Universal Basic Income: A Dynamic Assessment

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Economic Challenges of Demographic Inequalities
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Outline

Motivation

Universal Basic Income (UBI)

- Unconditional cash transfer: people can choose how to use the funds
- Universal and substantial

Increasingly popular policy proposal (even more so with the pandemic)

Proposed to help with:

- Inadequacies of current social safety net
- Growing inequality and low intergenerational mobility
- Robotization/Automation – "The robots are coming!"

But what are the consequences of a UBI?

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- We only have some partial short-run evidence from a variety of cash transfer programs (e.g., Gentilini et al (2019); Developing countries: Banerjee, Niehaus and Suri (2019), Hanna and Olken (2018); Developed countries: Hoynes and Rothstein (2019))
- Especially ignorant of the longer-run larger-scale consequences of UBI

Use quantitative model as an inexpensive "test"

- Particularly interested in the channels by which UBI affects welfare

Outline

1. **Model:**

   GE Life-cycle Aiyagari + Endogenous IG Links

   GE Life-cycle Aiyagari:
   - Uninsurable **wage shocks** & limited borrowing
   - Wage depends on **skills** and **education**

   Endogenous IG Links:
   - **Parental investments to build child's skills**
   - **Parental transfers**

2. **Estimation:**
   - Use U.S. household data close to the year 2000 (base year for prices)
   - Progressive tax function including deductions, credits, cash transfers.

3. **Validation:**
   - Model is in line with small-scale short-run
     - **cash transfer evidence** on **labor supply elasticity** and **child development**
     - **lottery winnings** and **labor earnings**
   - Model matches well untargeted moments related to inequality

4. **Policy:** Universal Basic Income (UBI)
   - Understanding the key role played by dynamics of K accumulation and intergenerational linkages
   - Additional UBI Results
     - Alternative forms of taxation
     - Higher prob. of being out of work (Automation/robotization)

Literature

Brief Preview of Results

Universal Basic Income: Effects of $8,000 a year

- **Every cohort suffers welfare losses**
  - Adult agents at $t = 0$ on average lose 6% c.e.
  - New steady state: 22% $\downarrow$ c.e.
  - Inequality falls

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- **UBI decreases labor supply, skills, education, savings, and inequality**
  - Y falls by 20% in LR, about half due to $\downarrow K$ and the remainder to $\downarrow$ efficiency units of labor (skills, college, and labor supply)
  - Inequality in post-tax income $\downarrow$ and intergenerational mobility $\uparrow$

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- **K dynamics and intergenerational links play key roles in welfare results**
  - Endogenous skills account for half the long-run welfare losses but almost none of the losses for adults
  - Replacing endogenous capital stock and interest rate with exogenous ones decreases LR welfare losses by even more and adults gain from UBI
  - Mirleesian-style decomoposition shows even small transfer decreases welfare once it is received by all, even in PE but larger losses in GE

Outline

Model: Outline

GE Aiyagari-style model

- 4 stages (80 years, 20 periods): childhood, college, work, retirement
- Uncertainty and incomplete markets
- Endogenous borrowing, saving, labor supply, and college choices
- Wage depends on age, education, skills, and shock (incl. out-of-work shock)
- Aggregate firm: combines capital, non-college labor, and college labor

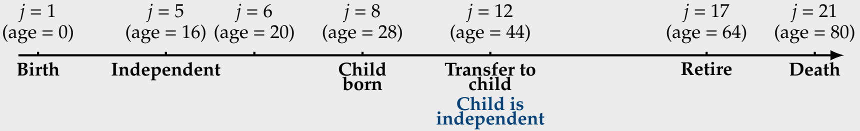
Endogenous intergenerational links

- Parent cares about child's welfare
- Parent invests in child's skills
  - Production function based on Cunha, Heckman, Schennach (2010)
- Monetary transfer to child

Potential role for government intervention because of:

- Imperfect capital and insurance markets
- Inability of parents to write contracts with children

Model: Timeline



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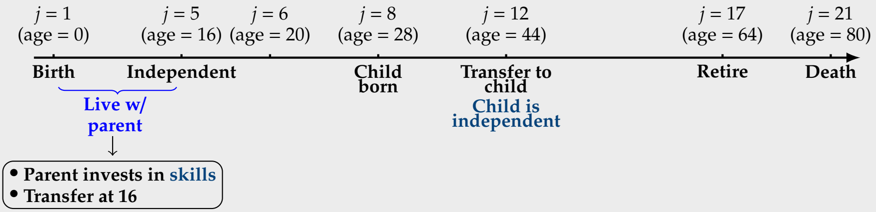

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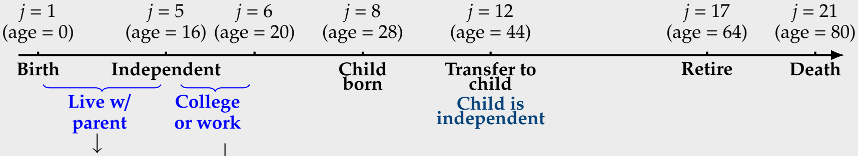
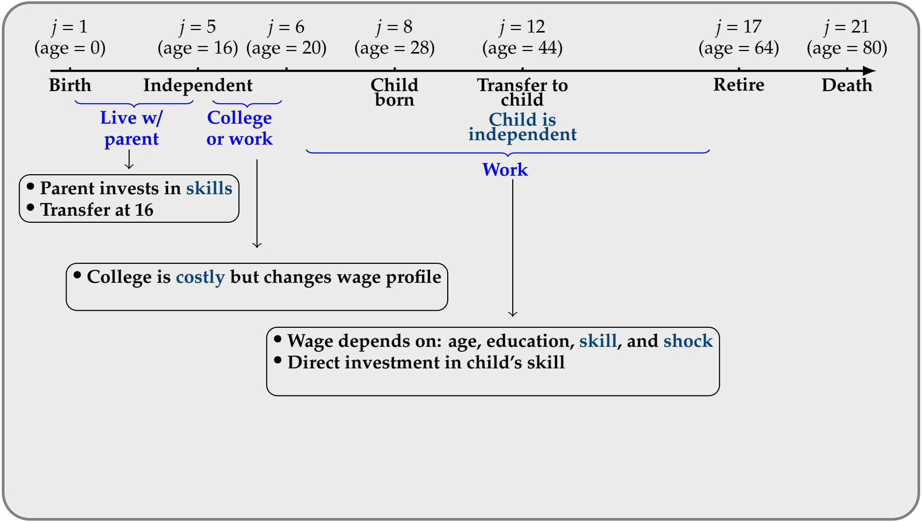


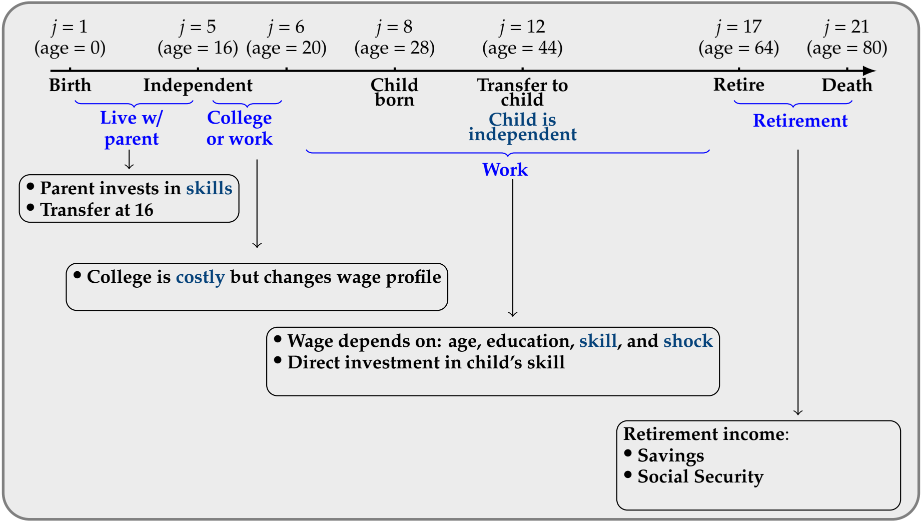
- **Parent invests in skills**
- **Transfer at 16**

- **College is costly but changes wage profile**

Model: Timeline

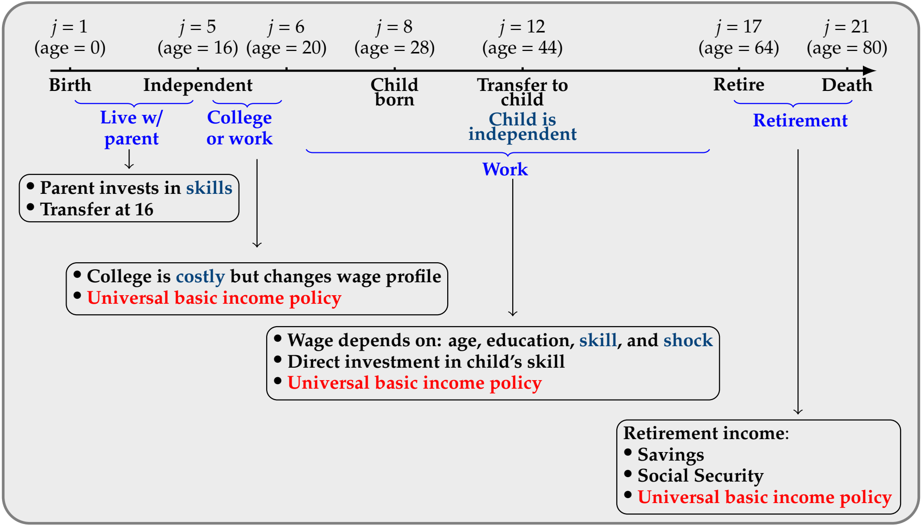


Model: Timeline



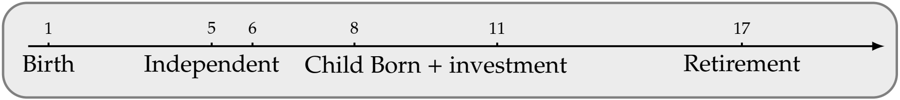
▸ Stationary Equilibrium

Model: Timeline



▸ Stationary Equilibrium

Work



$$V_j\left(a, \boldsymbol{\theta}, e, \eta \right) = \max_{c,a',h} u(c,h) + \beta \mathbb{E}\left[V_{j+1}\left(a', \boldsymbol{\theta}, e, \eta' \right)\right]$$

$$c + a' = y + a\left(1+r\right) - T\left(y, a, c\right)$$

$$y = h w_e E_{j,e}\left(\boldsymbol{\theta}, \eta\right) \quad , \quad a' \geq \underline{a}_j \quad , \quad 0 \leq h \leq 1, \quad \eta' \sim \Gamma_{j,e}(\eta)$$

