxes, higher benefits

Social Security: Single vs Single-Earner HHs



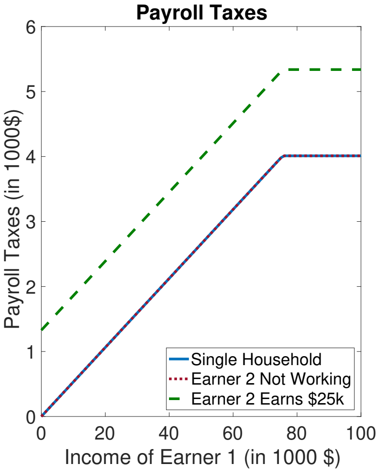
- Single vs single-earner HHs: Same taxes, different benefits

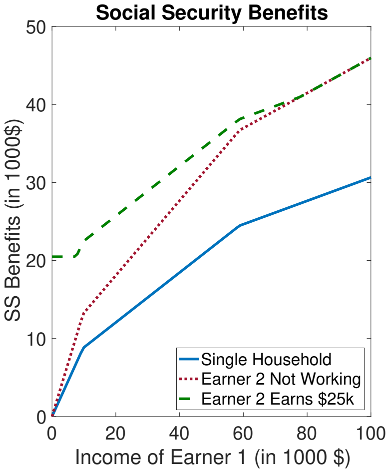
Social Security: Biased towards Married Couples



- Labor force participation within HH affects social security

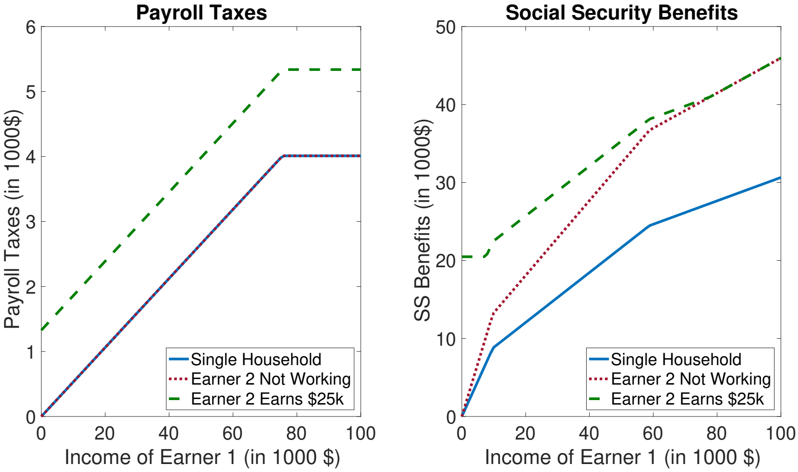
Social Security: Summary





- Education, marital status, LFPR $\Rightarrow$ social security

Social Security: Summary



- Social security $\stackrel{?}{\Rightarrow}$ if and who to get married to; education

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  - Single/single-earner households: same payroll taxes, yet different benefits
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Motivation and Research Question

- Social security system biased towards married couples
  - Single/single-earner households: same payroll taxes, yet different benefits
- Education, marital status, LFPR $\Rightarrow$ social security
- Social security $\overset{?}{\Rightarrow}$ if and who to get married to; education
- **Research Question: How do changes in tax and retirement policy affect education and marriage?**
- Relevance: SS Benefits need to be reduced post 2033

What Do I Do

- Document facts relating to social security and household structure
- Build dynamic discrete choice model of time allocation with endogenous human capital accumulation and equilibrium marriage markets
    - Households made up of distinct individuals ▸ Collective Households
    - Time split into work, home, and leisure
- Estimate for 1940-49 cohort using PSID, HRS data
- Decompose the effect of tax and retirement policy on education and marriage
- Effect on education, marriage, and work when:
    - Payroll taxes are increased
    - Spousal benefits are removed
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  - Joint income taxation is removed
- Increase in payroll taxes: $\uparrow$ education [without marriage]; no change [with marriage]

Contribution to Literature

- Endogenous human capital accumulation $\Leftrightarrow$ retirement earnings [Blundell, French and Tetlow (2016), Manuelli, Seshadri and Shin (2012), Fan, Seshadri and Taber (2017)]

- Human capital $\Leftrightarrow$ if and who you marry [Chiappori, Iyigun and Weiss (2009), Chiappori, Salanie and Weiss (2017), Chiappori, Dias and Meghir (2018), Eckstein, Keane and Lifshitz (2019)]

- Marital status $\Rightarrow$ retirement earnings (spousal benefits) [Gustman and Steinmeier (2009), Banks, Blundell and Rivas (2007), Borella, De Nardi and Yang (2019)]

- Collective model of decision-making with equilibrium marriage markets [Chiappori (1988, 1992), Choo and Siow (2006), Gayle and Shephard (2019)]

Endogenous marriage and decision making within household crucial to understanding tax implications

Model

Model Environment

- Life-cycle model, discrete-time
- Males and females
  - Identical at the start; differ by human capital accumulation process and efficiency in work, home production
- Endogenous human capital and asset accumulation

Model Environment

- Life-cycle model, discrete-time
- Males and females
  - Identical at the start; differ by human capital accumulation process and efficiency in work, home production
- Endogenous human capital and asset accumulation
- Two goods: Private consumption good, and public good of home production
- Taxes (payroll, medicare and income) and social security benefits (including spousal benefits)
- Individual utility from: Private consumption, home production good, and own leisure
  - Additively separable and risk-averse ▸ Specification
- Collective model: weighted sum of utilities λ^{i,k^m} $\leftarrow$ prices that clear frictionless marriage market ▸ Utility ▸ Details
- Type 1 EV shocks

State Space and Choices

t=1
Males
Females

State — Human Capital H^f
Assets A^f

Shocks — HC Shock ϵ_i

Choice — Education i (j)
$i = 1$ (low)
$i = 2$ (high)

State Space and Choices

	t=1 Males Females	t=2 Males of type j Females of type i
State	Human Capital H^f Assets A^f	Education i (j)
Shocks	HC Shock ϵ_i	Love Shock θ^i_{i,k_m}
Choice	Education i (j) $i = 1$ (low) $i = 2$ (high)	Marriage $k_m = 0, j = 1, 2$

State Space and Choices

	t=1 Males Females	t=2 Males of type j Females of type i	t $=[3, t_w]$ Single Households Married Households
State	Human Capital H^f Assets A^f	Education i (j)	$H_t^i, H_t^{k_m}$ Joint A_t^{i,k_m}
			Weight λ^{i,k_m}
Shocks	HC Shock ϵ_i	Love Shock θ^i_{i,k_m}	Choice Shock ϵ_t^{i,k_m}
Choice	Education i (j) $i=1$ (low) $i=2$ (high)	Marriage $k_m = 0, j = 1, 2$	Work: $M_t^i, M_t^{k_m}$ Home: $Q_t^i, Q_t^{k_m}$ Savings: ρ_t^{i,k_m} Sharing Rule: s_t^{i,k_m}

State Space and Choices

	t=1	t=2	t $=[3, t_w]$	t $= [t_r, T]$	
	Males Females	Males of type j Females of type i	Single Households Married Households	Single Households Married Households	
State	Human Capital H^f Assets A^f	Education i (j)	$H_t^i, H_t^{k_m}$ Joint A_t^{i,k_m}	Income $Y_t^i, Y_t^{k_m}$ Joint A_t^{i,k^m}	All agents die
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Time Allocation

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- Household decisions: time allocation (home, work, leisure) + savings + division of resources
  - Time spent at home, Q_t, produces a non-marketable public good Home Production
  - Time spent at work $M_t \rightarrow$ higher income today + higher human capital tomorrow HC+Income
  - Standard asset accumulation as a result of savings ρ_t Assets

Marriage

	t=1	t=2	t $=[3, t_w]$	t $= [t_r, T]$	
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- Utility from marriage: Economic component + love shock (Choo and Siow 2006)
- Individuals get married: Public good of home production, policy incentives (income tax, spousal benefits), insurance, preference for marriage
- Pareto weight λ^{i,k_m} result of supply = demand ▸ Marriage Clearing

Jointness of Education and Marriage

	t=1 Males Females	t=2 Males of type j Females of type i	t $=[3, t_w]$ Single Households Married Households	t $= [t_r, T]$ Single Households Married Households	
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- Education $\Rightarrow$ Labor Market $+$ Marriage Market
- Marriage $\Rightarrow$ Education

education $\Leftrightarrow$ marriage

Individual's Problem

Key Mechanisms

Estimation

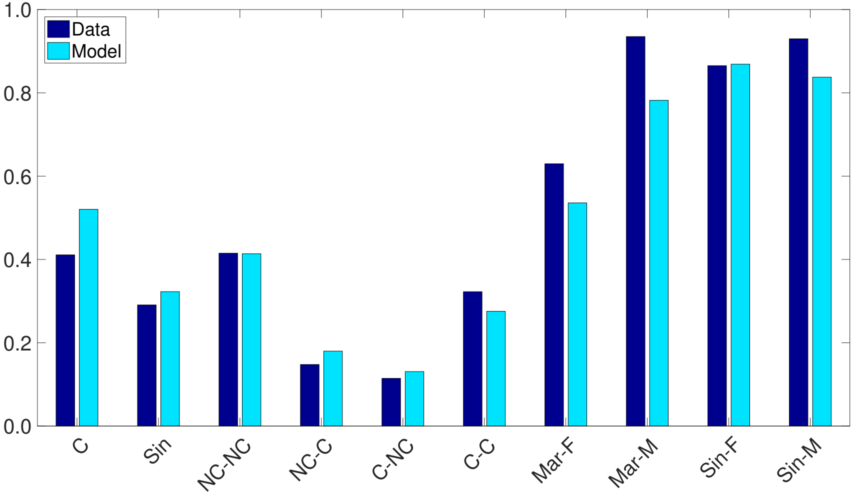
Estimation

- Data: PSID, HRS ▸ Data ▸ Key Statistics
- Parameters to estimate ($\boldsymbol{\theta}$): ▸ Outside Parameters
  - Utility: $\eta_C, \beta_Q, \eta_Q, \beta_L, \eta_L$
  - Home Production: $\{\boldsymbol{\Gamma^i}\}_{i=1,2}, \{\boldsymbol{\Gamma^j}\}_{j=1,2}, \{\tilde{\boldsymbol{\Gamma}}_{\boldsymbol{i}}\}_{i=1,2}, \Gamma_{i=j}, \alpha$
  - Fixed Costs: $FC^f_{ft}, FC^f_{pt}, FC^m_{pt}, FC^m_{ft}$
- Semi-parametric identification (Magnac and Thesmar, 2002) + Identification of λ (Gayle and Shephard, 2019) ▸ Identification
- Two-step estimation ▸ Estimation Details
- Summary of Estimates: ▸ Summary
  - High gains from homogamy in marriage
  - Fixed costs higher for females than males
  - Higher Pareto weights for college educated

Model Fit

Education+Marriage
Data
Model
NC
C
Sin
NC-NC
NC-C
C-NC
C-C
Married Female, Work
Married Male, Work
T2-NW
T2-PT
T2-FT
T3-NW
T3-PT
T3-FT
Married Female, Home
Single Female, Work
Single Male, Work
T2-L
T2-M
T2-H
T3-L
T3-M
T3-H
T4-L
T4-M
T4-H
Single Female, Home
Married Male, Home
Single Male, Home

Model Fit



Data
Model
1.0
0.8
0.6
0.4
0.2
0.0
C
Sin
NC-NC
NC-C
C-NC
C-C
Mar-F
Mar-M
Sin-F
Sin-M

Counterfactuals

Tax and Retirement Policy Implications

- **Decomposition: With and Without Marriage Channel**
    - Focus on payroll taxes
- Effect of tax and retirement policy on:
    - Education
    - Marriage

Decomposition: With and Without Marriage Channel

Model	College	Single	Married LFPR		Single LFPR	
			Female	Male	Female	Male
Baseline	0.52	0.32	0.54	0.78	0.87	0.84
Increasing Payroll Taxes Proportionately by 50% ($6\% \rightarrow 9\%$)						
Without Marriage ($\Delta\%$)						
With Marriage ($\Delta\%$)						

- Percent difference from the baseline

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Without Marriage (Δ%)	1.65			3.10		0.35
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- Fan, Seshadri, Taber (2019): College $\Uparrow$ 2.6%; Male LFPR $\Uparrow$ 3.1%

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With Marriage ($\Delta\%$)	0.08	-1.18	-0.54	0.99	0.52	0.65

- Two-fold returns to education: Labor-market and marriage market
- Mechanism: More household specialization $\Rightarrow \downarrow$ female bargaining power $\Rightarrow \downarrow$ singlehood rates Change in λ
- Endogenous marriage and decision making within household crucial to understanding tax implications

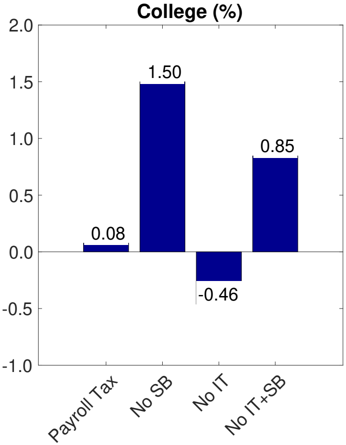
Tax and Retirement Policy Implications

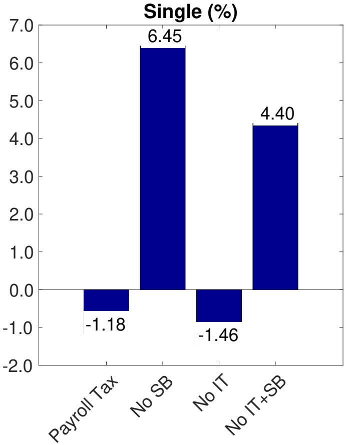
- Decomposition: With and Without Marriage Channel
  - Focus on payroll taxes
- **Effect of tax and retirement policy on**:
  - **Education**
  - **Marriage**