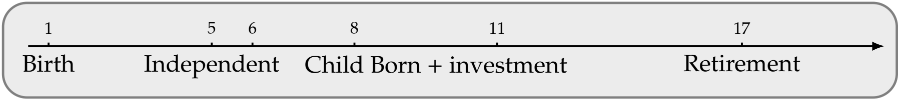
where

a : assets $\qquad$ $\boldsymbol{\theta}$: agent's skills

e : education

η : wage shock

Intergenerational Links: Child's Skills



$$V_j\left(a, \boldsymbol{\theta}, e, \eta, \boldsymbol{\theta}_k\right) = \max_{c, a', h, m} u(c, h) + \beta \mathbb{E}\left[V_{j+1}\left(a', \boldsymbol{\theta}, e, \eta', \boldsymbol{\theta}'_k\right)\right]$$

$$c + a' + m = y + a\left(1 + r\right) - T\left(y, a, c\right)$$

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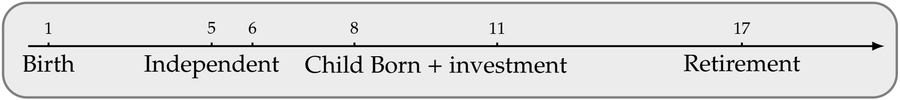
where

a : assets — $\boldsymbol{\theta}$: agent's skills

e : education — $\boldsymbol{\theta}_k$: child's skills

η : wage shock — m : money towards child's skills

Intergenerational Links: Child's Skills



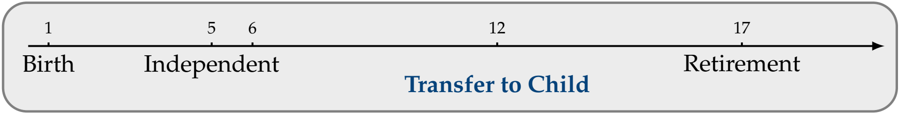
$$\underbrace{\boldsymbol{\theta}'_k}_{\text{Next period's child's skills}} = \left[\alpha_{1j} \underbrace{\boldsymbol{\theta}_k^{\rho_j}}_{\text{Current child's skills}} + \alpha_{2j} \underbrace{\boldsymbol{\theta}^{\rho_j}}_{\text{Parent's skills}} + \alpha_{3j} \underbrace{\mathrm{I}^{\rho_j}}_{\text{Parental investments}}\right]^{1/\rho_j} \exp(\boldsymbol{\nu})$$

$$\mathrm{I} = \bar{A}m \qquad m \geq 0 \qquad \boldsymbol{\nu} \sim N(0, \boldsymbol{\sigma}_{\nu j})$$

Based on Cunha el al. (2010)

Initial draw of skills depends on parental skill (AR1)

Intergenerational Links: Transfer to Child



Monetary transfer decision $\hat{a}$: made knowing own productivity shock but prior to child's college taste shock

$$V_{\text{Transfer}}\left(a, \boldsymbol{\theta}, e, \eta, \boldsymbol{\theta}_k\right) = \max_{\hat{a}} \underbrace{V_{j=12}\left(a - \hat{a}, \boldsymbol{\theta}, e, \eta\right)}_{\text{Parents' Continuation}} + \delta \underbrace{\mathbb{E}\left[V^{sw}_{j'=5}\left(\hat{a}, \boldsymbol{\theta}_k, \varepsilon\right)\right]}_{\text{Child's Utility}}$$

$$\hat{a} \geq 0, \qquad \underbrace{\varepsilon \sim N(\bar{\varepsilon}_e, \sigma_\varepsilon)}_{\substack{\text{Draw of school taste shock,} \\ \text{depends on parent's education}}}$$

where child's initial budget constraint is:

$$c + a' + p_e \mathbb{1}\left[e' = 1\right] = y - T\left(y, \hat{a}, c\right) + \hat{a}\left(1 + r\right)$$

This presentation: ignore details of college choice (agent can borrow at subsidized rate and work while in college. Tastes for schooling depend on child skills directly and, via shock, on parental educ.)

Competitive Equilibrium

Preferences: $u(c,h)$

$$u(c,h) = \frac{c^{1-\gamma_c}}{1-\gamma_c} - \mu \frac{h^{1+\gamma_h}}{1+\gamma_h}$$

Aggregate Production function

$$Y = AK^{\alpha}H^{1-\alpha}$$

$$H = \left[sH_0^{\Omega} + (1-s)\, H_1^{\Omega} \right]^{\frac{1}{\Omega}}$$

Capital markets: Agents trade only in risk-free bonds; wedge between borrowing and saving interest rate; natural borrowing limits

Perfect competition for goods and inputs; Agents maximize utility and mkts clear

Stationary distribution:

- Cross-sectional distribution of any cohort of age j is invariant over time periods.
- Distribution of initial states is determined by older generations.

More Model Stationary Equilibrium

Outline

Estimation: Summary

Map model outcomes to data using guiding principle that agents in the model represent a household.

We use a variety of micro data sets (PSID, NLSY79, CDS).

Estimation: Summary

Tax revenue used to fund transfers and retirement benefits

- Labor taxes: progressive marginal tax rate

$$\underbrace{y - T(y)}_{\text{After-Tax Labor Income}} = \lambda y^{1-\tau_y} + \omega + b$$

- y: pre-tax income
- Based on Feldstein (1969) and Benabou (2000)
- τ_y (.18) from Heathcote, Storesletten, and Violante (2017)
- Add ω → helps fit transfers received currently by low labor-income agents

Total tax and transfers function:

$$T(y, a, c, b) = y - \lambda y^{1-\tau_y} + \tau_a a r \mathbf{1}_{a \geq 0} + \tau_c c - \omega - b$$

- Taxes on capital income and consumption as well (Trabandt and Uhlig (2011))

- Labor productivity

$$log\left(\psi_{ij}^{e}\right) = \lambda^{e} log\left(\theta_{ic}\right) + \eta_{ij}^{e}, \quad \eta_{ij}^{e} = \rho^{e}\eta_{ij-1}^{e} + z_{ij}^{e}, \quad z_{ij}^{e} \overset{iid}{\sim} N\left(0, \sigma_{z}^{e}\right)$$

- Add out-of-work & superstar states to standard AR(1) wage process
  - Agents have no labor income for whole period → "out-of-work" shock
    - Estimate Probit model of working by education group (age, gender) using PSID
  - To match high degree of wealth and income inequality we assume a "superstar" productivity state
    - Match income share top 5%, wealth share of top 1% & 0.1%

SMM to match household-level data

- Target ratio of government expenses to output (19%) and the ratio of variance of pre to post-tax total income ($\omega \approx \$1,630$ per year)
- Parent investment in child skills and transfer: data from PSID and CEX and parameters from Cunha et al. (2010)

▸ Tax Function ▸ Out of Work ▸ Simulated Method of Moments

Estimation: External Parameters

Parameter	Value	Description	Source
Taxes			
τ_a	0.36	Tax rate on capital returns	Trabandt and Uhlig
τ_c	0.05	Tax rate on consumption	Trabandt and Uhlig
τ_y	0.18	Progressivity of labor income tax	Heathcote et al. [2017]
Borrowing Limit & Rates			
$\underline{a}^s$	0.09	College loan: $23,000	Stafford Loans
ι	0.10	Wedge of 10% (relative to r)	Gross and Souleles [2002]
ι^s	0.01	Wedge of 1% (relative to r)	Daruich and Kozlowski [2020]
Preferences			
β	0.92	Annual discount rate of 0.98	Standard
γ_c	1	Intertemporal elasticity of substitution of 1	Standard
γ_h	2	Frisch elasticity of 1/2	Standard
$\overline{h}$	0.27	Being in college requires 30 hours per week	NCES
Intergenerational Persistence of Initial Skills			
$\hat{\rho}_c$	0.03	Cognitive skills	Cunha et al. [2010]
$\hat{\rho}_{nc}$	0.39	Noncognitive skills	Cunha et al. [2010]
Aggregate Production Function			
A	4.35	Average annual income of high-school household, age 48	Normalization
α	1/3	Labor income share of 1/3	Standard
δ_k	0.24	Annual depreciation rate of 6.5%	Standard
Ω	0.43	Substitutability in aggregate labor H	CPS (1962–2015)
s	0.53	High-school weight in aggregate labor H	CPS (1962–2015)

Estimation: Parameters

Parameter	Value	Description	Moment	Data	Model
Preferences					
μ	40.8	Mean labor disutility	Avg. weekly hours worked	31.0	30.7
δ	0.66	Altruism	Intergenerational persistence of income	0.31	0.31
School Taste: $\kappa(\varepsilon,\theta) = \alpha + \alpha_{\theta_c} log(\theta_c) + \alpha_{\theta_{nc}} log(\theta_{nc}) + \varepsilon$; $\varepsilon \sim N(\bar{\varepsilon}_{e_p}, \sigma_\varepsilon)$; $\bar{\varepsilon}_{e_p=0} = 0, \bar{\varepsilon}_{e_p=1} = \bar{\varepsilon}$					
α	60.6	Avg. taste for college	College share	0.32	0.32
α_{θ_c}	-76.3	College taste and cog. skills relation	College: cog skills slope	0.38	0.34
$\alpha_{\theta_{nc}}$	-19.5	College taste and noncog. skills relation	College: noncog skills slope	0.08	0.09
σ_ε	61.3	SD of college taste shock	College: residual variance	0.17	0.16
$\bar{\varepsilon}$	-43.5	Draw of school taste: mean by parent's education	Intergenerational persistence of education	0.69	0.69
Investment in Skill Formation: $I = \bar{A}m$					
$\bar{A}$	8.5	Productivity normalization	Average log-skills	0.0	0.0
Superstar Shock					
$\bar{\eta}$	6.11	Efficiency in superstar state	Income share top 5pct	0.33	0.32
$\bar{\pi}$ ($\times 10^4$)	2.23	Probability of entering state	Wealth share top 1pct	0.34	0.35
$\underline{\pi}$	0.34	Probability of exiting state	Wealth share top 0.1pct	0.17	0.18
Labor Income Tax: $y - \lambda y^{1-\tau} - \omega$					
λ	0.82	Tax function	Gov. Expenses/Output	0.19	0.20
ω ($\times 10^2$)	5.91	Lump-sum transfer	Income variance ratio: Disposable to pre-gov	0.63	0.63

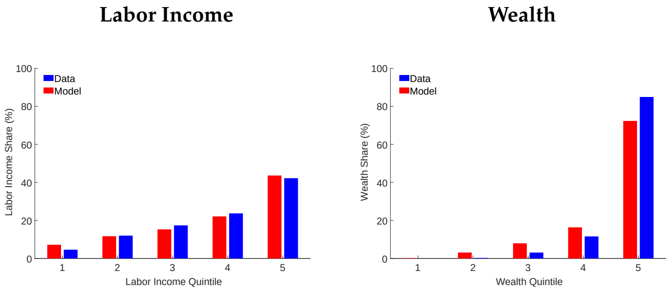
Moments' Information

Outline

Validation: Non-Targeted Moments

Moment	Data	Model
Investments in Children		
Avg. annual expenditures on children [Lee and Seshadri, 2019]	\$5,500–7,500	\$6,896
Expenditure ratio by parental income: middle to bottom (USDA)	1.38	1.35
Expenditure ratio by parental income: top to bottom (USDA)	2.01	1.76
Intergenerational Mobility [Chetty et al., 2014]		
Prob. of child born in bottom 20% exiting bottom 20%	66.3%	65.9%
College		
Income ratio by education: college vs high school (PSID)	1.73	1.80
Regression of child's college dummy to log-labor-income (PSID)	0.23	0.18
Avg. parental transfers as a share of avg. annual labor income (PSID)	1.44	1.55
Avg. parental transfers: ratio by child's education (PSID)	1.37	1.25
Share of college students with loans (NCES)	62–68%	68%
Share of college students with loans: high-school parent (NCES)	71–78%	82%
Share of college students with loans: college parent (NCES)	55–65%	56%
Income and Wealth Inequality (PSID and World Inequality Database)		See Figure 1
Savings		
Capital-output ratio (annualized) [Inklaar and Timmer]	≈ 3	2.9

Validation: Income and Wealth Inequality



Notes: The labor income shares by quintile are from the cross-section of agents age 20-64. We use PSID data and compare with model estimates excluding those that obtained a superstar shock that period. Wealth shares are obtained from the World Inequality Database. In the model, we include all working-age adults.

Validation: Wealth Shocks & Cash Transfer Evidence

- Lottery winnings on labor income earnings
  - Golosov et al. (2021) event study of effect of winning lottery of at least 30K (2016) on labor earnings
  - Large and immediate effects from winning: average annual labor earnings fall by $2.34 dollars for every $100 of post-tax lottery winnings (measured on a per-adult level during the first 5 years after winning.
- Non-labor-income elasticity of labor supply
  - Based on 22 alternative elasticity estimates (Blundell-MaCurdy 1999)
  - Median estimate of -0.07. 10-90th range: $(-0.29, -0.01)$
- Effect on child's skill formation:
  - Exogenous change in income based on EITC changes (Dahl-Lochner 2012)
  - Extra $\$1,000$ to parents $\rightarrow$ increases combined reading and math scores of children by 4.1% of a std dev.

Apply lottery & cash-transfer experiment in model:

- Small scale: prices and taxes are not affected
- Short run and, for skill formation, *targeted*

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- Short run and, for skill formation, *targeted*

Model is in line with these empirical results

- **Lottery winnings** (use distribution from paper): we find similar results. In the first period (4 years) labor earnings ↓ $2.20 per $100

- **Elasticity labor supply:** give extra $1000 per year for different lengths of time (1-5 periods and through life span) yields cross-section average between -0.02 and -0.08, depending on time span

- **Child's cognitive skills:** Give parent $1000 per year while child lives with them. Child's cognitive skills increase between 1.1-2.75 percent of a standard deviation of children for parent with annual income less than $30,000 (within the the range estimated by Dahl and Lochner (2017))

▸ Dahl-Lochner ▸ Blundell-MaCurdy

Outline

UBI Policy: Features and Road Map

UBI discussed in policy circles: every adult, ages 16-79, receives an *annual* transfer of $8000 (year 2000 dollars)

Assume balanced budget required every period

- UBI is in addition to current redistribution programs
  - Benchmark: λ_t adjusts for budget balance (recall: $y - T(y) = \lambda_t y^{1-\tau_y}$)

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- Alternative implementations
  - UBI replaces some current redistribution programs:
    - (i) Linear tax ($\tau_y = 0$, λ_t adjusts) or (ii) $\omega = 0$
  - UBI reduces administrative expenditures in public sector
  - UBI funded by consumption tax rather than labor tax λ

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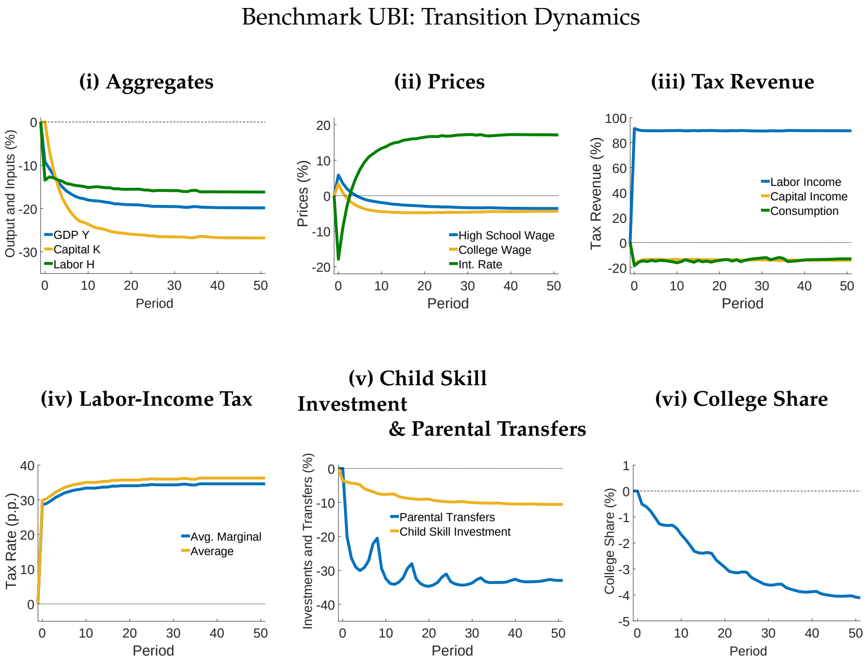
Evaluate role of UBI on welfare, distinguishing among:

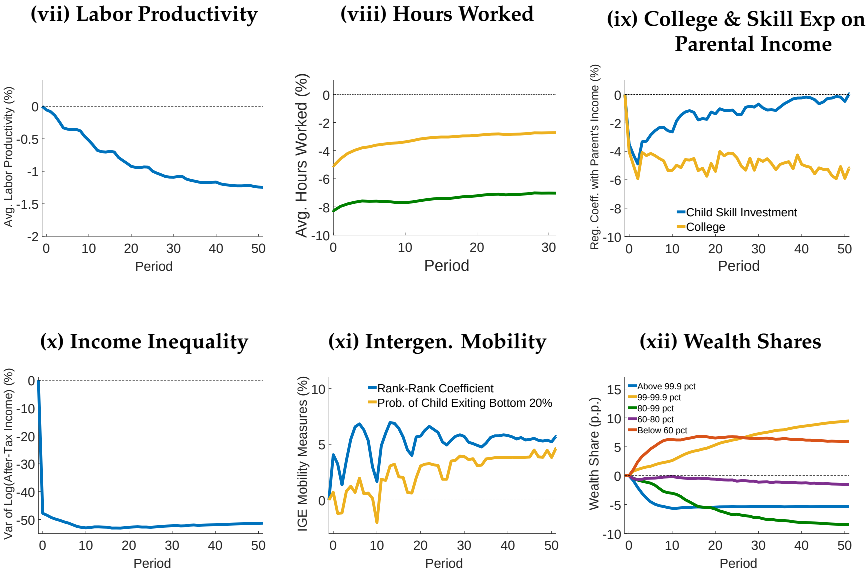
- incentive effects, taxation effects, GE consequences
- importance of endogenous K market and intergenerational linkages
- Mirrleesian decomposition

Implications of riskier environment

- Increased probability of skills becoming obsolete (out-of-work state) → Robotization/automation


Benchmark UBI: Transition Dynamics
(i) Aggregates
Output and Inputs (%)
GDP Y
Capital K
Labor H
Period
(ii) Prices
Prices (%)
High School Wage
College Wage
Int. Rate
Period
(iii) Tax Revenue
Tax Revenue (%)
Labor Income
Capital Income
Consumption
Period
(iv) Labor-Income Tax
Tax Rate (p.p.)
Avg. Marginal
Average
Period
(v) Child Skill Investment
& Parental Transfers
Investments and Transfers (%)
Parental Transfers
Child Skill Investment
Period
(vi) College Share
College Share (%)
Period

Benchmark UBI: Dynamic Response

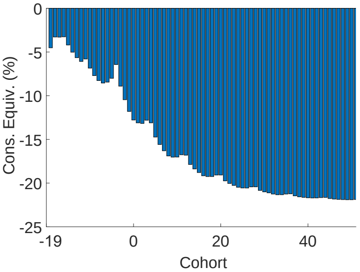


- New ss: Y $\downarrow$ almost 20%.
    - Half is from $K \downarrow$ of 27%; remainder due to $H \downarrow$
- Transition:
    - Hours worked $\downarrow$ sharply and immediately
    - K also falls fairly rapidly
    - r first $\downarrow$ (due to $\downarrow$ hours work); after K $\uparrow$ as $K/H \downarrow$
- Decrease in K, H, c, college, and productivity (parents invest less in child skills) require a sharp $\uparrow$ in labor taxes (via λ) to balance budget
- Inequality falls

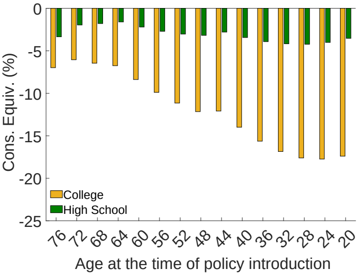
Welfare Dynamics

Welfare Dynamics of UBI

By Cohort



Adults at $t = 0$ by age and education



- Negative welfare consequences for all cohorts
- Only 26.5% of all adults favor introduction of UBI

Understanding the Welfare Results

Next: Several exercises to understand the results

1. SS results: contribution of PE and GE to welfare changes
2. Endogenous intergenerational linkages: compare adjacent cohorts
3. Understanding the dynamic mechanisms:
   - Replace endogenous skill formation with exogenous transition matrix
   - Replace equilibrium capital market with exogenous one

   Mirleesian-Style Decomposition:
4. How do our results square with greater redistribution results from literature?

Understanding Steady-State Effects - I

Table: UBI: From Short-Run PE to Long-Run GE

Alternative Exercises			Change from Initial Steady State (%)					
Budget Balanced	Long Run	GE	Skill Inv. m	Parental Transfers	Labor Prod.	College	Capital	Hours Worked
No	No	No						
Yes	No	No						
Yes	Yes	No						
Yes	Yes	Yes	**-11.5**	**-32.2**	**-1.3**	**-4.3**	**-26.9**	**-21.3**

Budget Balanced	Long Run	GE	Income Inequality	Wage w_0	Wage w_1	Rate r	Welf. Adults	Welf. SS or Children
No	No	No						
Yes	No	No						
Yes	Yes	No						
Yes	Yes	Yes	**-50.5**	**-3.5**	**-4.2**	**16.6**	**-6.0**	**-22.3**

What explains the negative LR effects on vars other than inequality?

Understanding Steady-State Effects - I

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Budget Balanced	**Long Run**	**GE**	**Skill Inv.** m	**Parental Transfers**	**Labor Prod.**	**College**	**Capital**	**Hours Worked**
No	No	No	6.7	57.3	0.3	0.9	5.1	-9.6
Yes	No	No						
Yes	Yes	No						
Yes	Yes	Yes	**-11.5**	**-32.2**	**-1.3**	**-4.3**	**-26.9**	**-21.3**

Budget Balanced	**Long Run**	**GE**	**Income Inequality**	**Wage** w_0	**Wage** w_1	**Rate** r	**Welf. Adults**	**Welf. SS or Children**
No	No	No	-3.1	–	–	–	27.3	8.4
Yes	No	No						
Yes	Yes	No						
Yes	Yes	Yes	**-50.5**	**-3.5**	**-4.2**	**16.6**	**-6.0**	**-22.3**

What explains the negative LR effects on vars other than inequality?

- If UBI is received only by one cohort and no tax consequences: $m\uparrow$, transfers, college, & productivity $\uparrow$, hours work $\downarrow$, small $\downarrow$ inequality

Understanding Steady-State Effects - I

Table: UBI: From Short-Run PE to Long-Run GE

Alternative Exercises			Change from Initial Steady State (%)					
Budget Balanced	Long Run	GE	Skill Inv. m	Parental Transfers	Labor Prod.	College	Capital	Hours Worked
No	No	No	6.7	57.3	0.3	0.9	5.1	-9.6
Yes	No	No	-3.2	-48.8	-0.1	-0.4	-26.3	-17.1
Yes	Yes	No						
Yes	Yes	Yes	**-11.5**	**-32.2**	**-1.3**	**-4.3**	**-26.9**	**-21.3**

Budget Balanced	Long Run	GE	Income Inequality	Wage w_0	Wage w_1	Rate r	Welf. Adults	Welf. SS or Children
No	No	No	-3.1	–	–	–	27.3	8.4
Yes	No	No	-4.1	–	–	–	-4.0	-5.7
Yes	Yes	No						
Yes	Yes	Yes	**-50.5**	**-3.5**	**-4.2**	**16.6**	**-6.0**	**-22.3**

What explains the negative LR effects on vars other than inequality?