Tax and Retirement Policy Analysis

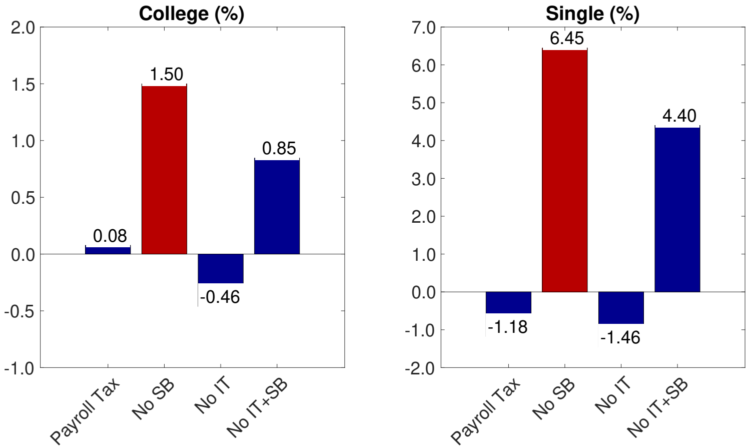
1. Payroll Tax: $\Uparrow$ by 50 %
2. No Spousal Benefits
3. No Joint Income Taxation
4. Marriage Neutral System

Tax and Retirement Policy Analysis



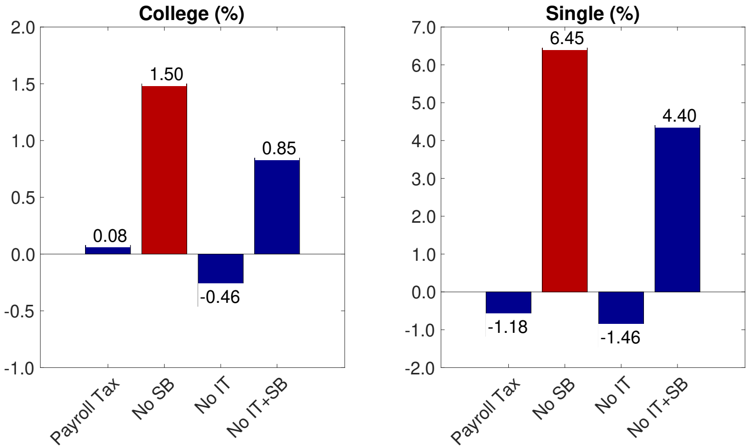


Tax and Retirement Policy Analysis: No Spousal Benefits



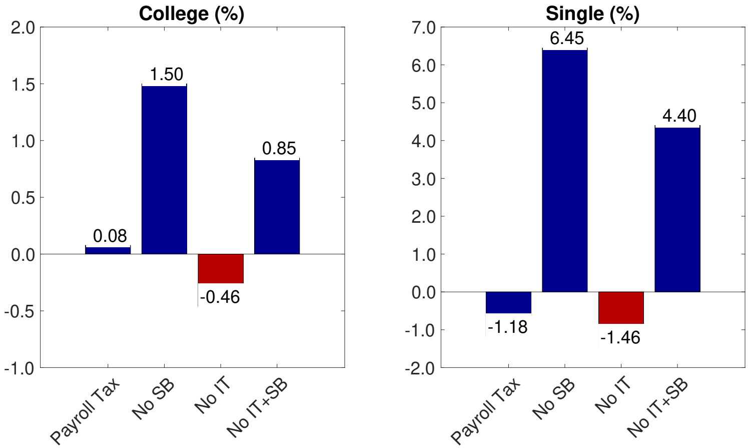
- Retirement earnings $\Downarrow \Rightarrow$ Lower income; benefit of marriage removed

Tax and Retirement Policy Analysis: No Spousal Benefits



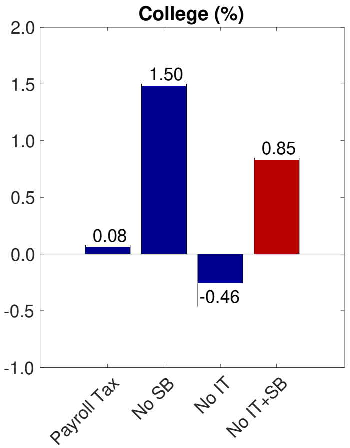
- Household specialization $\Downarrow$ education, marriage to college males $\Uparrow$

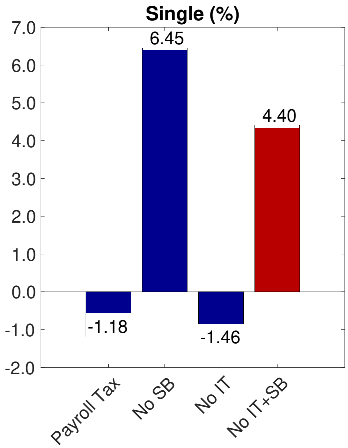
Tax and Retirement Policy Analysis: No Joint Income Taxation



- Household specialization $\Downarrow \Rightarrow$ Rise in NC-NC matches

Tax and Retirement Policy Analysis: Marriage Neutral Policy





- Household specialization $\Downarrow \Rightarrow$ Rise in marriage to college males

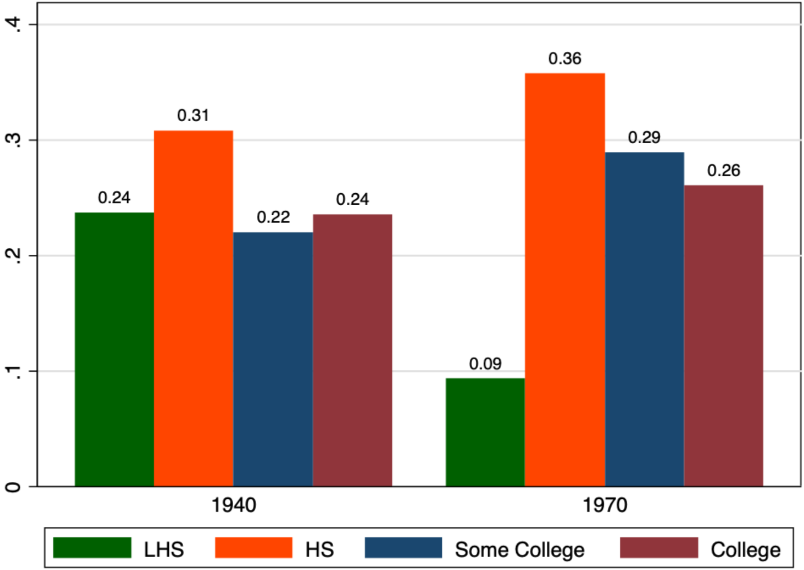
Conclusion

- How do changes in tax and retirement policy affect education and marriage?
- Develop a dynamic discrete choice model with endogenous education and marriage
- Estimate the model for 1940-49 cohort using PSID and HRS
- Increasing payroll taxes $\implies$ no change on college, $\downarrow$ single
- Removing spousal benefits, joint IT $\implies$ $\downarrow$ household specialization

Endogenous marriage and decision making within household crucial to understanding tax implications

Thank You!

College At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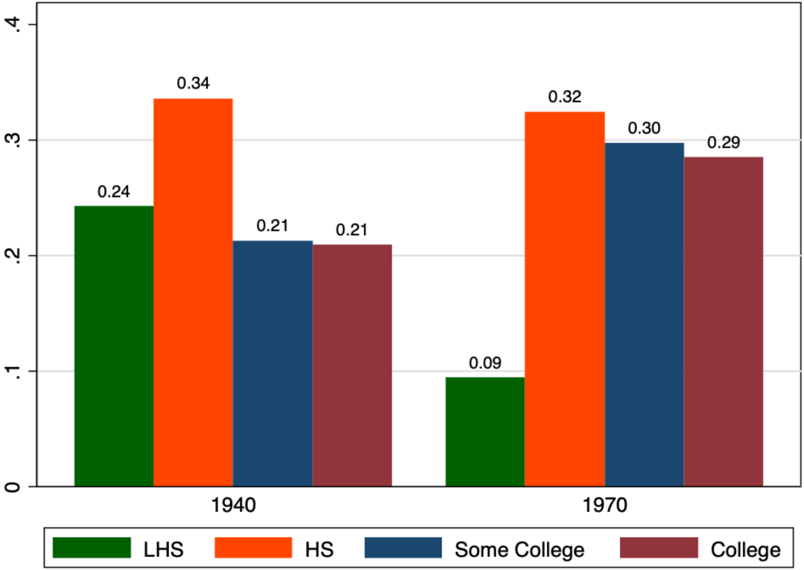
LHS
HS
Some College
College

College At



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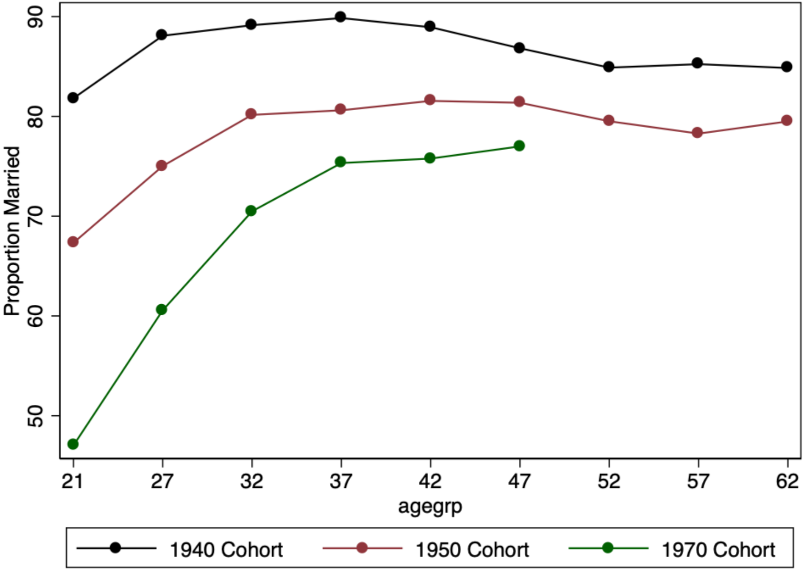
Fall in Ma


Proportion Married
90
80
70
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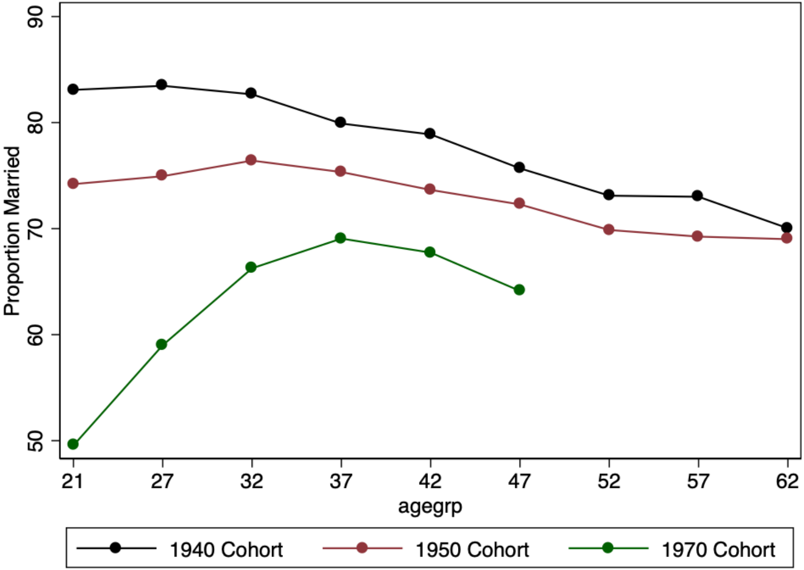
52
57
62
agegrp
1940 Cohort
1950 Cohort
1970 Cohort

Stronger F



90
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1940 Cohort
1950 Cohort
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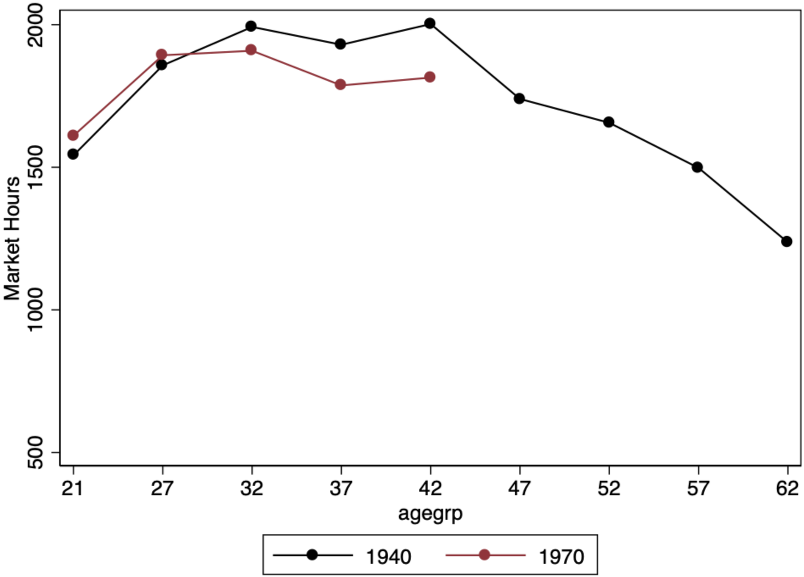
Change in



Market Hours
500
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2000
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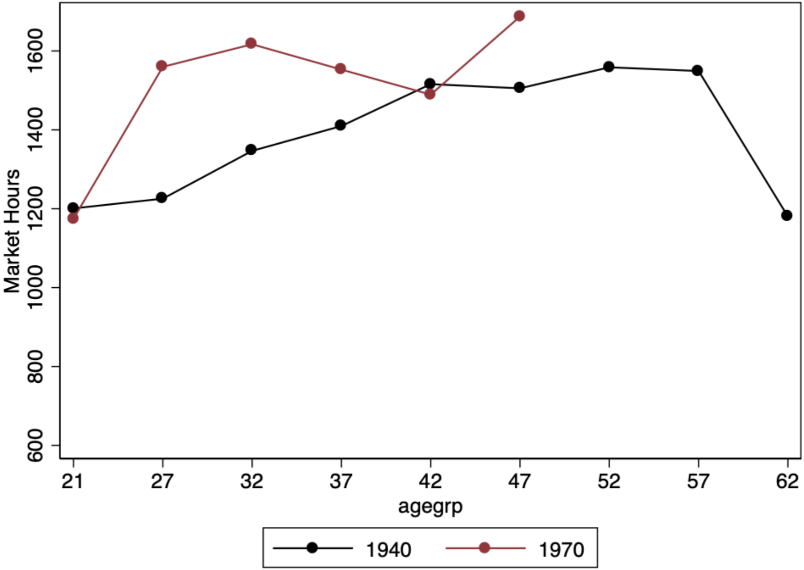
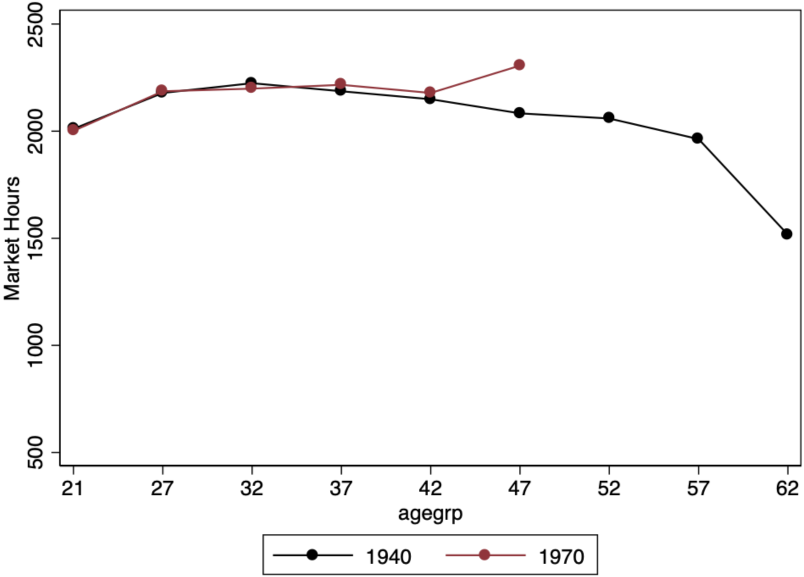
62
agegrp
1940
1970

Change in

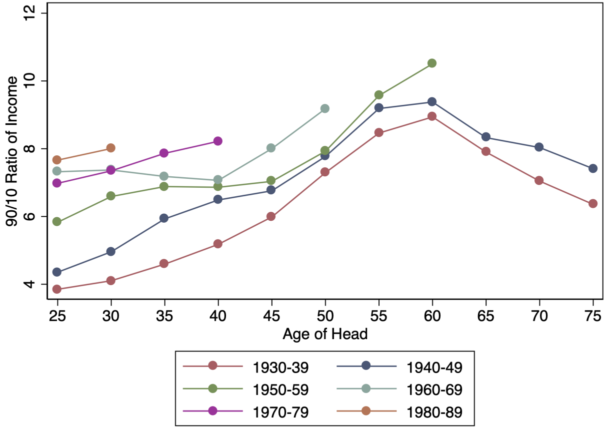

Market Hours
1600
1400
1200
1000
800
600
21
27
32
37
42
47
52
57
62
agegrp
1940
1970

Change in



2500
2000
1500
1000
500
Market Hours
21
27
32
37
42
47
52
57
62
agegrp
1940
1970

Inequality Trends



Source: CPS Data. *Note:* The above data is for 1940-49 cohort, for heads in the age group of 65-69 years. Quintiles are assigned separately for each cohort on the basis of equivalent household income (taking into account the number of household members, using an equivalence scale ($\sqrt{\text{Number of Adults} + 0.5^*\text{Number of Children}}$)

Stage 1: Education

$$
\begin{aligned}
V^S(H_1, \epsilon_1; \lambda_1, \mathbf{X}) = \max_{k_1 \in K_1} \; & u^S(C_1) + \epsilon^S_{k_1} \\
& + \beta \sum_{H_2} V^1(H_2; \lambda_1, \mathbf{X}) F(H_2 | H_1, I_1) \\
\text{subject to: } & M_1 + I_1 = 1 \\
& C_1 = Y_1(H_1, M_1, FC, t) \\
& H_2 = (1 - \delta) H_1 + (I_1 H_1)^\alpha
\end{aligned}
$$

Back

Stage 3: Work

$$
\begin{aligned}
&V_2^C(H_2^1, H_2^2, A_2, \epsilon_2; \lambda_1 \mathbf{X}) = \max_{k_2 \in K_2} \lambda_1 u^1(L_2^1, C_2, C_2^Q; \mathbf{X^1}) \\
&+ (1-\lambda_1)u^2(L_2^2, C_2, C_2^Q; \mathbf{X^2}) + \epsilon_{k_2}^C \\
&+ \beta \sum_{H_3^1, H_3^2, A_3} V_3^C(H_3^1, H_3^2, A_3; \lambda_1, \mathbf{X}) F(H_3^1, H_3^2, A_3 | H_2^1, H_3^1, A_2, k_2 = 1) \qquad (1) \\
&\text{subject to: } M_2^1 + Q_2^1 + L_2^1 = 1 \qquad (2) \\
&M_2^2 + Q_2^2 + L_2^2 = 1 \qquad (3) \\
&H_3^1 = (1-\sigma)H_2^1 + (M_2^1 H_2^1)^\alpha \qquad (4) \\
&H_3^2 = (1-\sigma)H_2^2 + (M_2^2 H_2^2)^\alpha \qquad (5) \\
&A_3 + C_2 = Y_2(H_2^1, M_2^1, FC, t) + Y_2(H_2^2, M_2^2, FC, t) + (1+r)A_2 \qquad (6) \\
&C_2^Q = \zeta(\mathbf{X}) f(Q_2^1, Q_2^2) \qquad (7)
\end{aligned}
$$

Back

Individual's Problem - Retirement (Single)

$$\max_{k_4 \in K_4} u^S(L_4, C_4, C_4^Q; \mathbf{X}) + \beta V_5^S(A_5; \mathbf{X}) + \epsilon_{k_4}^S$$

subject to: $Q_4 + L_4 = 1$

$$Y_4 = F_{ss}(Y_3(H_3))$$

$$C_4 + A_5 = Y_4 + (1+r)A_4$$

$$C_4^Q = \zeta(\mathbf{X})Q_4$$

Back

Value Functions - Households

$$V_2^{C,1}(H_2^1, H_2^2, A_2; \lambda_1, \mathbf{X}) = \sigma_\epsilon \gamma + \sum_k p_2^k(H_2^1, H_2^2, A_2; \lambda_1, \mathbf{X})$$
$$\big[v_k^{C,1}(L_2^1, L_2^2, Q_2^1, Q_2^2, H_2^1, H_2^2, A_2; \mathbf{X})$$
$$- \sigma_\epsilon \log(p_2^k(H_2^1, H_2^2, A_2; \lambda_1, \mathbf{X})))\big]$$
$$V_2^{C,2}(H_2^1, H_2^2; \lambda_1, \mathbf{X}) = \sigma_\epsilon \gamma + \sum_k p_2^k(H_2^1, H_2^2, A_2; \lambda_1, \mathbf{X})$$
$$\big[v_k^{C,2}(L_2^1, L_2^2, Q_2^1, Q_2^2, H_2^1, H_2^2, A_2; \mathbf{X})$$
$$- \sigma_\epsilon \log(p_2^k(H_2^1, H_2^2, A_2; \lambda_1, \mathbf{X})))\big]$$

Back

Conditional Choice Probability

- As errors are Type 1 EV:

$$p_k(x;\mathbf{X}) = \frac{\exp(v_k(x)/\sigma_\epsilon)}{\sum_{k'} \exp(v_{k'}(x)/\sigma_\epsilon)}$$
$$\log\left(\frac{p_k(x;\mathbf{X})}{p_1(x;\mathbf{X})}\right) = \frac{1}{\sigma_\epsilon}\left[v_k(x) - v_1(x)\right]$$

- Arcidiacono and Miller (2011)

Back

Moments at Optimal

Moments	At Optimal
1	-0.17
2	0.05
3	0.04
4	-0.30
5	0.01
6	4.88

Back

Set Parameters

Parameter	Description	Value
β	Discount Factor	0.95
b_1	Bequest Function	5.00
b_2	Bequest Function	0.00
r	Rate of Return	0.05
t	Payroll Tax	0.06
A_0	Initial Assets	0.00
FC_f	Fixed Cost, Female	1.50
FC_m	Fixed Cost, Male	1.00
bp_1	Social Security Function	1.11
bp_2	Social Security Function	6.69
cap	Social Security Function	3.49
w_1^f	Wages, Female	[14.6, 25.4]
w_1^m	Wages, Male	[20.9, 34.9]

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Estimates

Parameter	Type	Estimate
η_Q	Utility Parameter	0.10
η_L	Utility Parameter	1.15
β_Q	Utility Parameter	1.21
β_L	Utility Parameter	1.46
α	Home Production	0.76
η_C	Utility Parameter	2.16
Γ_1^f	Home Production	15.11
Γ_2^f	Home Production	14.09
Γ_2^m	Home Production	13.40
$\Gamma_1^{c,f}$	Home Production	2.03
$\Gamma_2^{c,f}$	Home Production	1.40
Γ^h	Home Production	1.92
σ_n	Marriage	1.00
FC_{pt}^f	Fixed Costs	8.09
FC_{pt}^m	Fixed Costs	1.39
FC_{ft}^f	Fixed Costs	17.40
FC_{ft}^m	Fixed Costs	4.64

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Value Functions - Singles

$$
\begin{aligned}
V_4^{S,i}(Y_3^i, A_4^i, \boldsymbol{\epsilon_{k_4}}; \mathbf{X^i}) = & \max_{k_4^i \in K_4^i} u^{S,i}(C_4^i, C_4^{Q,i}, L_4^i; \mathbf{X^i}) \\
& + \beta V_5^{S,i}(A_5^i; \mathbf{X^i}) + \epsilon_{k_4^i} \\
\text{subject to: } & Q_4^i + L_4^i = 1 \\
& C_4^i + A_5^i = Y_4^i = F_{ss}^S(Y_3^i) + (1+r)A_4^i \\
& C_4^i = (1 - \rho_4^i)Y_4^i \\
& C_4^{Q,i} = \zeta_i(\mathbf{X^i})Q_4^i
\end{aligned}
$$

k : L (Leisure), Q (Home Production), M (Market Time), ρ (Savings Rate) Back

Value Functions - Married Couples

$$
\begin{aligned}
V_4^{C,ij}(Y_3^i, Y_3^j, A_4^{ij}, \boldsymbol{\epsilon^C_{k_4}}; \lambda_{ij}, \mathbf{X^i}, \mathbf{X^j}) = \max_{k_4^{ij} \in K_4^{ij}} \; & \lambda_{ij} u^{C,i}(C_4^i, C_4^{Q,ij}, L_4^i; \mathbf{X^i}) \\
& + (1-\lambda_{ij}) u^{C,j}(C_4^j, C_4^{Q,ij}, L_4^j; \mathbf{X^j}) \\
& \quad + \epsilon^C_{k_4^{ij}} + \beta V_5^{C,ij}(A_5^{ij}; \mathbf{X^i}, \mathbf{X^j})
\end{aligned}
$$

$$
\begin{aligned}
\text{subject to: } & Q_4^i + L_4^i = 1; \qquad Q_4^j + L_4^j = 1 \\
& C_4^{ij} + A_5^{ij} = Y_4^{ij} = F_{ss}^C(Y_3^i, Y_3^j) + (1+r)A_4^{ij} \\
& C_4^{ij} = (1-\rho_4^{ij})Y_4^{ij} \\
& C_4^i + C_4^j = C_4^{ij}; \qquad C_4^i = s_{ij} C_4^{ij} \\
& C_4^{Q,ij} = \zeta_{ij}(\mathbf{X^i}, \mathbf{X^j}) f_Q(Q_4^i, Q_4^j)
\end{aligned}
$$

k : L (Leisure), Q (Home Production), M (Market Time), ρ (Savings Rate) Back

Value Functions - Married Couples

$$V_2^{C,ij}(H_2^i, H_2^j, A_2^{ij}, \boldsymbol{\epsilon_{k_3}^C}; \lambda_{ij}, \mathbf{X^i}, \mathbf{X^j}) = \max_{k_2^{ij} \in K_2^{ij}} \lambda_{ij} u^{C,i}(C_2^i, C_2^{Q,ij}, L_2^i; \mathbf{X^i})$$
$$+ (1-\lambda_{ij}) u^{C,j}(C_2^j, C_2^{Q,ij}, L_2^j; \mathbf{X^j}) + \epsilon_{k_2^{ij}}^C$$
$$+ \beta \mathbb{E}_{H_3^i, H_3^j, A_3^{ij}} \left[V_3^{C,ij}(H_3^i, H_3^j, A_3^{ij}; \lambda_{ij}, \mathbf{X^i}, \mathbf{X^j}) \right]$$

subject to: $M_2^i + Q_2^i + L_2^i = 1; \qquad M_2^j + Q_2^j + L_2^j = 1$

$$H_3^i = (1-\sigma) H_2^i + (M_2^i H_2^i)^\alpha$$
$$H_3^j = (1-\sigma) H_2^j + (M_2^j H_2^j)^\alpha$$
$$C_2^{ij} + A_3^{ij} = Y_2^{ij} = y_2^i(H_2^i, M_2^i, FC^i, \tau) + y_2^j(H_2^j, M_2^j, FC^j, \tau) + (1+r) A_2^{ij}$$
$$C_2^{ij} = (1-\rho_2^{ij}) Y_2^{ij}$$
$$C_2^i + C_2^j = C_2^{ij}; \qquad C_2^i = s_{ij} C_2^{ij}$$
$$C_2^{Q,ij} = \zeta_{ij}(\mathbf{X^i}, \mathbf{X^j}) f_Q(Q_2^i, Q_2^j)$$

k : L (Leisure), Q (Home Production), M (Market Time), ρ (Savings Rate)