- Next, let that cohort bear the tax burden: Their K ↓, hours ↓, m ↓, transfers large ↓. They and their children worse off

Understanding Steady-State Effects - I

Table: UBI: From Short-Run PE to Long-Run GE

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Budget Balanced	Long Run	GE	Skill Inv. m	Parental Transfers	Labor Prod.	College	Capital	Hours Worked
No	No	No	6.7	57.3	0.3	0.9	5.1	-9.6
Yes	No	No	-3.2	-48.8	-0.1	-0.4	-26.3	-17.1
Yes	Yes	No	-14.2	-65.9	-1.6	-5.3	-58.4	-20.4
Yes	Yes	Yes	**-11.5**	**-32.2**	**-1.3**	**-4.3**	**-26.9**	**-21.3**

Budget Balanced	Long Run	GE	Income Inequality	Wage w_0	Wage w_1	Rate r	Welf. Adults	Welf. SS or Children
No	No	No	-3.1	–	–	–	27.3	8.4
Yes	No	No	-4.1	–	–	–	-4.0	-5.7
Yes	Yes	No	-57.0	–	–	–	-7.4	-28.6
Yes	Yes	Yes	**-50.5**	**-3.5**	**-4.2**	**16.6**	**-6.0**	**-22.3**

What explains the negative LR effects on vars other than inequality?

- UBI for all cohorts, PE LR: $K \downarrow$ by almost 60% $\Rightarrow$ K tax revenue $\downarrow$ by same % $\Rightarrow \omega \downarrow$: m, transfers, college, productivity, welfare all $\downarrow$
- Inequality dramatically reduced, showing the importance of higher taxes and income transfers in achieving this result

Understanding Steady-State Effects - I

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Yes	Yes	No	-14.2	-65.9	-1.6	-5.3	-58.4	-20.4
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Budget Balanced	Long Run	GE	Income Inequality	Wage w_0	Wage w_1	Rate r	Welf. Adults	Welf. SS or Children
No	No	No	-3.1	–	–	–	27.3	8.4
Yes	No	No	-4.1	–	–	–	-4.0	-5.7
Yes	Yes	No	-57.0	–	–	–	-7.4	-28.6
Yes	Yes	Yes	**-50.5**	**-3.5**	**-4.2**	**16.6**	**-6.0**	**-22.3**

What explains the negative LR effects on vars other than inequality?

- Full GE: mitigates via $r \uparrow$ (though w $\downarrow$). Smaller $\downarrow m$, transfers, & welfare

Understanding steady-state welfare effects - II

Changes in welfare must arise from:

- Changes in $V_{j=5}(a,\theta,\varepsilon) \rightarrow V'_{j=5}(a,\theta,\varepsilon)$
- Changes in the distribution over those states, $\mu_{j=5}(a,\theta,\varepsilon) \rightarrow \mu'_{j=5}(a,\theta,\varepsilon)$

A Decomposition:

1. Keep $V_{j=5}(a,\theta,\varepsilon)$ constant at original ss value of baseline economy
2. Change $\mu_{j=5}(a,\theta,\varepsilon)$ to $\mu'_{j=5}(a,\theta,\varepsilon)$ (ss distribution with UBI)

$\Rightarrow$ Yields welfare loss of 10.6%, i.e., 47% of the total steady-state losses

- Parents invest less in child skills and transfers, leading to a different ss distribution ($\mu'_{j=5}$)

Alternative Decomposition:

- Keeping $\mu_{j=5}(a,\theta,\varepsilon)$ constant and $V_{j=5}(a,\theta,\varepsilon) \rightarrow V'_{j=5}(a,\theta,\varepsilon)$ yields -12.4% decrease, i.e., 56% of the total losses

Intergenerational Linkages during the Transition

	Cohort				
	-5 **(Fixed $\theta, \hat{a}, e$)**	**-4** **(Fixed $\theta, \hat{a}$)**	**-3** **(Almost Fixed θ)**	**0**	**Steady State**
Skill Investment (m) (%)	0.0	0.0	-0.8	-5.9	-11.5
Parental Transfers $\hat{a}$ (%)	0.0	0.0	-20.1	-30.1	-32.2
College (%)	0.0	-0.5	-0.6	-1.3	-4.3
Labor Productivity (%)	0.0	-0.1	-0.1	-0.3	-1.3
Consumption Equivalence (%)	-8.0	-6.4	-8.9	-12.8	-22.3

Compare adjacent cohorts that are young at $t = 0$

- Cohort 0: newborn when UBI is introduced. First cohort whose state vars are all affected by UBI: Large ↓ in m & transfers. Econ still richer (K, H) → taxes still lower. Suffers 57% of ss welfare loss.
- Cohort -3: skills almost fixed ⇒ smaller decrease in productivity. Welfare decrease is 30% smaller
- Cohort -4: skills fixed, transfer received: much smaller welfare ↓
- Cohort -5: Loses more than cohort -4 since its education decisions are not optimal for the new environment
- 6.4pp difference between cohorts 0 and -4: Cohort -3 has a 3.9pp diff with cohort 0 ⇒≈ 2/3 losses come from skill investment; 1/3 from parental transfers

The Role of Endogenous Skills and K

Examine role of endogenous skills and K market by:

1. Replacing endogenous skills by a transition matrix that gives each child a draw from the original steady-state distribution of skills corresponding to their parents' education and skill level
   - Although the model is not reestimated, it provides almost as good a fit of the moments used in the estimation of the pre-UBI benchmark model

2. Keeping the aggregate K and interest rate are constant at their steady state values of the pre-UBI benchmark model $\Rightarrow$ capital tax revenue unchanged
   - By design, model is exactly observationally equivalent to the steady state of the pre-UBI benchmark model
   - Note that agents can still borrow and save as before

In all cases, the change is calculated with respect to new ss of modified model prior to introduction of UBI

Table: UBI: The Roles of Endogenous Skills and Capital Market

	Change from Initial Steady State (%)					
	Skill Inv. m	**Parental Transfers**	**Labor Prod.**	**College**	**Capital**	**Hours Worked**
Benchmark Model	-11.5	-32.2	-1.3	-4.3	-26.9	-21.3
Fixed Skills	–	-34.6	-0.0	-0.4	-25.7	-21.9
Fixed Capital	-4.3	-52.7	-0.4	-1.2	–	-15.2
Fixed Skills & Capital	–	-51.7	-0.0	-0.0	–	-16.0

	Income Inequality	**Wage** w_0	**Wage** w_2	**Rate** r	**Welf. Adults**	**Welf. Steady State**
Benchmark Model	-50.5	-3.5	-4.2	16.6	-6.0	-22.3
Fixed Skills	-51.3	-2.5	-5.3	16.4	-5.9	-12.6
Fixed Capital	-46.7	5.1	3.8	–	2.4	-4.2
Fixed Skills & Capital	-47.4	5.6	3.4	–	2.7	-0.8

- Exog skills: welfare loss 56% smaller in LR; almost no change for adults
- Fixed K: adults gain and LR welfare losses less than 1/5th of what they were before (less reliance on labor tax leading to positive consequences)
- Both: small ↑ welfare adults relative to prior exp. but much smaller LR welfare losses

Outline

Mirleesian-Style Decomposition

- Public finance lit suggests too little redistribution in US (e.g., Saez, 2001; Golosov et al., 2016; Heathcote and Tsujiyama, 2021)
- Introduce small UBI by by permanently increasing ω by \$100 (annually) for all adults
- Financed (balanced budget) by changing the labor tax rate λ in each period
- Decompose changes into mechanical, behavioral in PE, and total effect in GE

Mirleesian Decomposition

- Mechanical effect: no behavioral response to $100 and labor tax increase needed to finance it (assume changes accommodated solely via consumption)
- SR PE: Give transfer to only 1 cohort and allow behavioral response. Only that cohort pays additional tax to finance transfer
- LR PE: Give transfer to all cohorts with balanced budget in each period
- LR GE: All prices allowed to change

Table: Small Increase in Lump Sum Transfers: A Mirrleesian-Style Decomposition

	Welf. Adults	Welf. S. State	Taxes λ	Hours Worked	Skill Inv. m	Parental Transfers	College
Benchmark Model							
Mechanical	0.0483	0.0625	-0.4245	–	–	–	–
Short-run PE	0.0053	0	-0.5688	-0.1515	0.0254	0.0459	0.0033
Long-run PE	-0.0103	-0.1560	-0.5500	-0.1586	0.0073	-0.7840	-0.0146
Long-run GE	-0.0179	-0.3237	-0.6332	-0.1263	-0.0259	-1.6052	-0.0291

	Labor Prod.	Labor Income	Capital K	Wage w_0	Wage w_1	Int. Rate r
Mechanical	–	–	–	–	–	–
Short-run PE	0.0012	-0.1090	–	–	–	–
Long-run PE	-0.0047	-0.1118	-0.5614	–	–	–
Long-run GE	-0.0096	-0.0346	-1.2431	0.0654	0.0576	-0.2529

	Welf. Adults	Welf. S. State	Taxes λ	Hours Worked	Skill Inv. m	Parental Transfers	College
Long-run GE Model with Fixed:							
Skills	-0.0082	-0.0197	-0.5054	-0.2037	–	0.1290	0.0000
Capital	0.3284	0.3887	-0.3448	-0.1560	0.0804	-0.4673	0.0303
Skills & Capital	0.2312	0.2160	-0.3894	-0.1819	–	-0.1774	-0.0038

	Labor Prod.	Labor Income	Capital K	Wage w_0	Wage w_1	Int. Rate r
Skills	0.0000	-0.1501	-0.1666	-0.1038	0.0708	0.1012
Capital	0.0103	0.1581	–	0.2746	0.2378	–
Skills & Capital	-0.0007	0.0843	–	0.1815	0.2194	–

Conclusion

Use model to evaluate universal basic income policy

- GE OLG incomplete markets model with out-of-work shocks, distortionary taxes, and endogenous intergenerational links
- Validation exercises shows model does a good job on key moments & elasticities
- UBI generates avg negative welfare consequences for every cohort and very large losses in the LR despite decreasing inequality

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K Dynamics and endogenous intergenerational links play key roles

- Replacing endogenous skills with policy invariant transition matrix halves LR welfare losses but leave adult welfare loss basically unchanged
- An exogenous aggregate K stock and constant r yields smaller LR welfare loss and leaves adults better off

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Some lessons

- Results point to potential problems with evaluating policy changes solely from evidence derived from SR settings for small groups
- They also serve as a caution to tax lit. that evaluates reforms without physical and human capital accumulation or that abstracts from equilibrium feedback

APPENDIX

Related Literature

UBI and Related Macro:

- Lopez-Daneri (2016): Negative income tax in an open economy (r fixed).
  - Large gains (behind the veil of ignorance), no human capital or intergenerational (IG) linkages
- Fabre, Pallage, & Zimmerman (2014): Comparison of UI (monitoring)to UBI (in absence of GE and IG links).
  - Find that monitoring costs would need to be implausibly large to dominate UI.
- Luduvice (2019): Contemporaneous OLG macro model. Very different results: welfare increases in the LR.
  - Slightly richer demographic structure and more explicit income securty system.
  - Parents do not care about their children's welfare.
  - No skill formation nor education $\Rightarrow$ No IG links
  - Consumption taxation

Dynamic Consequences of Tax & Education Policy

- Benabou (2002): Seminal paper dynamic calibrated model of human (but no physical) capital accumulation
- Krueger and Ludwig (2016): Optimal labor tax and college subsidy policy in heterogenous agent economy with capital accumulation. (No borrowing nor skill formation.)
- Heathcote, Storesletten and Violante (2017): Optimal degree of progressivity

Endogenous IG links: skill formation

- Daruich (2019) & Lee and Seshadri (2019)

Basic Income

- Philosophical/Ethical arguments: Van Parijs & Vanderborght (2017), etc. Large literature...
- Early foundational work: Atkinson (1991)
- Theory: Ghatak and Maniquet (2019)

Back

Outline

Child's Skill Production Function

Based on Cunha, Heckman and Schennach (ECTA, 2010)

$$\underbrace{\theta'_k}_{\substack{\text{Next period} \\ \text{child's skills}}} = \Bigg[\alpha_{1j} \underbrace{\theta_k^{\rho_j}}_{\substack{\text{Current} \\ \text{child's skills}}} + \alpha_{2j} \underbrace{\theta^{\rho_j}}_{\substack{\text{Parent's} \\ \text{skills}}} + \alpha_{3j} \underbrace{\mathrm{I}^{\rho_j}}_{\substack{\text{Parental} \\ \text{investments}}} \Bigg]^{1/\rho_j} \exp(\nu), \quad \nu \sim N(0, \sigma_{\nu j})$$