Value Functions - Marriage

$$V^{f,2}(H_2^i, A_2^i, \boldsymbol{\theta^{i,g}}; \mathbf{X^i}) = \max_{k_2^i} \Big\{ V_2^{S,i}(H_2^i, A_2^i, \boldsymbol{\epsilon_{k_2}}; \mathbf{X^i}) + \theta_{i0}^{i,g},$$
$$\{V_2^{C,i}(H_2^i, H_2^j, A_2^{ij}, \boldsymbol{\epsilon_{k_3}^C}; \lambda_{ij}, \mathbf{X^i}, \mathbf{X^j}) + \theta_{ir}^{i,g}\}_{r=\forall j \in J}\} \Big\}$$

Back

Value Functions - Education

$$V^f(H_1^f, \boldsymbol{\epsilon^f_{k_1}}; \mathbf{X^f}) = \max_{k_1^f \in K_1^f} u^f(C_1^f) + \epsilon^f_{k_1^f} + \beta \mathbb{E}_{H_2^i}\left[V^{f,2}(H_2^i; \mathbf{X^i})\right]$$

subject to: $M_1^f + I_1^f = 1$

$$C_1^f = y_1^f(H_1^f, M_1^f, FC^f, \tau)$$

$$H_2^f = (1-\delta)H_1^f + (I_1^f H_1^f)^\alpha$$

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Value Functions - Households

Retirement: $V_4^C(Y_4^1, Y_4^2, A_4, \epsilon_4^C; \lambda_1, \mathbf{X}) = \max_{k_4 \in K_4} \lambda_1 u^1(L_4^1, C_4^1, C_4^Q; \mathbf{X^1})$

$+ (1-\lambda_1) u^2(L_4^2, C_4^2, C_4^Q; \mathbf{X^2}) + \beta V_5^C(A_5; \lambda_1, \mathbf{X}) + \epsilon_{k_4}^C$

T=3:Work $V_3^C(H_3^1, H_3^2, A_3, \epsilon_3; \lambda_1, \mathbf{X}) = \max_{k_3 \in K_3} \lambda_1 u^1(L_3^1, C_3, C_3^Q; \mathbf{X^1})$

$+ (1-\lambda_1) u^2(L_3^2, C_3, C_3^Q; \mathbf{X^2}) + \epsilon_{k_3}^C$

$+ \beta \sum_{Y_4, A_4} V_4^C(Y_4^1, Y_4^2; \lambda_1, \mathbf{X}) F(Y_4^1, Y_4^2, A_4 | Y_3^1, Y_3^2, A_3, k_3 = 1)$

T=2:Work $V_2^C(H_2^1, H_2^2, A_2, \epsilon_2; \lambda_1, \mathbf{X}) = \max_{k_2 \in K_2} \lambda_1 u^1(L_2^1, C_2^1, C_2^Q; \mathbf{X^1})$

$+ (1-\lambda_1) u^2(L_2^2, C_2^2, C_2^Q; \mathbf{X^1}) + \epsilon_{k_2}^C$

$+ \beta \sum_{H_3^1, H_3^2, A_3} V_3^C(H_3^1, H_3^2, A_3; \lambda_1, \mathbf{X}) F(H_3^1, H_3^2, A_3 | H_2^1, H_3^1, A_2, k_2 = 1)$

- Let $V_t^{C,1}(.)$ be the married female value function and $V_t^{C,2}(.)$ be the married male value function Equation Back

Value Functions - Education and Marriage

Marriage:

$$V^1(H_2;\lambda_1,\mathbf{X}) = \max_j \{V_2^S(H_2,A_2;\mathbf{X}) + \theta_{i0}^{i,g}, \{V_2^{C,1}(H_2,r;\lambda_1,\mathbf{X}) + \theta_{ir}^{i,g}\}_{r=\forall H_2^2}\}$$

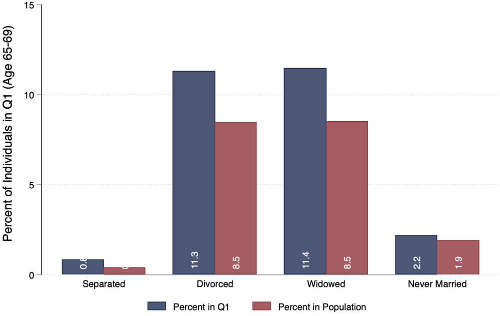
$$V^2(H_2;\lambda_1,\mathbf{X}) = \max_i \{V_2^S(H_2,A_2;\mathbf{X}) + \theta_{j0}^{j,g}, \{V_2^{C,2}(r,H_2;\lambda_1,\mathbf{X}) + \theta_{rj}^{j,g}\}_{r=\forall H_2^2}\}$$

Education:

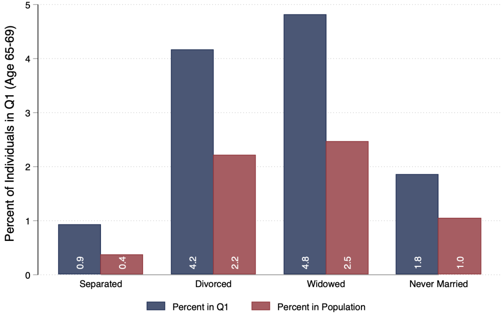
$$\begin{aligned} V^f(H_1,\epsilon_1;\lambda_1,\mathbf{X}) = \max_{k_1\in K_1} \; & u^S(C_1) + \epsilon_{k_1}^S \\ & + \beta \sum_{H_2} V^1(H_2;\lambda_1,\mathbf{X}) F(H_2|H_1,I_1) \end{aligned}$$

$$\begin{aligned} V^m(H_1,\epsilon_1;\lambda_1,\mathbf{X}) = \max_{k_1\in K_1} \; & u^S(C_1) + \epsilon_{k_1}^S \\ & + \beta \sum_{H_2} V^2(H_2;\lambda_1,\mathbf{X}) F(H_2|H_1,I_1) \end{aligned}$$

Divorced and Widowed Form Major Chunk of Single Females



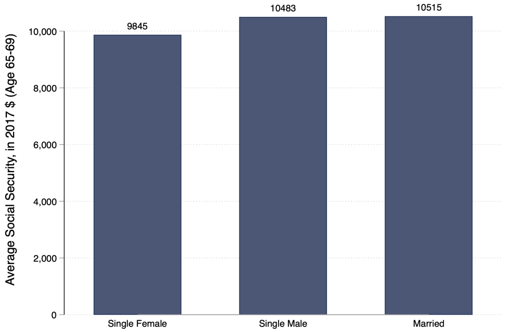
(a) Non-Hispanic White



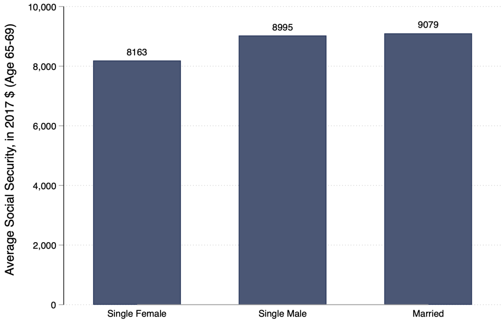
(b) Black

Back

Inherent Bias in Benefits



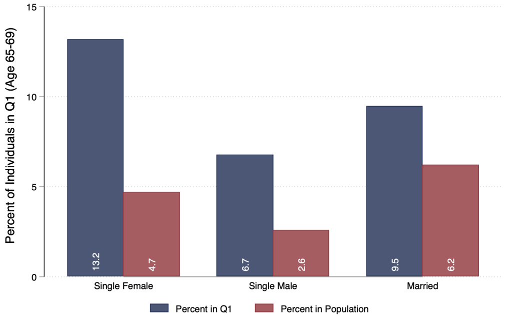
(a) Non-Hispanic White



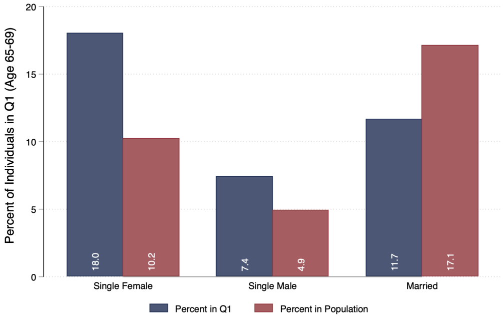
(b) Black

Back

LHS and HS Worst Off



(a) LHS



(b) HS

Back

Single Females Worst Off

	Obs.	Zero (%)	Reliance (%)	Mean	Median	S.D.
1940-49	40536	17.8	23.0	16779.9	15986.6	12696.8
By Marital Status and Gender						
Single Female	12300	19.0	29.4	12303.9	12382.4	9162.1
Single Male	6142	20.0	31.2	13233.1	13890.8	9647.2
Married	22094	16.6	17.1	20257.7	20850.7	14015.3

Back

Low Educated Most Reliant on Social Security

	Obs.	Zero (%)	Reliance (%)	Mean	Median	S.D.
By Education						
Less than High School	5427	17.7	38.5	13465.2	12175.1	10597.8
High School	13073	14.5	27.8	17221.7	16402.5	11968.9
Some College	10435	15.6	21.6	17408.3	16636.2	12456.5
College	11601	23.6	11.5	17267.3	17024.5	14277.2

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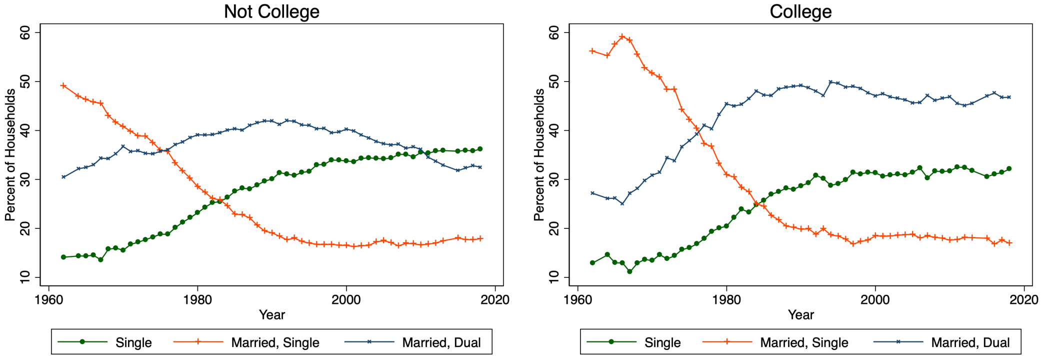
Nearly Half of Single, Low Educated Females Rely on Social Security

	Obs.	Zero (%)	Reliance (%)	Mean	Median	S.D.
By Education, Marital Status and Gender						
Less than High School						
Single Female	1893	18.8	43.1	9893.9	9931.0	7520.4
Single Male	1034	18.6	48.7	11359.2	11364.8	8596.4
Married	2500	16.6	30.7	17040.5	16926.3	12091.8
High School						
Single Female	4150	16.1	34.6	12584.4	12626.5	8746.6
Single Male	1992	17.0	35.9	13755.1	14594.3	9161.6
Married	6931	12.7	21.5	20994.7	21844.2	13028.2
Some College						
Single Female	3422	17.1	27.0	12923.6	13277.7	9017.9
Single Male	1548	17.9	29.1	14014.3	14769.4	9838.0
Married	5465	14.1	16.2	21177.8	21756.2	13708.0
College						
Single Female	2835	25.7	15.7	12754.3	13521.5	10569.7
Single Male	1568	26.8	15.8	13034.3	14496.3	10512.4
Married	7198	22.1	8.9	19966.9	20454.4	15533.0

Rise in Dual Earner Couples for College-Educated, Relative to Single



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Moments

Moments	Description	Pins down
1-8	Retirement, Couples, Home Production and Leisure	$\eta_Q, \eta_L, \beta_L, \beta_Q, \alpha$
9	Retirement, Couples, Consumption	η_C
10-12, 13-15, 16-18	Marriage market equations for males	$\lambda_{ij}, \Gamma_{ij}$
19-21, 22-24, 25-27	Marriage market equations for females	$\lambda_{ij}, \Gamma_{ij}$
28-29, 30-31	Retirement, Singles	Γ_1, Γ_2
32-40	Equilibrium clearing for marriage market	λ_{ij}
41-49	Equating model with data for marriage market, females	σ_η

Back

Stage 4: Retirement

- Couple's utility maximization problem:

$$
\begin{aligned}
V_4^{H,ij}(z_4^i, \boldsymbol{\epsilon^H_{k_4}}) = \max_{k_4^{ij} \in K_4^{ij}, s_4^{ij} \in [0,1]} & \lambda_{ij} u^{H,i}(C_4^i, C_4^{Q,ij}, L_4^i; \mathbf{X^i}) \\
& + (1-\lambda_{ij}) u^{H,j}(C_4^j, C_4^{Q,ij}, L_4^j; \mathbf{X^j}) \\
& + \epsilon^H_{k_4^{ij}} + \beta \sum_{z' \in z_5^{ij}} V_5^{H,ij}(z') F(z' | z_4^{ij}, \lambda_{ij}, k_4^{ij} = 1)
\end{aligned}
$$

subject to: $Q_4^i + L_4^i = 1; \qquad Q_4^j + L_4^j = 1$

$$
\begin{aligned}
& C_4^{ij} + A_5^{ij} = Y_4^{ij} = F_{ss}^C(Y_3^i, Y_3^j) + (1+r) A_4^{ij} \\
& C_4^{ij} = (1 - \rho_4^{ij}) Y_4^{ij} \\
& C_4^i + C_4^j = C_4^{ij}; \qquad C_4^i = s_4^{ij} C_4^{ij} \\
& C_4^{Q,ij} = \zeta_{ij}(\mathbf{X^i}, \mathbf{X^j}) f_Q(Q_4^i, Q_4^j)
\end{aligned}
$$