- Investment's productivity depends on child/parent's skills
- Parameters can vary with child's age

Back

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- Investment's productivity depends on child/parent's skills
- Parameters can vary with child's age

Parameter values

- **Estimation from CHS (2010)**
  - Estimated on a representative sample
  - Skills are more malleable when children are young

Back

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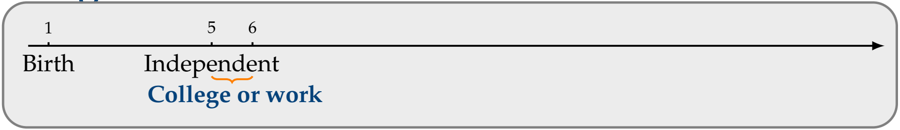
- Investment's productivity depends on child/parent's skills
- Parameters can vary with child's age

Model requires specifying and estimating investment function I

$$\mathrm{I} = \bar{A}\left[\alpha_m (m + g)^{\gamma} + (1 - \alpha_m) t^{\gamma}\right]^{1/\gamma}$$

Outline

College Choice



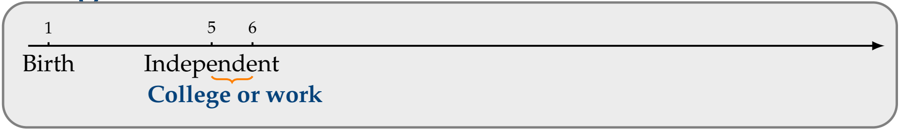
Work

$$V_j(a, \boldsymbol{\theta}, e, \eta) = \max_{c, a', h} u(c, h) + \beta \mathbb{E}\left[V_{j+1}(a', \boldsymbol{\theta}, e, \eta')\right],$$

$$c + a' = y + a(1+r) - T(y, a, c) + b$$

$$y = h w_e E_{j,e}(\boldsymbol{\theta}, \eta), \quad a' \geq \underline{a}_{j,e}, \quad 0 \leq h \leq 1, \quad \eta' \sim \Gamma_{j,e}(\eta).$$

College Choice



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College

$$V_j^s(a, \boldsymbol{\theta}, e=1) = \max_{c,a',h} u\left(c, h + \bar{h}\right) + \beta \mathbb{E}_{\eta|e} V_{j+1}(a', \boldsymbol{\theta}, e, \eta')$$

$$c + a' + p_e = y + a(1+r) - T(y,a,c) + b$$

$$y = hw_0 E_{j,e}(\boldsymbol{\theta}), \quad a' \geq \underline{a}^s, \quad 0 \leq h \leq 1 - \bar{h}, \quad \eta' \sim \Gamma_{j=6,e=1}$$

College Choice

1 5 6

Birth Independent

College or work

Work

$$V_j(a, \boldsymbol{\theta}, e, \eta) = \max_{c,a',h} u(c,h) + \beta \mathbb{E}\left[V_{j+1}(a', \boldsymbol{\theta}, e, \eta')\right],$$

$$c + a' = y + a(1+r) - T(y,a,c) + b$$

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College

$$V_j^s(a, \boldsymbol{\theta}, e = 1) = \max_{c,a',h} u\left(c, h + \bar{h}\right) + \beta \mathbb{E}_{\eta|e} V_{j+1}(a', \boldsymbol{\theta}, e, \eta')$$

$$c + a' + p_e = y + a(1+r) - T(y,a,c) + b$$

$$y = hw_0 E_{j,e}(\boldsymbol{\theta}), \quad a' \geq \underline{a}^s, \quad 0 \leq h \leq 1 - \bar{h}, \quad \eta' \sim \Gamma_{j=6,e=1}$$

Work or college:

$$V_j^{sw}(a, \boldsymbol{\theta}, \varepsilon) = \max\left\{\mathbb{E}_{\eta|e=0} V_j(a, \boldsymbol{\theta}, 0, \eta), V_j^s(a, \boldsymbol{\theta}, 1) - \kappa(\varepsilon, \boldsymbol{\theta})\right\}$$

Back

Preliminaries: Skills and Wages

Labor income of individual of age j, education e, and skills θ is product of:

1. Wage of your education group: w_e.
2. **Labor efficiency units**: $E_{j,e}(\theta)$.
3. Hours worked: h.

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3. Hours worked: h.

Labor efficiency units evolve stochastically as sum of three components:

$$\log E_{j,e} = \lambda^e \log(\theta) + \epsilon_j^e + \eta_j^e$$

where

- λ_e is education-specific return to skills.
- ϵ_j^e is education-specific age profile.
- η_j^e is stochastic component with persistent cdf $\Gamma_{j,e}$.

Back to Timeline

Preliminaries: Market Structure

During working years

- Can borrow: limits by education group.
- Interest rate $r^b = r + \iota$ where r is the returns to saving and ι is the wedge between borrowing and lending capital.

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College Loans

- Pay **subsidized interest rate** r^c:

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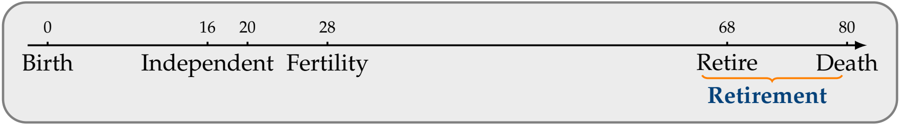
College Loans

- Pay **subsidized interest rate** r^c:

Today: Presentation of model abstracts from different interest rates.

Retirement



Social Security: Received every period, relative to education e and permanent skill θ.

$$V_j(a,\theta,e) = \max_{c,a'} u(c,0) + \beta V^{w}_{j+1}(a',\theta,e),$$
$$c + a' = \pi(\theta,e) + a(1+r) - T(\pi(\theta,e),a,c),$$
$$a' \geq 0$$

▸ Replacement rate ▸ Model Time Line

Aggregate Production Function

- Cobb-Douglas with constant returns to scale:

$$Y = K^{\alpha} H^{1-\alpha}$$

where H is the CES aggregator

$$H = \left[s L_1^{\rho} + (1 - s) L_2^{\rho} \right]^{\frac{1}{\rho}}$$

Stationary Equilibrium

- **Distributions:**
  - Cross-sectional distribution of any cohort of age j is invariant over time periods.
  - Distribution of initial states is determined by older generations.
- **Household optimize:** Household make choices of education, consumption, labor, parental time and expenditures, transfers such that maximize utility.
- **Firms maximize profits.**
- **Prices clear markets.**

Back to Timeline Back to Agg. Prod.

Role for Government Intervention

Why may UBI increase welfare?

1. **Borrowing constraints**
   - Agent may not be able to use her own future income
   - Limiting consumption (and leisure), college and early childhood investments
2. **Lack of insurance**
   - Labor income is risky
   - UBI provides a guaranteed minimum income
3. **Redistribution**
   - Low-income agents would benefit
   - High-income agents would lose

Back

Outline

Tax Function

Marginal tax rate is progressive

$$\underbrace{y - T(y)}_{\text{After-Tax Income}} = \lambda_y y^{1-\tau_y} + \omega$$

- y: pre-tax income
- Based on Feldstein (1969) and Benabou (2000)

Statistical Fit Back

Tax Function

Marginal tax rate is progressive

$$\underbrace{y - T(y)}_{\text{After-Tax Income}} = \lambda_y y^{1-\tau_y} + \omega$$

- y: pre-tax income
- Based on Feldstein (1969) and Benabou (2000)

Estimation

- Use estimation of τ_y from Heathcote, Storesletten and Violante (2017)
  - Takes into account deductions and public cash transfers
  - Determines tax progressivity
- Estimate λ_y to match average tax rate

Add Out-of-Work Shock to Standard Income Process

Following spirit of Castaneda, Diaz-Gimenez and Rios-Rull (2003)

- Estimate standard AR(1) wage shock process
- Add state that makes people have no labor income
- Estimate probit model of working by education group using PSID

$$\begin{aligned}\Pr\left(\text{Working}_{i,t}\right) = \Phi\Big(&\alpha + \beta_1 \text{Working}_{i,t-1} \times age_{i,t} + \beta_2 \text{Working}_{i,t-1} \times age_{i,t}^2 \\ &+ \beta_3 \text{Working}_{i,t-1} + \beta_4 age_{i,t} + \beta_5 age_{i,t}^2 + \gamma_t + \text{gender}_i + \varepsilon_{i,t}\Big)\end{aligned}$$

▸ Income after being out of work ▸ Regression Table ▸ Back

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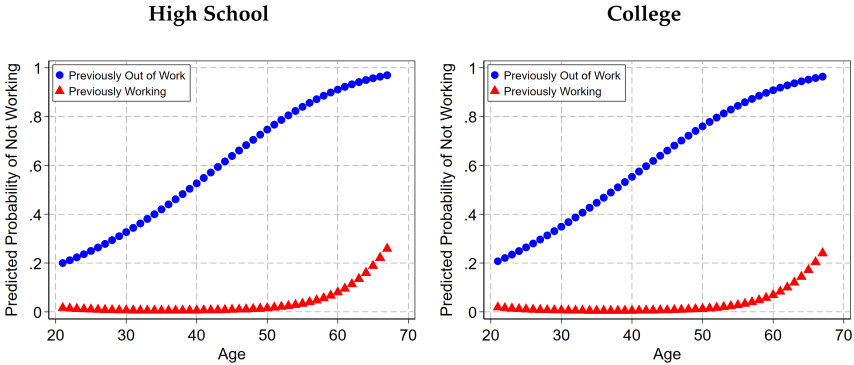
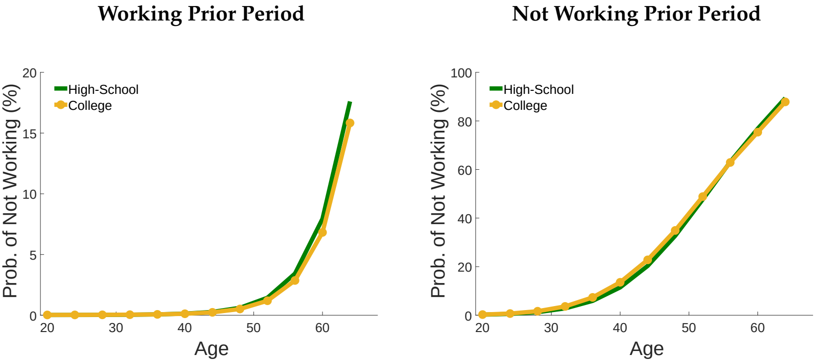


Income after being out of work
Regression Table
Back

Out-of-Work Shock: Data ⇒ Model Periods

Transform probability to model periods (4 years)

- Out-of-work as not working for 4 years



Income after being out of work
Back

Out-of-Work Shock: Wages After Out of Work

Regression of wage on whether hh worked prior period (by education group)

$$\log\left(\text{Wage}_{i,t}\right) = \alpha + \beta \text{Working}_{i,t-1} + \delta_1 \text{age}_{i,t} + \delta_2 \text{age}^2_{i,t} + \gamma_i + \Delta_t + \varepsilon_{i,t}$$

	Household Data		Individual Data	
	High School	College	High School	College
$\text{Working}_{i,t-1}$	0.340***	0.347***	0.289***	0.224***
	(0.0250)	(0.0427)	(0.0167)	(0.0290)
Age	0.0373***	0.0782***	0.0430***	0.0853***
	(0.00204)	(0.00290)	(0.00189)	(0.00284)
Age^2	-0.000406***	-0.000801***	-0.000457***	-0.000894***
	(2.30e-05)	(3.28e-05)	(2.14e-05)	(3.24e-05)
Observations	24,172	14,547	32,955	20,061
R-squared	0.588	0.636	0.611	0.601

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Back

Estimation: Simulated Method of Moments

Estimated to match two-adult household level data

- **Avg. tax rate** and **lump-sum transfer** ω ($\approx \$2,400$ per year)

Intergenerational linkages as in Daruich (2020)

- **Parental investments**
  - **Hours:** Use PSID Child Development Supplement (CDS)
  - **Expenses:** CDS misses child care and school fees. Use CEX
- **Parental transfers**
  - Informative about altruism
  - Estimate from PSID Rosters and Transfers Supplement

▸ Skill Prod. Func. ▸ More Details ▸ CHS Multiple Skills ▸ Back

Estimation: Simulated Method of Moments

1. Standard parameters from literature.
   - e.g., discounting; intertemporal elasticity of substitution; Frisch elasticity...
2. Externally calibrated.
   - e.g., income process; borrowing limits... Details
3. **Simulated Method of Moments**.
   - Key moments to match novel elements of model.
   - Estimated to match household level data.

Back

Parametrization: Preferences

Utility function is:

$$u(c,h) = \frac{c^{1-\gamma_c}}{1-\gamma_c} - \mu \frac{h^{1+\gamma_h}}{1+\gamma_h}$$

Parametrization: Preferences

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$$u(c,h) = \frac{c^{1-\gamma_c}}{1-\gamma_c} - \mu \frac{h^{1+\gamma_h}}{1+\gamma_h}$$

Disutility of investing time t on children's skills:

$$v(t) = \xi t$$

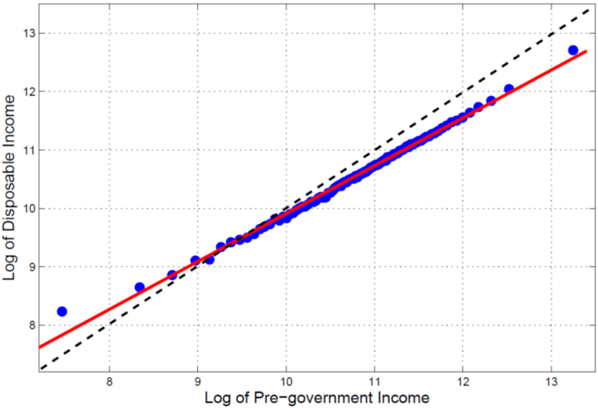
- From literature: $\gamma_c = 2$, $\gamma_h = 2$.
- To estimate: μ and ξ.

Government Taxes

- **Tax function** has form: $T(a, c) = \tau_k a r \mathbf{1}_{a \geq 0} + \tau_c c - \omega$.
- **Tax rates** from McDaniel (2014): $\tau_y = 0.22$, $\tau_c = 0.07$, and $\tau_k = 0.27$.
- Estimate lump-sum transfer ω such that ratio of the variances of disposable and pre-government log-income is 0.69 (PSID). Details

Back

Fit of Tax Function (Heathcote et al, 2017)



Back

Cunha, Heckman and Schennach (2010)

	Cognitive Skills		Non-Cognitive Skills	
	1st Stage	2nd Stage	1st Stage	2nd Stage
Current Cognitive Skills	0.479	0.831	0.000	0.000
Current Non-Cognitive Skills	0.070	0.001	0.585	0.816
Investments	0.161	0.044	0.065	0.051
Parent's Cognitive Skills	0.031	0.073	0.017	0.000
Parent's Non-Cognitive Skills	0.258	0.051	0.333	0.133
Complementarity parameter	0.313	-1.243	-0.610	-0.551
Variance of Shocks	0.176	0.087	0.222	0.101

▸ Back to SMM Intro ▸ Back to Results

Outline

Estimation: Labor income risk

Labor income of individual of age j, education e, and skills θ is product of:

1. Wage of your education group: w_e.
2. **Labor efficiency units**: $E_{j,e}(\theta)$.
3. Hours worked: h.

Labor efficiency units evolve stochastically as sum of three components:

$$\log E_{j,e} = \lambda^e \log(\theta) + \epsilon_j^e + \eta_j^e$$

where

- λ_e is education-specific return to skills.
- ϵ_j^e is education-specific age profile.
- η_j^e is stochastic component with persistent cdf $\Gamma_{j,e}$. Details

Back

Estimation: Return to Skill

	(1) High School	(2) College
λ^e	0.471	1.008
	(0.0335)	(0.0768)
ρ^e	0.914	0.967
	(0.0008)	(0.0009)
σ_z^e	0.032	0.046
	(0.0002)	(0.0002)
$\sigma_{\eta_0}^e$	0.051	0.047
	(0.0003)	(0.0003)

Note: The standard deviation of log-AFQT in the data is approximately 0.21.

Back

Age Profile

	(1) High School	(2) College
Age	0.0312***	0.0557***
	(0.00387)	(0.00577)
Age^2	-0.000271***	-0.000530***
	(4.65e-05)	(6.89e-05)
Inv. Mills Ratio	-0.739***	-0.715***
	(0.0813)	(0.127)
Constant	2.084***	1.927***
	(0.0779)	(0.118)
Observations	9,130	6,015
R-squared	0.051	0.093
# of households	1357	864

Back **Source**: PSID.

Income Shocks Process

$$\eta_j^e = \rho^e \eta_{j-1}^e + z_j^e, \quad z_j^e \sim N\left(0, \sigma_z^e\right)$$
$$\eta_0^e \sim N\left(0, \sigma_{\eta_0}^e\right)$$

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Back **Source**: PSID + NLSY.

Other elements of estimation

- Aggregate Production Function.
- Borrowing limits.
- Price of college.
- Retirement benefits.
- Labor Income Process.

Back

Aggregate Production Function

- Cobb-Douglas Form with constant returns to scale:

$$Y = AK^{\alpha}H^{1-\alpha}$$

  where H is the nested CES aggregator

$$H = \left[sL_1^{\Omega} + (1-s)\,L_2^{\Omega}\right]^{\frac{1}{\Omega}}$$

- Set $\alpha = 1/3$.
- Estimate using FOCs as in Katz and Murphy (1992) or Heckman et al (1998):
  - $s = 0.53$.
  - $\frac{1}{1-\Omega} = 1.75$.

Borrowing limits

Individuals can (unsecured) borrow **during working years**:

- Interest rate $r^b = r + \iota$ where r is the returns to saving and ι is the wedge between borrowing and lending capital.
- Borrowing limits estimated from self-reported limits by education in SCF: \$20k and \$34k for HS graduates and college graduates.

Borrowing limits

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- Borrowing limits estimated from self-reported limits by education in SCF: $20k and $34k for HS graduates and college graduates.

Borrowing is allowed for **college** at **subsidized interest rate** r^c:

- Pay interest rate $r^c = r + \iota^c$ where ι^c was estimated to be 1% annually in federal student loans (Mix of no interest rate loans and 2.6% loans). Note $\iota^c < \iota$.
- Borrowing limit estimated to be $23k.

Back

Price of College

College:

- Based on Delta Cost Project, yearly cost of college $\approx \$6,588$.
- This only considers tuition costs paid by individuals, i.e. it removes grants and scholarships.

Back

Government: Retirement Benefits

- Replacement benefits are based on current US Social Security (OASDI).
- Use education and FE in model to estimate average lifetime income, on which the system is based.

Back

Replacement rate

- h is the last level of human capital before retirement. The average life time income is summarized by $\widehat{y}(h,e)$.

- Progressive formula based on SSA

$$\pi(h) = \begin{cases} 0.9\widehat{y}(h,e) & \text{if } \widehat{y}(h,e) \leq 0.3\bar{y} \\ 0.9(0.3\bar{y}) + 0.32\left(\widehat{y}(h,e) - 0.3\bar{y}\right) & \text{if } 0.3\bar{y} \leq \widehat{y}(h,e) \leq 2\bar{y} \\ 0.9(0.3\bar{y}) + 0.32(2-0.3)\bar{y} + 0.15\left(\widehat{y}(h,e) - 2\bar{y}\right) & \text{if } 2\bar{y} \leq \widehat{y}(h,e) \leq 4.1\bar{y} \\ 0.9(0.3\bar{y}) + 0.32(2-0.3)\bar{y} + 0.15(4.1-2)\bar{y} & \text{if } 4.1\bar{y} \leq \widehat{y}(h,e) \end{cases}$$

where $\widehat{y}(h,e) = [0.98\ 1.17\ 0.98] \times h$ and $\bar{y}$ is approximately \$70,000.

Outline

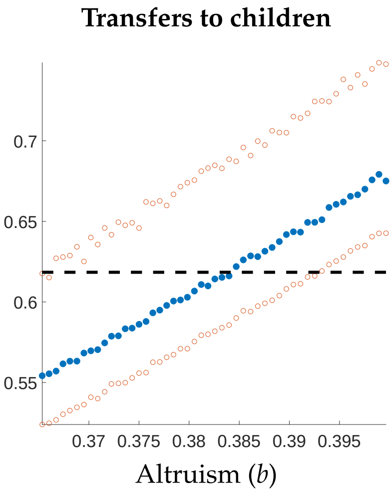
Estimation: Methodology

Global estimation

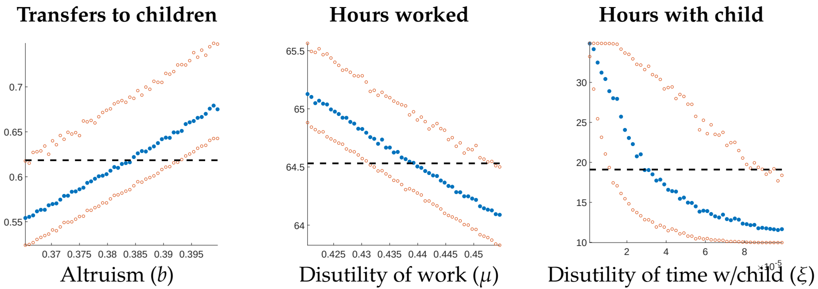
- Draw parameters from “large” uniform iid hypercube (sobol sequence)
- Trade-offs:
  - Obtain combination of parameters that best fits whole-sample moments
  - For moments M_n ($n = 1, ..., N$), obtain an estimated parameters P_n
  - Calculate standard deviations or confidence intervals of P_n
  - But very costly to do if number of parameters is large

Back to Estimation | Back to Parameters

Preferences



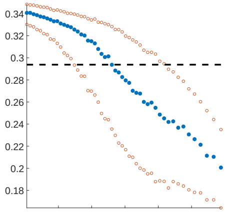
Preferences



Back to Methodology Back to Parameters

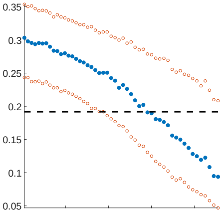
School Taste

Share of college grads (%)



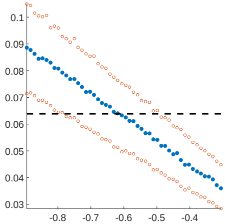
Mean school taste (α)

College: cog skills slope



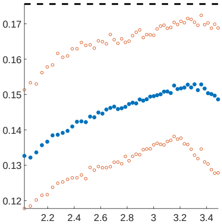
School taste-cog skill relation (α_c)

College: noncog skills slope



School taste-noncog skill relation (α_{nc})

College: residual variance

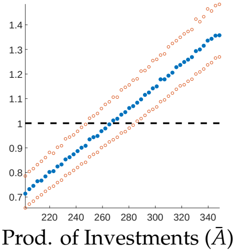


SD of taste shock (σ_ε)