- λ_{ij}: Pareto weight of Female; s_4^{ij}: Share of consumption to female Back

Stage 3: Work-Life

$$V_t^{H,ij}(z', \lambda_{ij}, \boldsymbol{\epsilon^H_{k_t}}) = \max_{k_t^{ij} \in K_t^{ij}, s_t^{ij} \in [0,1]} \lambda_{ij} u^{H,i}(C_t^i, C_t^{Q,ij}, L_t^i; \mathbf{X^i}) + \epsilon^H_{k_t^{ij}}$$

$$+ (1-\lambda_{ij}) u^{H,j}(C_t^j, C_t^{Q,ij}, L_t^j; \mathbf{X^j}) + \beta \sum_{z' \in z_t^{ij}} V_{t+1}^{H,ij}(z', \lambda_{ij}) F(z' | z_t^{ij}, \lambda_{ij}, k_t^{ij} = 1)$$

subject to: $M_t^i + Q_t^i + L_t^i = 1; \qquad M_t^j + Q_t^j + L_t^j = 1$

$$H_{t+1}^i = (1-\sigma) H_t^i + (M_t^i H_t^i)^{\alpha_2}$$

$$H_{t+1}^j = (1-\sigma) H_t^j + (M_t^j H_t^j)^{\alpha_2}$$

$$C_2^{ij} + A_{t+1}^{ij} = Y_t^{ij} = y_t^i(H_t^i, M_t^i, FC^i, \tau) + y_t^j(H_t^j, M_t^j, FC^j, \tau) + (1+r) A_t^{ij}$$

$$C_t^{ij} = (1-\rho_t^{ij}) Y_t^{ij}$$

$$C_t^i + C_t^j = C_t^{ij}; \qquad C_t^i = s_t^{ij} C_t^{ij}$$

$$C_t^{Q,ij} = \zeta_{ij}(\mathbf{X^i}, \mathbf{X^j}) f_Q(Q_t^i, Q_t^j)$$

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Summary Statistics - PSID

Variable	Overall	Single		Married	
		Male	Female	Male	Female
Number of Individuals		583.00	721.00	1590.00	1590.00
		[0.00]	[0.00]	[0.00]	[0.00]
Education	11.94	10.57	11.02	12.45	12.40
	[3.87]	[4.96]	[4.21]	[3.80]	[3.44]
Married	0.71	0.00	0.00	1.00	1.00
	[0.45]	[0.00]	[0.00]	[0.00]	[0.00]
Father's Income	42150.82	38477.03	30854.45	43703.29	45385.57
	[18138.14]	[9190.38]	[7902.02]	[13539.98]	[19813.54]
Income (25-50)	19839.74	35096.82	18591.55	51197.12	17325.61
	[14746.15]	[15683.81]	[12808.58]	[30493.56]	[13234.17]
Income (51-64)	27848.86	32411.39	26211.59	58615.45	27383.61
	[27780.20]	[29978.30]	[27980.90]	[69538.00]	[27240.38]
Hours Worked (25-50)	1160.94	1807.35	1138.91	2048.19	1047.43
	[533.61]	[322.19]	[508.91]	[475.32]	[484.06]
Hours Worked (51-62)	1317.86	1368.71	1255.79	1792.42	1322.61
	[625.39]	[670.45]	[601.40]	[668.62]	[621.35]
Housework Hours (25-50)	707.94	126.20	410.41	236.87	882.05
	[546.21]	[117.28]	[331.70]	[174.03]	[530.00]
Housework Hours (51-62)	849.78	302.91	722.98	363.29	978.79
	[393.82]	[140.57]	[241.94]	[186.13]	[355.99]
Consumption (25-50)	27807.17	24568.12	24235.92	29210.70	29210.70
	[6612.80]	[4739.10]	[5110.36]	[6698.27]	[6698.27]
Consumption (51-62)	26109.40	22575.67	21063.84	27901.23	27901.23
	[7557.15]	[5000.69]	[5721.72]	[7568.77]	[7568.77]
Assets (25-50)	116425.66	82404.30	76894.42	131625.82	131625.82
	[239363.43]	[69147.71]	[120696.60]	[275405.24]	[275405.24]
Assets (51-62)	349650.38	247748.01	176935.25	407492.11	407492.11
	[930155.48]	[280001.70]	[342206.49]	[1080535.66]	[1080535.66]

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Summary Statistics - HRS

Variable	Overall	Single		Married	
		Male	Female	Male	Female
Number of Individuals		754.00	1286.00	2332.00	2332.00
		[0.00]	[0.00]	[0.00]	[0.00]
Education	12.70	12.63	12.35	12.94	12.81
	[3.08]	[3.26]	[3.18]	[3.34]	[3.02]
Married	0.70	0.00	0.00	1.00	1.00
	[0.46]	[0.00]	[0.00]	[0.00]	[0.00]
Income (51-62)	28356.86	36038.30	28067.68	38459.70	27194.79
	[27129.64]	[29265.12]	[23152.98]	[35558.05]	[27590.53]
Income (63+)	13216.73	14461.83	9686.79	9452.46	13991.06
	[22505.21]	[18449.43]	[14406.11]	[17778.92]	[24733.95]
Hours Worked (51-62)	875.02	1322.09	1054.22	1205.46	753.33
	[667.59]	[851.79]	[707.17]	[790.73]	[574.25]
Hours Worked (63+)	357.66	523.91	256.99	279.42	358.70
	[486.46]	[633.32]	[392.48]	[452.71]	[475.28]
Housework Hours (51-62)	1399.31	1074.22	1193.09	989.12	1508.73
	[340.60]	[193.72]	[237.98]	[234.48]	[323.00]
Housework Hours (63+)	1417.04	1169.02	1375.09	1111.12	1468.56
	[313.70]	[229.15]	[268.61]	[264.45]	[316.30]
Leisure Hours (51-62)	3833.67	3936.25	3944.89	3687.29	3786.41
	[236.66]	[165.76]	[196.32]	[164.45]	[241.08]
Leisure Hours (63+)	4252.55	4307.70	4334.70	4294.77	4220.98
	[290.58]	[184.27]	[250.82]	[240.09]	[308.55]
Consumption (51-62)	61738.01	41964.26	40549.22	70777.07	70777.07
	[23554.39]	[12840.76]	[13049.72]	[21337.95]	[21337.95]
Consumption (63+)	51600.71	34348.61	36498.08	58549.37	58549.37
	[21868.38]	[12648.69]	[12985.59]	[21352.58]	[21352.58]
Assets (51-62)	522601.40	406539.79	264328.37	612577.72	612577.72
	[1057791.97]	[1776348.28]	[835431.94]	[937053.79]	[937053.79]
Assets (63+)	807358.55	603522.19	359184.69	963947.11	963947.11
	[1572984.83]	[1796055.23]	[583808.87]	[1690330.61]	[1690330.61]

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Model Solution: Key CCPs

- From marriage choice,

$$p^f(k_2^{m,i} = r | z_2^i, \boldsymbol{z_2^m}, \boldsymbol{\lambda^i}) = \frac{\exp[V_2^{H,i}(z_2^{ir}, \lambda_{ir})/\sigma_\vartheta]}{\exp[V_2^{S,i}(z_2^i)/\sigma_\vartheta] + \sum_{r' \in J} \exp[V_2^{H,i}(z_2^{ir'}, \lambda_{ir'})/\sigma_\vartheta]}$$
$$= \frac{\mu_{ir}^s(\boldsymbol{z_2}, \lambda_{ir})}{f^i}$$

- From education choice,

$$p^f(e_1^f | z_1^f, \boldsymbol{p(e_1)}, \boldsymbol{\mathcal{X}^c}, \boldsymbol{\theta}) = \frac{\exp[v^f(e_1^f, z_1^f, \boldsymbol{p(e_1)}, \boldsymbol{\mathcal{X}^c}, \boldsymbol{\theta})/\sigma_\epsilon]}{\sum_{e' \in E_1^f} \exp[v^f(e', z_1^f, \boldsymbol{p(e_1)}, \boldsymbol{\mathcal{X}^c}, \boldsymbol{\theta}))/\sigma_\epsilon]}$$
$$= \frac{f_i(p^f(e_1^f | z_1^f))}{\mathcal{F}}$$

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Definition of Equilibrium

A stationary equilibrium consists of

(i) conditional choice probabilities for single women $p^{S,i}(k_t^i|z_t^i)$, single men $p^{S,j}(k_t^j|z_t^j)$ and married couples $p^{H,ij}(k_t^{ij}|z_t^{ij},\lambda_{ij})$ for work-life and retirement $(t=2,3,4)$, respectively;

(ii) conditional choice probabilities of marriage for females $p^f(k_2^{m,i}|z_2^i,\boldsymbol{z_2^m},\boldsymbol{\lambda_i})$ and males $p^m(k_2^{m,j}|z_2^j,\boldsymbol{z_2^m},\boldsymbol{\lambda_j})$ (iii) conditional choice probability of education for females $p^f(e_1^f|z_1^f,\boldsymbol{p(e_1)},\boldsymbol{\mathcal{X}^c}),\boldsymbol{\theta})$ and males $p^m(e_1^m|z_1^m,\boldsymbol{p(e_1)},\boldsymbol{\mathcal{X}^c}),\boldsymbol{\theta})$;

(iii) an optimal rule for the Pareto weight $\boldsymbol{\lambda(z_2,p(e_1),\mathcal{X}^c),\theta}$ and a sharing rule $s_t^{ij,*}(\lambda_{ij})$

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Estimation Strategy

1. For each set of parameters $\boldsymbol{\theta}$, we first calculate the optimal λ. For each guess of $\boldsymbol{\lambda}$,
   - Calculate the probability of education for measure of males and females in each education category
   - Construct $ED(\lambda_{ij}) = \mu^d_{ij}(\lambda_{ij}) - \mu^s_{ij}(\lambda_{ij})\ \forall i, j$.
   - We then construct a score which is the sum of squared errors of excess demand.
2. Iterate on this using two algorithms: `DBCPOL` and then `DBCONF` to get optimal $\boldsymbol{\lambda}(\boldsymbol{\theta})$.
3. With optimal $\boldsymbol{\lambda}(\boldsymbol{\theta})$, construct CCPs to calculate score
4. Iterate on $\boldsymbol{\theta}$ to using `DBCONF` to find optimal $\boldsymbol{\theta}$

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λ

Female Education	Male Education	
	No Col	Col
No College	0.861	0.866
College	0.870	0.875

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Key Empirical Facts

1. 23 percent of individuals derive more than 3/4th of their income from social security (1940-49 cohort, 65-69 years)

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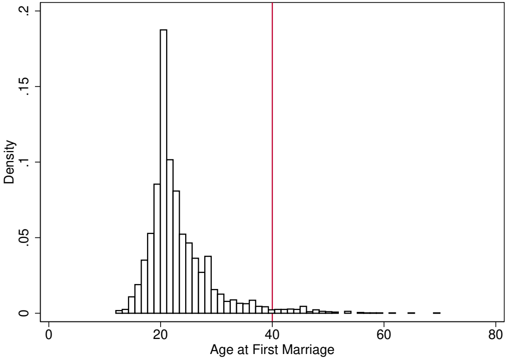
Education and Marriage plays a key role in reducing reliance on Social Security Back

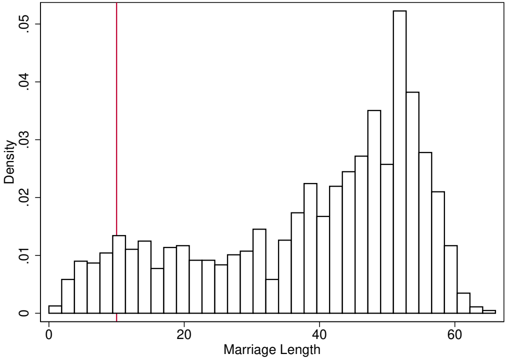
Estimates

Parameter	Type	Estimate (1940)	Estimate (1970)
η_Q	Utility Parameter	0.97	0.97
η_L	Utility Parameter	1.50	1.50
β_Q	Utility Parameter	2.46	2.46
β_L	Utility Parameter	1.53	1.53
α	Home Production	0.37	0.58
η_C	Utility Parameter	2.40	2.40
Γ_1^f	Home Production	2.57	4.48
Γ_2^f	Home Production	3.16	2.04
Γ_2^m	Home Production	3.86	2.19
$\Gamma_1^{c,f}$	Home Production	2.23	1.44
$\Gamma_2^{c,f}$	Home Production	1.51	1.55
Γ^h	Home Production	1.36	0.32
σ_n	Marriage	1.00	1.00
FC^f	Fixed Cost	2.78	0.50

Age at Marriage and Marriage Length



(a) Age at First Marriage



(b) Length of Longest Marriage

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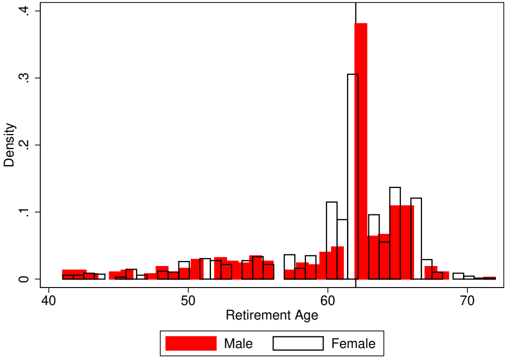
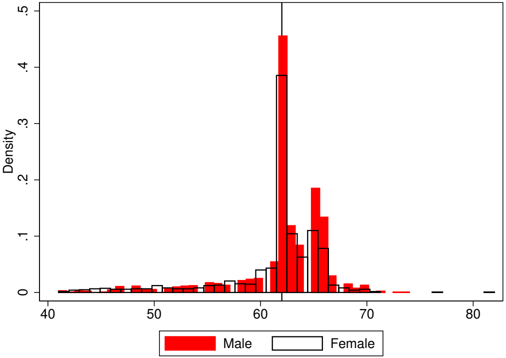
Retirement Age



(a) Single Households



(b) Married Households

◂ Back

Payroll Tax Parameters

Variable	Age $25-50$	Age $51-62$
Cap on Earnings (in 1000 Dollars)	75.53	104.97
Payroll Tax	5.31	6.20
Medicare	1.13	1.45

Note: These are calculated using Payroll Tax and Cap data from SSA. For ages 25-50 years, the years 1965-1999 are averaged and for ages 51-62 years, the ages 1991- 2011 are averaged.