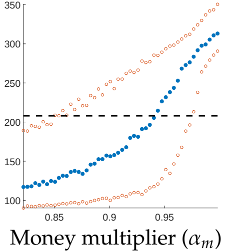
Back to Methodology Back to Parameters

Skill Formation Productivity

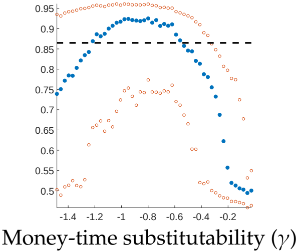
High-Low skilled ratio



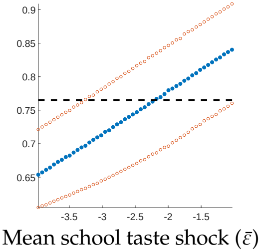
Ratio money-time



Money-time correlation

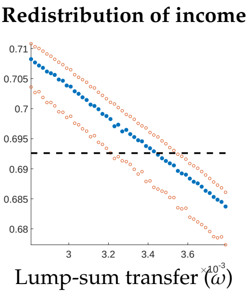


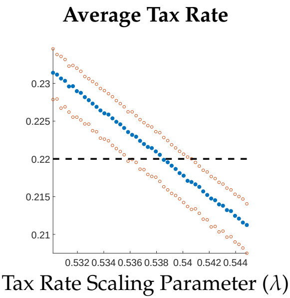
IGE persistence of education



Back to Methodology
Back to Parameters

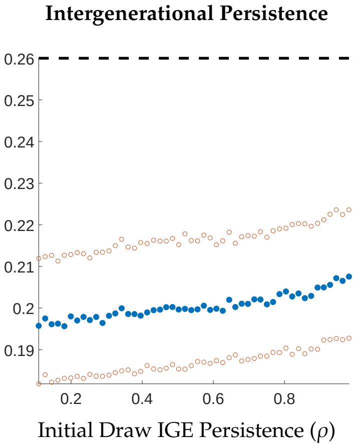
Tax Progressivity





Back to Methodology
Back to Parameters

Intergenerational Persistence



Back to Methodology Back to Parameters

Validation: Non-Targeted Moments

Moment	Data	Model
Investments in Children		
Avg. annual expenditures on children [Lee and Seshadri, 2019]	$5,500–7,500	$6,896
Expenditure ratio by parental income: middle to bottom (USDA)	1.38	1.35
Expenditure ratio by parental income: top to bottom (USDA)	2.01	1.76
Intergenerational Mobility [Chetty et al., 2014]		
Prob. of child born in bottom 20% exiting bottom 20%	66.3%	65.9%
College		
Income ratio by education: college vs high school (PSID)	1.73	1.80
Regression of child's college dummy to log-labor-income (PSID)	0.23	0.18
Avg. parental transfers as a share of avg. annual labor income (PSID)	1.44	1.55
Avg. parental transfers: ratio by child's education (PSID)	1.37	1.25
Share of college students with loans (NCES)	62–68%	68%
Share of college students with loans: high-school parent (NCES)	71–78%	82%
Share of college students with loans: college parent (NCES)	55–65%	56%
Income and Wealth Inequality (PSID and World Inequality Database)		See Figure 1
Savings		
Capital-output ratio (annualized) [Inklaar and Timmer]	≈ 3	2.9

▸ Back to estimation ▸ Back to RCT

Outline

Validation: Experimental Evidence

Experimental evidence on cash transfers (Dahl-Lochner 2012)

- Estimate effect of extra income on child's development
- Using Earned Income Tax Credit changes as exogenous variation
- Change of up to \$2,100 per year (mostly families making $< \$25k$)

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- Using Earned Income Tax Credit changes as exogenous variation
- Change of up to \$2,100 per year (mostly families making $< \$25k$)

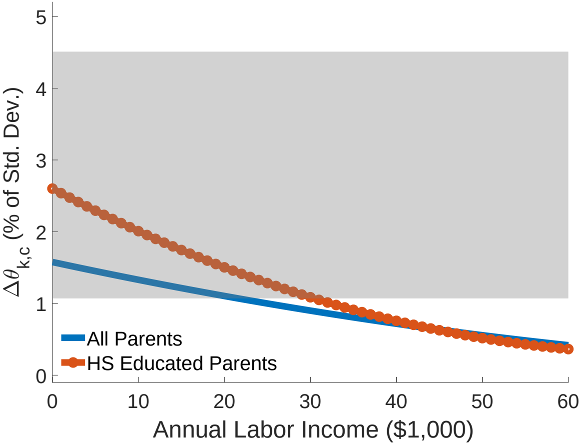
Apply cash-transfer experiment in model:

- Give \$1,000 transfer per year to parents (while child is in house)
- **Small scale:** prices and taxes are not affected
- **Target:** low-income parents

Back

Validation: Experimental Evidence

Change in skills per $1,000 increase in annual income



Back

Validation: Income Elasticity of Labor Supply

Non-labor Income Elasticity of Labor Supply (Blundell-MaCurdy 1999)

- Based on 22 alternative elasticity estimates
- Mean of -0.15, median of -0.07. 10-90th range: $(-0.29, -0.01)$

Apply cash-transfer experiment in model

- We transfer income equivalent to $1,000 per year to all households
- In short-run PE, evaluate alternative durations of transfer
- **Find elasticity between -0.015 and -0.084**

	Based on $1,000 per year for:		
	One period (4 years)	**Five periods (20 years)**	**Rest of life**
Mean	-0.018	-0.071	-0.084
Median	-0.015	-0.062	-0.084
10^{th} percentile	-0.036	-0.137	-0.147
90^{th} percentile	-0.005	-0.020	-0.025

Back

UBI: Aggregate Effects

Long-Run Aggregate Effects

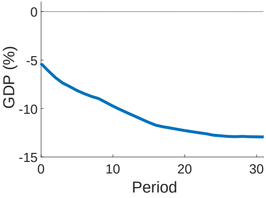
	Change from Baseline
GDP	-12.9%
Capital	-20.2%
Labor (Efficiency Units)	-9.2%
College Share	-12.4%
Average Labor Productivity: High-School	-1.9%
Average Labor Productivity: College	-3.7%
Average Hours Worked: High-School	-7.2%
Average Hours Worked: College	-2.8%

- 52% of GDP decrease is due to capital
- Remainder is due to fall in aggregate efficiency units H

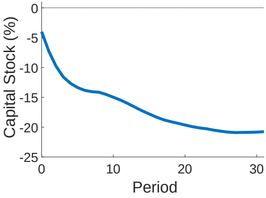
Transition

Transition Dynamics

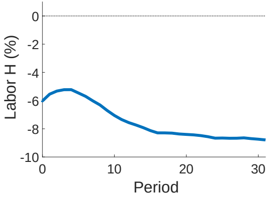
GDP



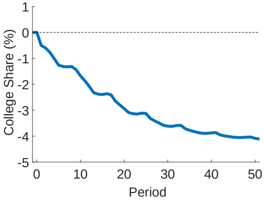
Capital



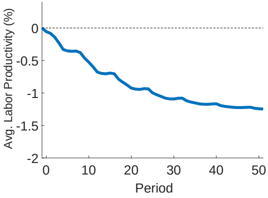
Labor



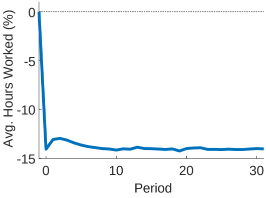
College Share



Labor Productivity



Time Worked



Back

Welfare

Consumption equivalence under veil of ignorance

Let utility under policy P with extra % consumption Δ be:

$$\tilde{V}^{P}_{j=5}(a,\theta,\varepsilon,\Delta) = \mathbb{E}^{P}\left\{\sum_{j=5}^{j=J_d}\beta^{(j-5)}u(c^{P}_{j}(1+\Delta),h^{P}_{j}) + \beta^{12-5}\delta\tilde{V}^{P}_{j'=5}(\hat{a},\theta_k,\varepsilon,\Delta)\right\}$$

Welfare

Consumption equivalence under veil of ignorance

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So average utility is:

$$\bar{V}^P(\Delta) = \int_{a,\Delta,\varepsilon}\tilde{V}^P_{J_i}(a,\Delta,\varepsilon,\Delta)\,\mu_P(a,\Delta,\varepsilon)$$

Then, welfare gain from going to policy P is given by Δ^P where:

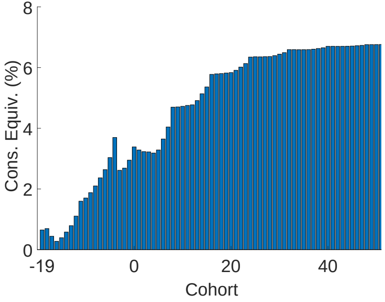
$$\bar{V}^{P_0}\left(\Delta^P\right) = \bar{V}^P(0)$$

Back to Policy Intro
Back to UBI

UBI: Consumption Taxes

Suppose UBI is financed by increasing consumption tax rate

- Requires an immediate increase in τ_c of 24 pp
- In new steady state, it is 25 pp higher
- Losers are now the older generations, young gain (high-school educ)
- Small steady-state gains (0.5% c.e.) ▸ Welfare by Educ/Age



▸ Back

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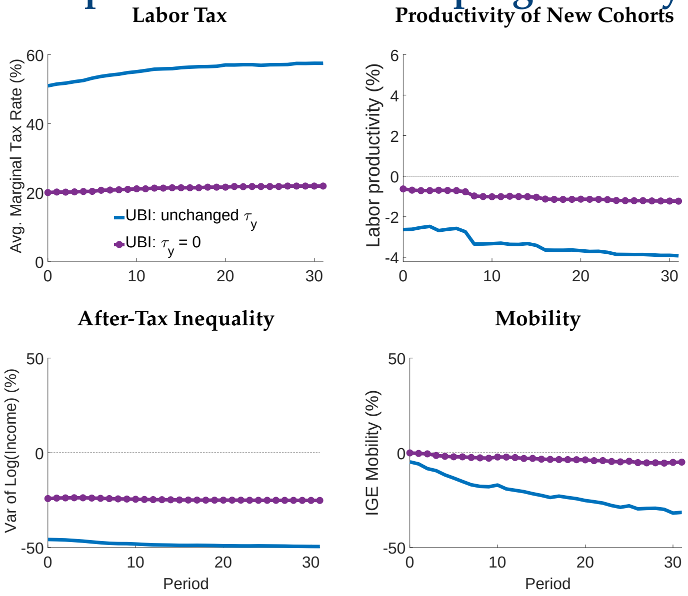
Gains are driven by consumption tax, not UBI:

- Suppose that prior to UBI, τ_c is increased by the 25pp required in the UBI s.s. and λ adjusts so as to keep budget neutral
- Yields large welfare losses among old (-2.3%) and large s.s. welfare gains (5.9%)
- Results reminiscent of Coleman (2000) & Correia (2010)

▸ Back

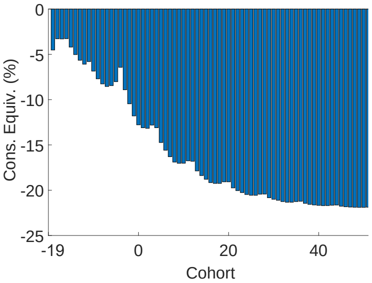
UBI as a replacement to current progressivity ($\tau_y = 0$)



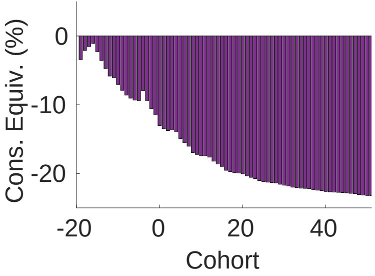
Back

UBI as a replacement to current progressivity ($\tau_y = 0$)

Unchanged τ_y



Replacing Current Progressivity ($\tau_y = 0$)