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Income Tax Parameters

Variable	Age $25-50$	Age $51-62$
	Married Couples	
Income $\leq$65,000	0.18	0.17
Income $>$65,000 and $\leq$ 200,000	0.35	0.29
Income $\geq$ 200,000	0.53	0.36
	Single Households	
Income $\leq$ 32,500	0.16	
Income $>$32,500 and $\leq$ 100,000	0.32	
Income $\geq$ 100,000	0.52	
Income $\leq$ 32,500		0.14
Income $>$32,500 and $\leq$ 100,000		0.28
Income $\geq$ 100,000		0.36

Note: These are calculated using Income Tax Rates and Brackets over the years. For ages 25-50 years, the years 1965-1999 are averaged and for ages 51-62 years, the ages 1991- 2011 are averaged.

Social Security Benefits

- 90 percent of AIME $\leq$ Bend Point 1, 32 percent of AIME $>$ Bend Point 1 and AIME $\leq$ Bend Point 2, 15 percent of AIME $>$ Bend Point 2.

Bend Point	Value
Bend Point 1 (in 1000 Dollars)	9.75
Bend Point 2 (in 1000 Dollars)	58.78

Note: These are calculated using Social Security bend points over the years. We use the years 2002 onwards.

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Distribution of Initial Ability

	Male	Female
Low	13.30	15.84
High	86.70	84.16

Source: Author's calculations from Panel Study of Income Dynamics, 1968-2019 and Health and Retirement Survey, 1992-2018

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Human Capital in $T = 2$ (H_2)

	Male		Female	
	HS and below	College	HS and below	College
Wage, Age 25-50	27.05	30.50	20.28	24.85

Source: Author's calculations from Panel Study of Income Dynamics, 1968-2019 and Health and Retirement Survey, 1992-2018

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Returns to Human Capital

Variable	Value
Depreciation	0.00
Returns to Human Capital	1.13

Source: Author's calculations from Panel Study of Income Dynamics, 1968-2019 and Health and Retirement Survey, 1992-2018

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Remaining Parameters

Parameter	Meaning	Value	Source
β	Discount Factor	0.98	Voena (2015)
r	Rate of Return on Assets	0.03	Voena (2015)
b_1	Weight on Bequest	-107.6	De Nardi and Yang (2014)
b_2	Curvature of Bequest Function	16.5	De Nardi and Yang (2014)

◂ Back

Definition of Equilibrium

A stationary equilibrium consists of

(i) conditional choice probabilities for single women $p^{S,i}(k_t^i|z_t^i)$, single men $p^{S,j}(k_t^j|z_t^j)$ and married couples $p^{H,ij}(k_t^{ij}|z_t^{ij}, \lambda_{ij})$ for work-life and retirement $(t = 2, 3, 4)$, respectively;

(ii) conditional choice probabilities of marriage for females $p^f(k_2^{m,i}|z_2^i, \boldsymbol{z_2^m}, \boldsymbol{\lambda_i})$ and males $p^m(k_2^{m,j}|z_2^j, \boldsymbol{z_2^m}, \boldsymbol{\lambda_j})$

(iii) conditional choice probability of education for females $p^f(e_1^f|z_1^f, \boldsymbol{p(e_1)}, \boldsymbol{\mathcal{X}^c}), \boldsymbol{\theta})$ and males $p^m(e_1^m|z_1^m, \boldsymbol{p(e_1)}, \boldsymbol{\mathcal{X}^c}), \boldsymbol{\theta})$;

(iv) an optimal rule for the Pareto weight $\boldsymbol{\lambda(z_2, p(e_1), \mathcal{X}^c), \theta}$ and a sharing rule $s_t^{ij,*}(\lambda_{ij})$

Existence: [sketch] Conditional on $\boldsymbol{p(e_1)}$, existence of λ follows from Gayle and Shephard (2019); for $\boldsymbol{p(e_1)}$ to be a fixed point, use Brouwer's fixed point theorem Back

Construction of Choices

- Ability: Father's Income (proxy); Low: $< \$53,794$ (in 2015 \$)
- Education: HS ≤ 12 years; College > 12 years
- Work: NW ≤ 400 hours, PT $\in (400, 1400)$ hours, FT ≥ 1400 hours
- Home Production: Low, Medium, High - varies by age, gender and marital status
- Savings Rate: Low: $< 70\%$

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Parameters Set Outside the Model

- Taxation: Payroll Tax + Cap, Income Tax ▸ Payroll Tax ▸ Income Tax
- Social Security Benefits: Bend Points ▸ Social Security
- Distribution of Initial Ability ▸ Dist
- Human Capital in T=2 ▸ Wages
- Returns to Human Capital ▸ Returns
- β, r, Bequest (b_1, b_2) ▸ Remaining Parameters

◂ Back

Time Allocation

- An individual can spend his time in 3 ways: working (M_t), in home production (Q_t), and in leisure (L_t)

Stage	Time Allocation
Work-Life	M_t, Q_t, L_t
Retirement	$M_t = 0, Q_t, L_t$
$M_t + Q_t + L_t = 1$	

- M_t, Q_t, L_t take on multiple values; $M_t \in \{NW, PT, FT\}$

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Human Capital and its Evolution

- Households draw human capital and assets from log-normal distribution
- Deterministic evolution - δ: depreciation; α_2: returns to working

$$H^a_{t+1} = (1-\delta)H^a_2 + (M^a_t H^a_t)^{\alpha_2}$$

- Most uncertainty arises in the initial years (Guvenen et. al 2019)

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Income and Taxes

- Individual's before-tax income: $y_t^a(H_t^a, M_t^a, FC^a)$; fixed cost FC^a
- Individuals pay taxes

$$\tau(\boldsymbol{y_t}, \boldsymbol{X^\tau}) = \underbrace{\min\{\boldsymbol{y_t}, c^p\} * \tau^p}_{\text{payroll tax}} + \underbrace{\boldsymbol{y_t} * \tau^m}_{\text{medicare tax}} + \underbrace{\tau^i(\boldsymbol{y_t}, \boldsymbol{c^a}(\boldsymbol{X}), \tau^{i,a}(\boldsymbol{X}))}_{\text{income tax}}$$

- Retirement income:

$$\begin{aligned} F_{ss}^S(y_T^a) = {} & 0.9 * \min\{bp_1, y_T^a\} + 0.32 * \min\{bp_2 - bp_1, \\ & \max\{0, y_T^a - bp_1\}\} + 0.15 * \max\{0, y_T^a - bp_2\} \end{aligned}$$

- If married, spousal benefit:

$$F_{ss}^a(\boldsymbol{y_T}) = \min\{F_{ss}^S(y_T^a), 0.5 * F_{ss}^S(y_T^b)\}$$

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Budget Constraint

- Single household's budget constraint:

$$C_t^a + A_{t+1}^a = Y_t^a = y_t^a(H_t^a, M_t^a, FC^a) - \tau(y_t^a, \boldsymbol{X^\tau}) + (1+r)A_t^a$$

- Married household's budget constraint:

$$C_t^{ij} + A_{t+1}^{ij} = Y_t^{ij} = y_t^i(H_t^i, M_t^i, FC^i) + y_t^j(H_t^j, M_t^j, FC^j) - \tau(\boldsymbol{y_t}, \boldsymbol{X^\tau}) + (1+r)A_t^{ij}$$

- Choose how much to save ρ_t^a in each stage

$$C_t^a = (1-\rho_t^a)Y_t^a$$

- For married individuals, consumption is divided according to sharing rule s_t^{ab}

$$C_t^a + C_t^b = C_t^{ij}; \qquad C_t^a = s_t^{ab} C_t^{ab}$$

Back

Home Production

- Time spent in home production produces a non-marketable public good in the household
- For single households:

$$C_t^{Q,a} = \Gamma_a(\mathbf{X^i})Q_t^a$$

where $\Gamma^a(\mathbf{X^a})$: efficiency scale.

- For married households:

$$C_t^{Q,ij} = \Gamma_{ij}(\mathbf{X^i}, \mathbf{X^j})(Q^i)^{\alpha}(Q^j)^{1-\alpha}$$

where $\Gamma_{ij}(\mathbf{X^i}, \mathbf{X^j})$: efficiency scale of home production; α: returns to scale in home production time by wife

Back

Preferences

- Utility comes from three components: own consumption C_t^a, home production $C_t^{Q,a}$ and own leisure L_t^a
- For single households:

$$u^{S,a}(C_t^a, C_t^{Q,a}, L_t^a, \epsilon_t^a; \boldsymbol{X^a}) = u(C_t^a, C_t^{Q,a}, L_t^a; \boldsymbol{X^a}) + \epsilon_t^a$$

- For married households:

$$u^{H,ab}(C_t^{ab}, C_t^{Q,ab}, L_t^{ab}, \epsilon_t^{ab}; \boldsymbol{X^a}, \boldsymbol{X^b}) = \lambda^{ab} u(C_t^a, C_t^{Q,ab}, L_t^a; \boldsymbol{X^a}, \lambda^{ab})$$
$$+ (1 - \lambda^{ab}) u(C_t^b, C_t^{Q,ab}, L_t^b; \boldsymbol{X^b}, \lambda^{ab}) + \epsilon_t^{ab}$$

- Each households experiences Type 1 EV preference shocks ($\sim$ health shocks)

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Individual's Problem

- A female at time $t = 0$ solves: Back

$$\max_{\substack{i,k_m,\\ \{k_t^i, k_t^{i,k_m}\}_{t=2}^T}} \mathbb{E}\Bigg\{ \sum_{i=1}^{I} \underbrace{d_i}_{\text{education}} \Bigg[u(i; z_1) + \epsilon_i$$

$$+ \beta \underbrace{d_{k_m=0}}_{\text{single}} \Bigg(\mathbb{E}_{h,a}\Bigg\{ \sum_{t=2}^{T+1} \sum_{k_t^i}^{K_t^i} d_{k_t^i} \left[u(k_t^i; z_t^i) + \epsilon_{k_t^i} \right] \Bigg\} + \theta_{i0}^i \Bigg)$$

$$+ \beta \sum_{k_m=1}^{J} \underbrace{d_{k_m}}_{\text{household}} \Bigg(\mathbb{E}_{h_i, h_{k_m}, a}\Bigg\{ \sum_{t=2}^{T+1} \sum_{k_t^{i,k_m}}^{K_t^{i,k_m}} d_{k_t^{i,k_m}} \Big[u(k_t^{i,k_m}, s_t^{i,k_m}; z_t^{i,k_m})$$

$$+ \epsilon_{k_t^{i,k_m}} \Big] \Bigg\} + \theta_{i,k_m}^i \Bigg) \Bigg] | z_1 \Bigg\}$$

subject to time allocation constraints, evolution of human capital, and budget constraints

Individual's Problem

- A female at time $t = 0$ solves:

$$
\max_{\substack{i, k_m, \\ \{k_t^i, k_t^{i,k_m}\}_{t=2}^T}} \mathbb{E}\Bigg\{ \sum_{i=1}^{I} \underbrace{d_i}_{\text{education}} \Bigg[u(i; z_1) + \epsilon_i
$$

$$
+ \beta \underbrace{d_{k_m=0}}_{\text{single}} \Bigg(\mathbb{E}_{h,a} \Bigg\{ \sum_{t=2}^{T+1} \sum_{k_t^i}^{K_t^i} d_{k_t^i} \Big[u(k_t^i; z_t^i) + \epsilon_{k_t^i} \Big] \Bigg\} + \theta_{i0}^i \Bigg)
$$

$$
+ \beta \sum_{k_m=1}^{J} \underbrace{d_{k_m}}_{\text{household}} \Bigg(\mathbb{E}_{h_i, h_{k_m}, a} \Bigg\{ \sum_{t=2}^{T+1} \sum_{k_t^{i,k_m}}^{K_t^{i,k_m}} d_{k_t^{i,k_m}} \Big[u(k_t^{i,k_m}, s_t^{i,k_m}; z_t^{i,k_m})
$$

$$
+ \epsilon_{k_t^{i,k_m}} \Big] \Bigg\} + \theta_{i,k_m}^i \Bigg) \Bigg] | z_0 \Bigg\}
$$

- choose i (education); $z_0 = [y_1^p, \boldsymbol{X^f}]$

Individual's Problem

- A female at time $t = 0$ solves:

$$\max_{\substack{i,k_m,\\ \{k_t^i,k_t^{i,k_m}\}_{t=2}^T}} \mathbb{E}\Bigg\{ \sum_{i=1}^{I} \underbrace{d_i}_{\text{education}} \Bigg[u(i; z_1) + \epsilon_i$$

$$+ \beta \underbrace{d_{k_m=0}}_{\text{single}} \Bigg(\mathbb{E}_{h,a}\Bigg\{ \sum_{t=2}^{T+1} \sum_{k_t^i}^{K_t^i} d_{k_t^i} \Big[u(k_t^i; z_t^i) + \epsilon_{k_t^i} \Big] \Bigg\} + \theta_{i0}^i \Bigg)$$

$$+ \beta \sum_{k_m=1}^{J} \underbrace{d_{k_m}}_{\text{household}} \Bigg(\mathbb{E}_{h_i,h_{k_m},a}\Bigg\{ \sum_{t=2}^{T+1} \sum_{k_t^{i,k_m}}^{K_t^{i,k_m}} d_{k_t^{i,k_m}} \Big[u(k_t^{i,k_m}, s_t^{i,k_m}; z_t^{i,k_m})$$

$$+ \epsilon_{k_t^{i,k_m}} \Big] \Bigg\} + \theta_{i,k_m}^i \Bigg) \Bigg] | z_1 \Bigg\}$$