Average gains are similar early on
Losses are smaller for future cohorts

Back

UBI: Other Alternatives

	Unchanged τ_y	**Double σ_z^e**	**UBI substitutes for initial ω**
Welfare gains for adults at $t = 0$	1.0%	2.6%	1.8%
Welfare gains in steady state	-9.1%	-7.7%	-7.6%

Back

UBI in a Riskier Environment

Motivation: Increased robotization/automation will render a greater proportion of skills/jobs obsolete

We do not have an explicit model of automation but can use model to study UBI in an environment with greater out-of-work risk

Interpret automation as

1. Permanent increase in probability of entering in out-of-work state
   - To match estimates of current jobs that will be destroyed in near future

	Current Jobs Destroyed after 30 years
Initial	3.3%
	5.0%
McKinsey, OECD ≈	10.0%
	15.0%
	20.0%
	25.0%
Frey and Osborne (2017) ≈	30.0%

   - College graduates are 58% less likely to lose jobs than HS graduates (McKinsey, 2017)

UBI in a Riskier Environment

Motivation: Increased robotization/automation will render a greater proportion of skills/jobs obsolete

We do not have an explicit model of automation but can use model to study UBI in an environment with greater out-of-work risk

Interpret automation as

1. Permanent increase in probability of entering in out-of-work state
   - To match estimates of current jobs that will be destroyed in near future
2. Adjust APF such that, *ceteris paribus*:
   - s: high-school wage kept constant (otherwise increases)

$$Y = AK^{\alpha}H^{1-\alpha}$$

$$H = \left[sH_0^{\Omega} + (1-s)\,H_1^{\Omega}\right]^{\frac{1}{\Omega}}$$

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Trade-off

- UBI provides **insurance** against being out of work ⇒ **More relevant**
- But fewer people work/pay taxes ⇒ **Greater distortions**

Automation: Long-Run Aggregate Effects

Automation: Long-Run Aggregate Effects without UBI

Jobs Destroyed	5%	10%	15%	20%	25%	30%
	Change from Baseline					
GDP	0.0%	-0.1%	0.0%	0.7%	1.3%	2.0%
Capital	1.9%	6.0%	9.7%	13.8%	17.4%	20.8%
Labor (Efficiency Units)	-1.5%	-5.5%	-8.7%	-11.4%	-13.9%	-16.3%
College Share	0.9%	4.5%	8.9%	12.9%	17.3%	20.9%
Average Labor Productivity: High-School	0.0%	0.1%	0.1%	0.2%	0.3%	0.6%
Average Labor Productivity: College	0.0%	-0.1%	-0.0%	-0.1%	-0.5%	-0.7%
Average Hours Worked: High-School	-1.6%	-5.8%	-9.4%	-11.8%	-14.1%	-16.3%
Average Hours Worked: College	-0.8%	-3.2%	-5.5%	-7.8%	-9.9%	-11.7%
Average Hours Worked: All, Excl. Out of Work	0.2%	0.7%	1.0%	1.1%	1.3%	1.4%
Total Factor Productivity $\hat{A}$	0.4%	1.8%	3.1%	4.6%	6.2%	7.9%
High School Weight in Aggregate Labor $\hat{s}$	-0.3%	-1.2%	-2.1%	-2.9%	-3.9%	-4.7%
Interest Rate r	-3.7%	-12.7%	-20.4%	-25.9%	-31.1%	-36.8%
High-School Wage w_0	1.3%	4.6%	7.9%	10.5%	13.1%	16.2%
College Wage w_1	0.4%	1.8%	2.9%	4.2%	5.5%	7.1%
Average Labor Income Tax Rate	1.1%	4.7%	7.6%	9.4%	11.0%	12.9%
Welfare in Steady State	-0.68%	-1.75%	-1.92%	-1.42%	-0.69%	0.01%
Welfare for Adults at $t = 0$	-1.08%	-3.45%	-5.26%	-6.30%	-7.17%	-7.80%

Automation: Welfare Effects of UBI

Jobs Destroyed	Welfare Gains: Cons. Equiv. (%)			
	Adults at $t = 0$		Steady State	
	UBI	ECD	UBI	ECD
Baseline = 3.3%	1.01		-9.13	
5.0%	1.28		-9.22	
10.0%	1.66		-10.02	
15.0%	1.80		-11.15	
20.0%	1.97		-11.76	
25.0%	2.12		-12.55	
30.0%	2.25		-13.08	

Automation: opposite implications for current and future generations

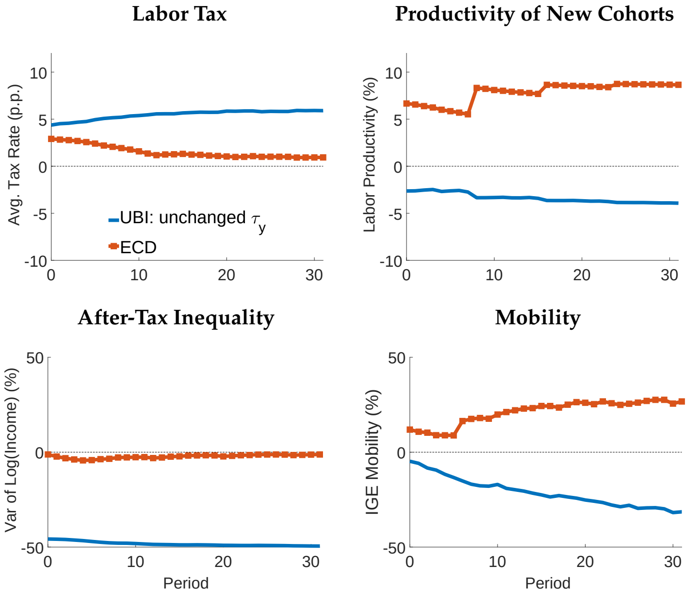
- Increases value of UBI for current adults
- But worsens welfare for future generations

Automation: UBI vs ECD

Jobs Destroyed	Welfare Gains: Cons. Equiv. (%) Adults at $t = 0$		Steady State	
	UBI	ECD	UBI	ECD
Baseline = 3.3%	1.01	-1.89	-9.13	8.82
5.0%	1.28	-1.72	-9.22	8.83
10.0%	1.66	-1.60	-10.02	8.82
15.0%	1.80	-1.61	-11.15	8.73
20.0%	1.97	-1.58	-11.76	8.84
25.0%	2.12	-1.62	-12.55	8.66
30.0%	2.25	-1.64	-13.08	8.48

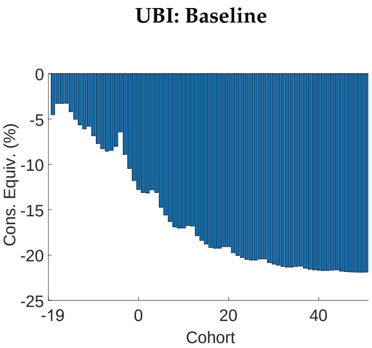
- ECD: publicly supplied program g for early childhood development
- Modeled as perfect substitute for m: $I = \bar{A}\left[\alpha_m (m+g)^\gamma + (1-\alpha_m)\tau^\gamma\right]^{1/\gamma}$
- Universal (and obligatory) program for 4 years: \$50,964
- On average, negative for adults at $t = 0$, large welfare gains for future generations

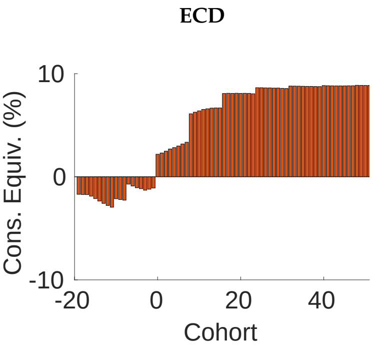
UBI vs. ECD



Intergenerational mobility: $\text{ChildRank}_i = \alpha + \beta\ \text{ParentRank}_i + \epsilon_i$ Back

Welfare: UBI vs. ECD



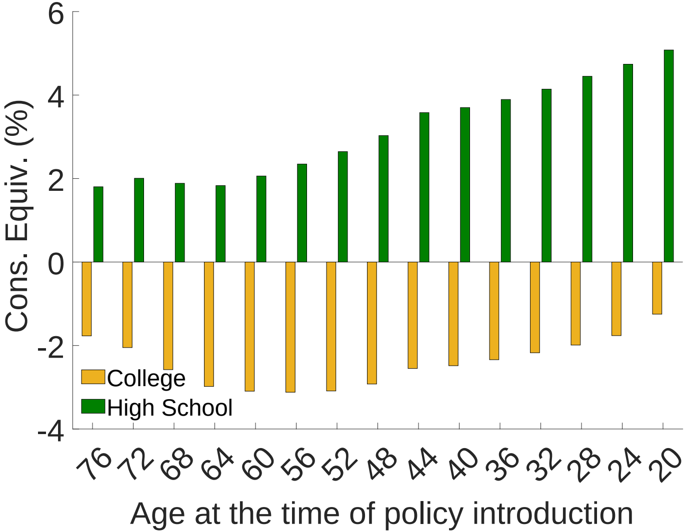


Very different welfare implications

- UBI: Large long-run welfare losses but voted in favor by current cohort
- ECD: Large long-run welfare gains but voted against

Back

UBI Financed via Consumption Tax



Back

Evidence on Early Childhood Programs

It is important to observe adult follow-ups (Garcia et al, 2017)

- Rather than using early measures to project adult outcomes

Most US evidence is from three programs:

- Large increases in education and income, and social gains
- **Perry Preschool Program** (ages 3–5)
  Schweinhart et al (2005) and Heckman et al (2010)
- **Carolina Abecedarian Project** (ABC) and **Carolina Approach to Responsive Education** (CARE)
  Ramey et al (2002) and Garcia et al (2017)

Head Start

- It is the largest program, between ages 4 (or 3) and 5
- Experimental evidence predicted smaller gains than non-experimental
- Larger gains if program substitution is accounted for (Kline and Walters, 2016)

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Early Childhood Development Programs around the world

Programs inspired by ABC/CARE around the world:

- Infant Health and Development Program (Spiker et al, 1997)
- John's Hopkins Cerebral Palsy Study (Schneider and McDonald, 2007)
- Classroom Literacy Interventions and Outcomes (Sparling, 2010)
- Massachusetts Family Child Care Study (Collins, 2010)
- Many more in US, Manitoba, Australia (Garcia, Heckman, Leaf, and Prados, 2017)

Back

Validation: Experimental Evidence

Use **RCT to validate the estimated model**

- **Garcia, Heckman, Leaf, and Prados (2020):**
  - Two US early childhood programs (ABC, CARE) in 1970s
  - Cost ≈ $13.5k per year for 5 years, i.e., total $67.5k per child
  - Followed up into adulthood and observe education/income

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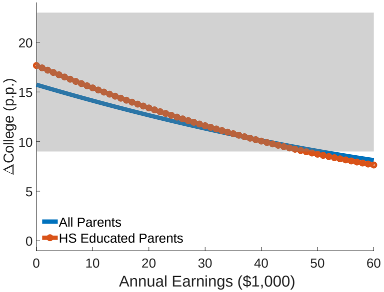
- **Apply similar policy in model:**
  - **Small scale:** prices and taxes are not affected
  - **Target:** disadvantaged children of less-educated and low-income parents
  - **One-generation:** policy is not received by following generations

Back to Non-targeted Moments
Back to Automation

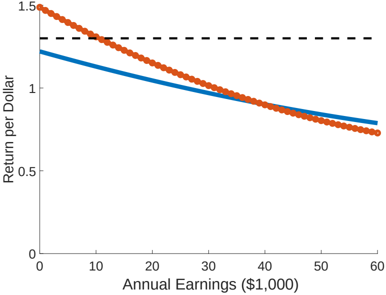
Validation: Experimental Evidence

Use RCT to validate the estimated model

College Graduation



Lifetime Earnings Return



Back to Non-targeted Moments
Back to Automation

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