- choose k_m (marriage); $z_1 = [i, \boldsymbol{X^i}]$

Individual's Problem

- A female at time $t = 0$ solves:

$$\max_{\substack{i,k_m,\\ \{k_t^i,k_t^{i,k_m}\}_{t=2}^T}} \mathbb{E}\Bigg\{ \sum_{i=1}^{I} \underbrace{d_i}_{\text{education}} \Bigg[u(i;z_1) + \epsilon_i$$

$$+ \beta \underbrace{d_{k_m=0}}_{\text{single}} \Bigg(\mathbb{E}_{h,a}\Big\{ \sum_{t=2}^{T+1} \sum_{k_t^i}^{K_t^i} d_{k_t^i} \Big[u(k_t^i; z_t^i) + \epsilon_{k_t^i} \Big] \Big\} + \theta_{i0}^i \Bigg)$$

$$+ \beta \sum_{k_m=1}^{J} \underbrace{d_{k_m}}_{\text{household}} \Bigg(\mathbb{E}_{h_i,h_{k_m},a}\Big\{ \sum_{t=2}^{T+1} \sum_{k_t^{i,k_m}}^{K_t^{i,k_m}} d_{k_t^{i,k_m}} \Big[u(k_t^{i,k_m}, s_t^{i,k_m}; z_t^{i,k_m})$$

$$+ \epsilon_{k_t^{i,k_m}} \Big] \Big\} + \theta_{i,k_m}^i \Bigg) \Bigg] |z_1 \Bigg\}$$

- choose $k_t^i = [M_t, Q_t, \rho_t]$ (if single); $z_t^i = \{H_t^i, A_t^i, \boldsymbol{X^i}\}$

- A female at time $t = 0$ solves: Back

$$\max_{\substack{i,k_m,\\ \{k_t^i, k_t^{i,k_m}\}_{t=2}^T}} \mathbb{E}\Bigg\{\sum_{i=1}^{I} \underbrace{d_i}_{\text{education}} \Bigg[u(i; z_1) + \epsilon_i$$

$$+ \beta \underbrace{d_{k_m=0}}_{\text{single}} \Bigg(\mathbb{E}_{h,a}\Bigg\{\sum_{t=2}^{T+1}\sum_{k_t^i}^{K_t^i} d_{k_t^i}\Big[u(k_t^i; z_t^i) + \epsilon_{k_t^i}\Big]\Bigg\} + \theta_{i0}^i\Bigg)$$

$$+ \beta \sum_{k_m=1}^{J} \underbrace{d_{k_m}}_{\text{household}} \Bigg(\mathbb{E}_{h_i,h_{k_m},a}\Bigg\{\sum_{t=2}^{T+1}\sum_{k_t^{i,k_m}}^{K_t^{i,k_m}} d_{k_t^{i,k_m}}\Big[u(k_t^{i,k_m}, s_t^{i,k_m}; z_t^{i,k_m})$$

$$+\epsilon_{k_t^{i,k_m}}\Big]\Bigg\} + \theta_{i,k_m}^i\Bigg)\Bigg]\Big|z_1\Bigg\}$$

- choose $k_t^{i,k_m} = [M_t^i, Q_t^i, M_t^{k_m}, Q_t^{k_m}, \rho_t]$ (if single); $z_t^{i,k_m} = \{H_t^i, H_t^{k_m}, A_t^{i,k_m}, \lambda^{i,k_m}, \boldsymbol{X^i}, \boldsymbol{X^{k_m}}\}$

Marriage Market Clearing

- Supply = demand

$$\mu_{ij}(\boldsymbol{\lambda}) = \mu_{ij}^{d}(\boldsymbol{\lambda^{i}}) = \mu_{ij}^{s}(\boldsymbol{\lambda^{j}})$$

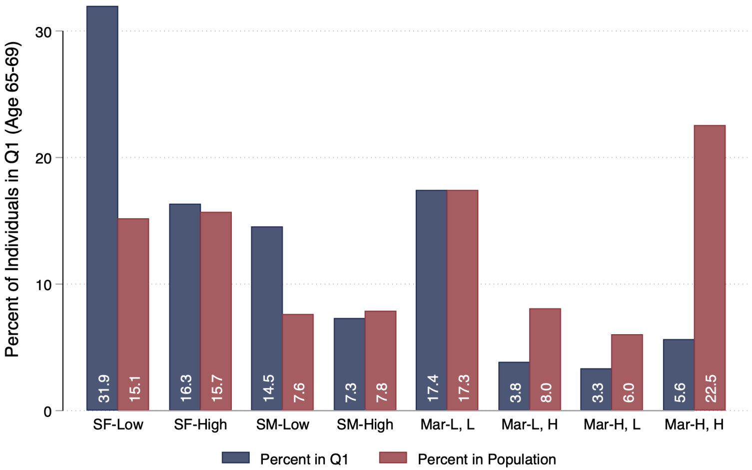
- Married + Single = Total of that type

$$\sum_{j\in\{1,2\}} \mu_{ij}^{s}(\boldsymbol{\lambda}) + \mu_{i0}^{s} = f^{i}(p^{f}(i|z_1^{f},\boldsymbol{\lambda}),\mathcal{F}) \quad \forall i \in I$$

$$\sum_{i\in\{1,2\}} \mu_{ij}^{d}(\boldsymbol{\lambda}) + \mu_{0j}^{d} = m^{j}(p^{m}(j=1|z_1^{m},\boldsymbol{\lambda}),\mathcal{M}) \quad \forall j \in J$$

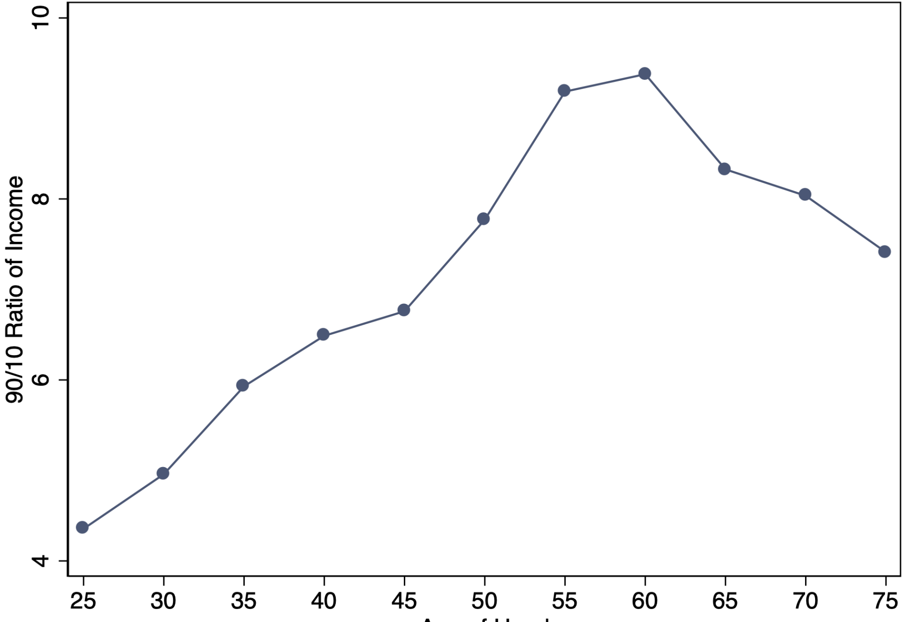
Back

Who Forms the Bottom Quintile?

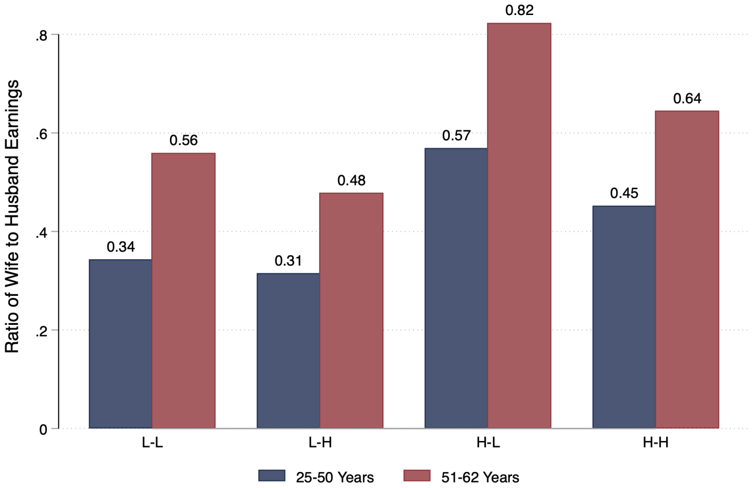


Back

Househ



Ratio of Wife/Husband Earnings Vary with the Type of Household



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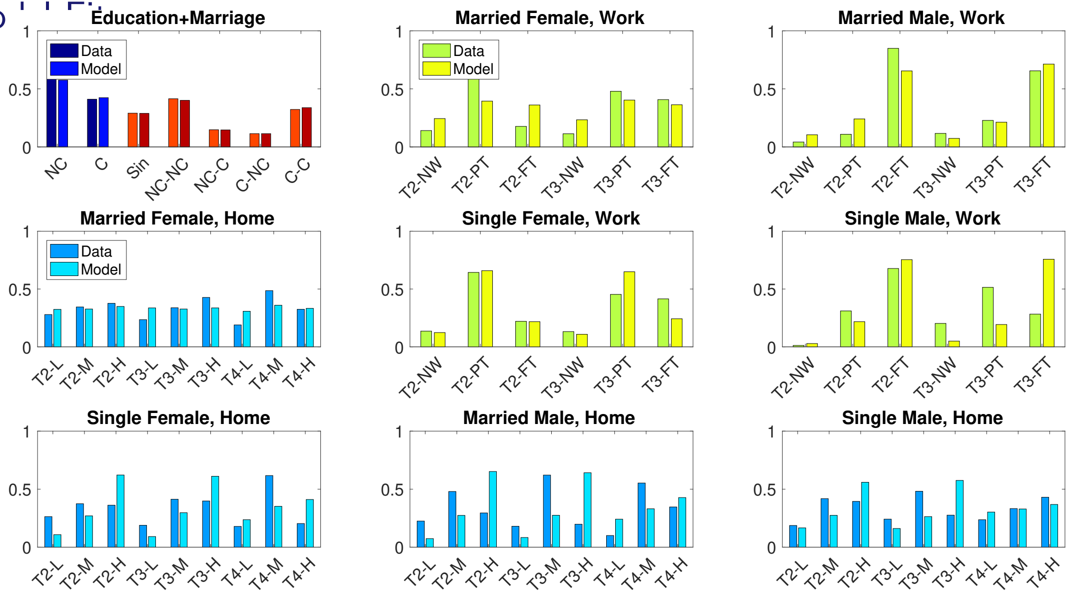
Model Fit



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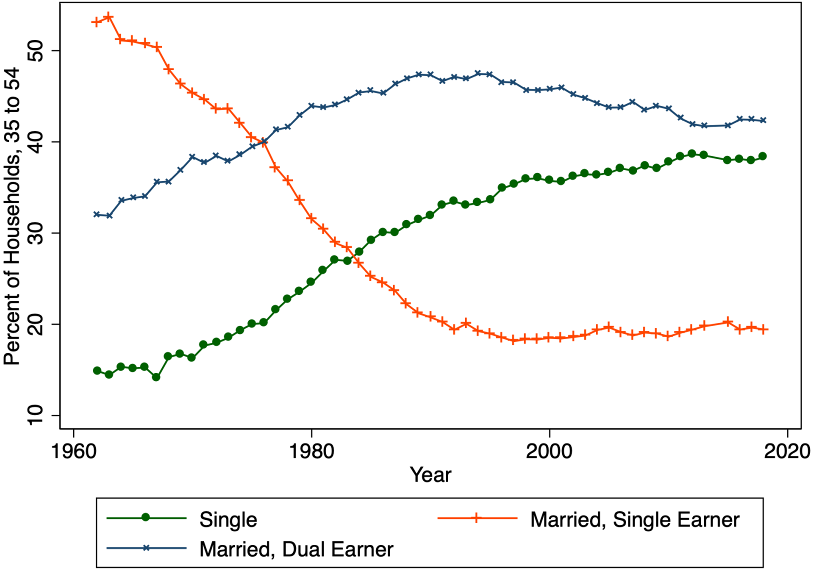
Specification

- Utility function:

$$u^a(L, C, C^Q; \mathbf{X}) = \frac{C^{1-\eta_C} - 1}{1-\eta_C} + \beta_Q \frac{(C^Q)^{1-\eta_Q} - 1}{1-\eta_Q} + \beta_L \frac{L^{1-\eta_L} - 1}{1-\eta_L}$$

◂ Back

Single Hou



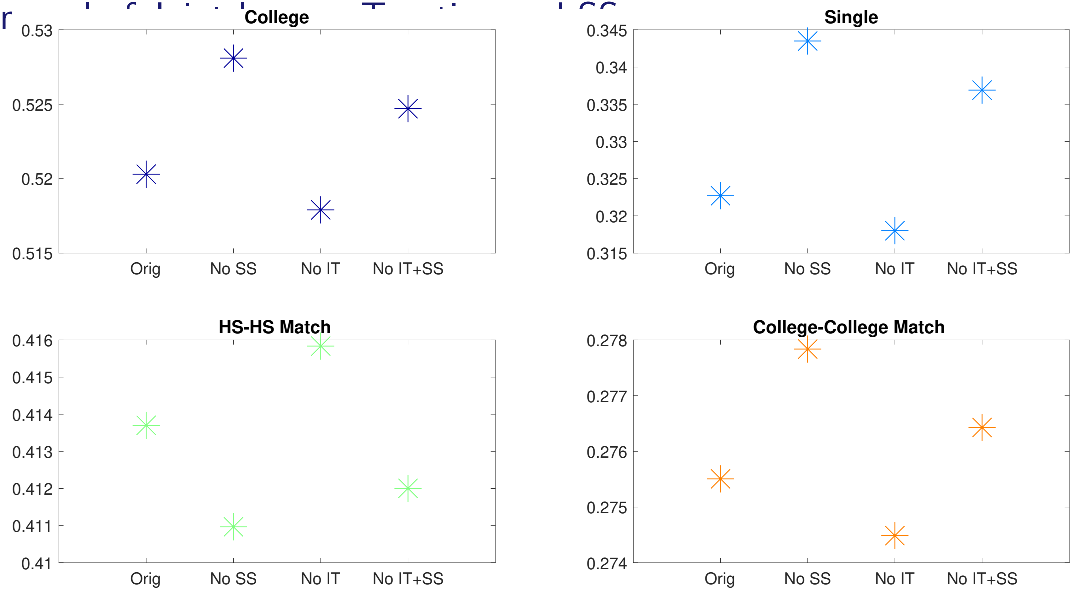
Percent of Households, 35 to 54
10
20
30
40
50
1960
1980
2000
2020
Year
Single
Married, Single Earner
Married, Dual Earner

Identification

- Utility Parameters on Consumption (η_C): Variation in savings rate choice in retirement stage from single's problem
- Utility Parameters on Home Production and Leisure ($\beta_L, \beta_Q, \eta_L, \eta_Q$): Variation in choices in work-life of singles (couples)
- Home Production Parameters ($\mathbf{\Gamma}, \alpha$): Variation in the home production choices with types for each gender; and within household types for married couples
- Fixed Costs: Variation in choice of work across singles (couples)
- Variance of love shock: Comparison of model generated singles with the data

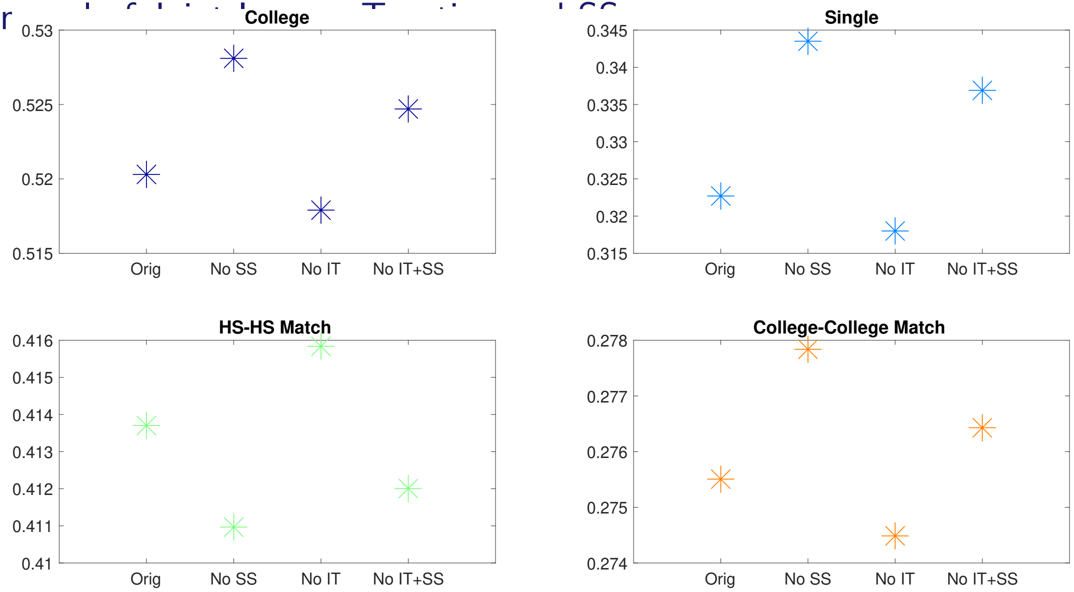
Equilibrium Back

Rer



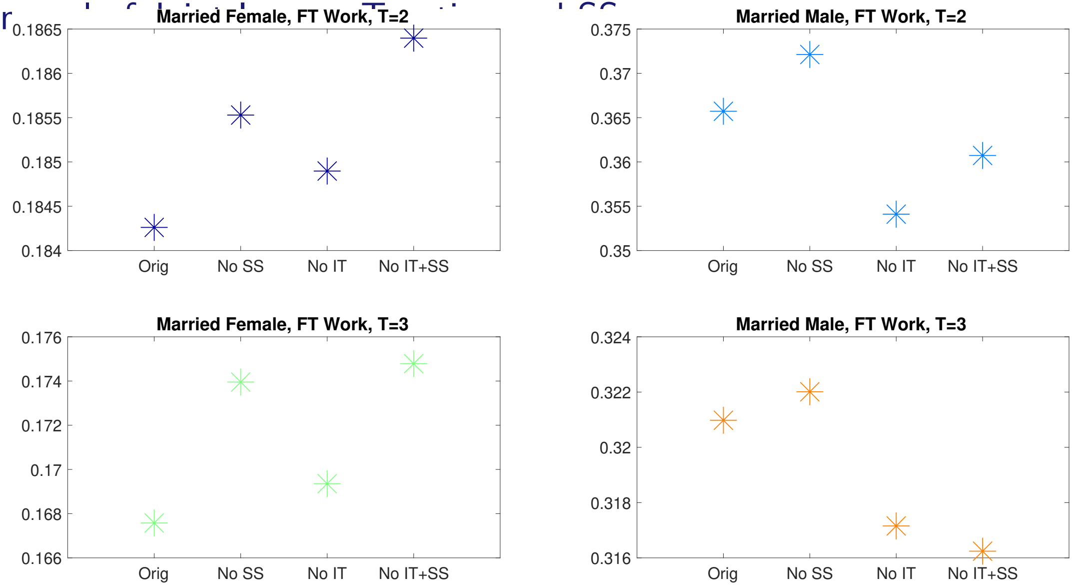
- No Joint IT $\implies$ higher cost of working, fall in marriage and labor market return

Rer



- No Joint IT $\implies$ increased marriage, higher bargaining power of women

Rer



- No Joint IT $\Longrightarrow$ females work more due to lower cost in terms of taxes; males

Percent Change in λ

Policy	NC-NC	NC-C	C-NC	C-C
Payroll Taxes	-0.51	-0.48	-0.49	-0.46
No SB	-0.19	-0.17	-0.18	-0.17
No IT	0.19	0.16	0.15	0.13
No SB+IT	-0.01	-0.02	-0.03	-0.05

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Background and Data

Retirement System: Background

- Three pillars: Social security, employment-based pensions and own savings
- Set up in 1935, social security 'earned right'
  - 'Genderless'; differential treatment built-in
  - Expanded to include wives and widows in 1939
- Benefits based on highest 35 years of earnings
  - Progressive in nature
- Payroll taxes $\rightarrow$ Trust Fund; insolvency a concern: Benefits need to be 75% in 2033
  - Worker to beneficiary ratio: $>$20 in 1950s to $<$ 5 in 2020s

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Data

- Datasets used: PSID, HRS (Public+Restricted), CAMS ▸ PSID ▸ HRS ▸ Choice Set
- Male: 1940-1949 cohort; Female: 1940-1954 cohort
- Education: HS or Below (Not College); Some College and Above (College)
- Married: Longest marriage that lasts ≥ 10 years for age at marriage $\leq$ 46 years ▸ Marriage

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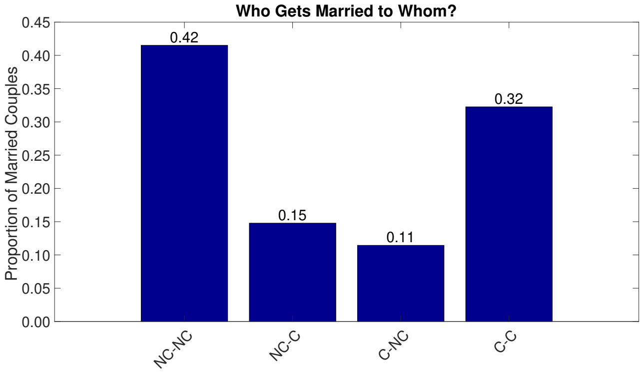
Key Statistics

- College: 41%
- Single: 29%
- NC: Not College;
  C: College



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Estimation

- T=1: Age 18-24; T=2: Age 25; T=3: Age 25-49; T=4: 50-62; T=5: 63-99
  Retirement Age
- Parameters estimated outside the model Parameters-1
  - Taxation, social security benefits, distribution of human capital, β, r, bequest parameters
- Parameters to estimate ($\boldsymbol{\theta}$):
  - Utility: $\eta_C, \beta_Q, \eta_Q, \beta_L, \eta_L$
  - Home Production: $\{\boldsymbol{\Gamma^i}\}_{i=1,2}, \{\boldsymbol{\Gamma^j}\}_{j=1,2}, \{\boldsymbol{\tilde{\Gamma}_i}\}_{i=1,2}, \Gamma_{i=j}, \alpha$
  - Fixed Costs: $FC^f_{ft}, FC^f_{pt}, FC^m_{pt}, FC^m_{ft}$
- Semi-parametric identification (Magnac and Thesmar, 2002) + Identification of λ (Gayle and Shephard, 2019) Identification

Estimation Method

- Two-step estimation:
  1. For each set of parameters $\boldsymbol{\theta}$, calculate optimal $\boldsymbol{\lambda}(\boldsymbol{\theta})$ by minimizing excess demand
  2. With optimal $\boldsymbol{\lambda}(\boldsymbol{\theta})$, construct CCPs to calculate score

$$\hat{\theta} = \arg\min [h(\theta)]^T W [h(\theta)]$$

Key CCPs Algorithm

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Summary of Estimates

- Home Production:
  - High gains from homogamy in marriage
  - Higher weight on female time in home production (~ 0.8)
- Fixed costs:
  - Higher for females compared to males
  - 8 times higher for part-time and 4 times higher for full-time
- Utility Parameters
  - Consumption $\eta_C = 2.2$
  - Most weight on home production
- Pareto Weight
  - Higher weights for college educated

▸ Parameters ▸ Lambda ◂ Back

Key Mechanisms

human capital $\Leftrightarrow$ marital status $\Leftrightarrow$ retirement earnings

- Retirement earnings $\Rightarrow$ education, marital status
- Education, marital status $\Rightarrow$ retirement earnings
  - Low educated, single females form disproportionately represented in the bottom quintile at 65-69 years Who?
- Marriage and within-household decisions affect labor force participation and income Ratio-HW
  - Within household income inequality higher for low-low couples compared to high-low couples (wife-husband)
- Returns to education two-fold: Labor markets + marriage market returns

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Preferences and Household Decision Making ◂ Summary ◂ Model

- Individual utility from: Private consumption, home production good, and own leisure
  - Additively separable and risk-averse ▸ Specification
- Collective model: Household formed by many individuals
- Weighted sum of utilities $\lambda^{i,k^m} \leftarrow$ prices that clear frictionless marriage market ▸ Utility
- Distribution of resources endogenous s^{ij}
- Assume allocations are Pareto-efficient
- Imperfectly transferable utility: Time allocation decisions and taxation/social security benefits relevant

Home Production

- Time spent at home, Q_t, produces a non-marketable public good
- Efficiency scales $\Gamma^{a,k_m=0}(g,a)$ vary by gender, g, and education, a

$$C_t^{Q,a} = \Gamma^{a,k_m=0}(g,a)Q_t^a$$

- Couples: Time input of both spouses; α: Returns to scale in home production by wife;

$$C_t^{Q,ij} = \Gamma_{ij}(\mathbf{X^i}, \mathbf{X^j})(Q^i)^\alpha(Q^j)^{1-\alpha}$$

- Efficiency scales, Γ_{ij}, vary by type of household
  - Homogamy component $\Gamma_{i=j}$ and based on female $\tilde{\Gamma}_i$

  $\rightarrow$ $\Gamma_{ij} = \Gamma_{i=j} \times \tilde{\Gamma}_i$ (Gayle and Shephard 2019)
  - Assortative mating

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Human Capital and Income

- Before work-life, uncertainty in human capital (Guvenen et. al, 2019)
- Human capital follows deterministic evolution through work-life
  - Depends on time spent working, M_t, and human capital previous period ▸ Human Capital
  - Varies by gender
- Income is a function of human capital, H, and time worked, M; fixed cost of working, $FC_f^g t$

$$Y_t(H, M, FC, g) = (1 - \tau)HM - \mathbb{1}[PT]FC_p^g t - \mathbb{1}[FT]FC_f^g t$$

- $M_t \implies$ higher consumption today + higher human capital tomorrow (learning-by-doing)

◂ Back

Taxes, Assets and Consumption

- Taxes: payroll, medicare, income (joint)
  - Payroll taxes funds social security system
  - Income tax varies by marital status
- Receive social security (and spousal benefits if married) during retirement

Income Tax

- Standard asset accumulation as a result of savings ρ_t Budget Constraint
- For married, consumption a function of sharing rule, s^{ij}
  - Joint assets + one-time marriage $\Rightarrow s^{ij}(\lambda^{ij})$
- Bequests (De Nardi, 2004)

$$u_{T+1}(A_T; \mathbf{X}) = b_1[(b_2 + A_T)^{1-\eta_C} - 1]$$

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