# The Macroeconomic Consequences of Early Childhood Development Policies

Diego Daruich
University of Southern California (Marshall)

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# Motivation

**Early childhood investments increase education and income**

- Effects can be large (e.g., Garcia, Heckman, Leaf, and Prados, 2020)

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- Based on small-scale and short-run programs

**Consequences of *large-scale* and *long-run* policy depend on**

- GE effects on capital and labor markets
- Deadweight loss of raising taxes
- Intergenerational dynamics

# Today

**What is the impact of a *permanent* and *universal* early childhood government investment policy?**

Particularly on: income, inequality, intergenerational mobility, and welfare

Use an overlapping generations (OLG) model

- with distortionary taxes
- in general equilibrium

# Today

**What is the impact of a *permanent* and *universal* early childhood government investment policy?**

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Use an OLG model with distortionary taxes and in general equilibrium

**GE Life-cycle Aiyagari** + **Endogenous Intergenerational Links**

- Wage depends on **skills**

- **Parental investments of time and money to build child's skills**

- **Potential role for government investments because of:**
  - Imperfect capital and insurance markets
  - Inability to write contracts with children

# Outline

1. **Model:** GE Life-cycle Aiyagari + Endogenous Intergenerational Links

   - Wage depends on **skills**

   - **Parental investments of time and money to build child's skills**

2. **Estimation:**
   - Skill production function based on Cunha, Heckman, Schennach (2010)
   - Key moments on **parental investments and transfers from PSID**

3. **Validation**
   - Model replicates small-scale short-run **RCT evidence**
     (Garcia, Heckman, Leaf, and Prados, 2020)

4. **Policy:** **large-scale** government investments in early childhood
   - Long-run effects
   - Transition (with alternative ways to finance it)
   - Alternative policy in paper: parenting education

# Preview of Results

## Large long-run effects

- **Average income** grows by 7%
- $\downarrow$**Inequality**, $\uparrow$**Int. mobility** $\approx$ half of gap between US and Canada
- **Welfare** gains of 9%

  Welfare: Consumption equivalence for a newborn under veil of ignorance

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## Investing in a child today will make him a better parent tomorrow

- **Transition**: Large increase in gains after first generation has its own children

## Who does not benefit from the reform?

- Older individuals at the time the policy is introduced
- But this depends on how the transition is financed

# Related Literature

## Inequality and social mobility

- **GE Quantitative Life-cycle Aiyagari:** De Nardi (2004); Conesa and Krueger (2006); Bakis, Kaymak, and Poschke (2015); Abbott, Gallipoli, Meghir, Violante (2019)...
- **Contribution**: Endogenous early childhood development

## Early childhood development

- **Empirical:** Carneiro and Heckman (2002, 2003); Todd and Wolpin (2003); Cunha, Heckman, and Schennach (2010); Dahl and Lochner (2012), Agostinelli and Wiswall (2016)...
- **Structural:** Cunha (2013); Del Boca, Flinn, and Wiswall (2014); Abbott (2016); Caucutt and Lochner (2017)...
- **Contribution**: Large-scale policy evaluation framework (labor and savings choices, general equilibrium, multiple generations)

**Both:** Lee and Seshadri (2019), Yum (2019)

- **Contribution**: alternative policies and transition (crucial to observe intergenerational dynamics)

# Outline

Model

Estimation: USA 2000

Policy

# Model: Timeline

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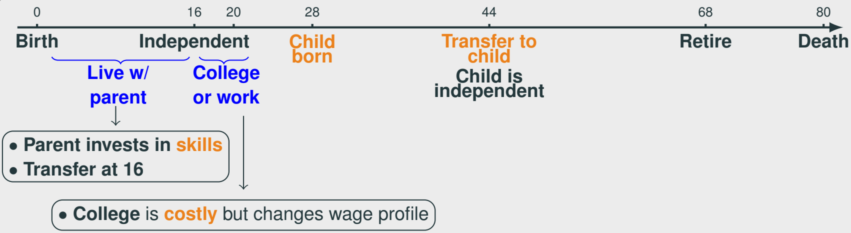

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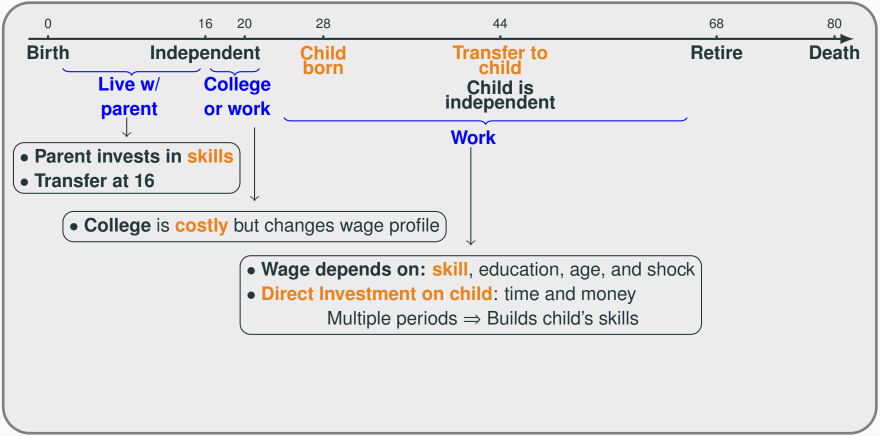

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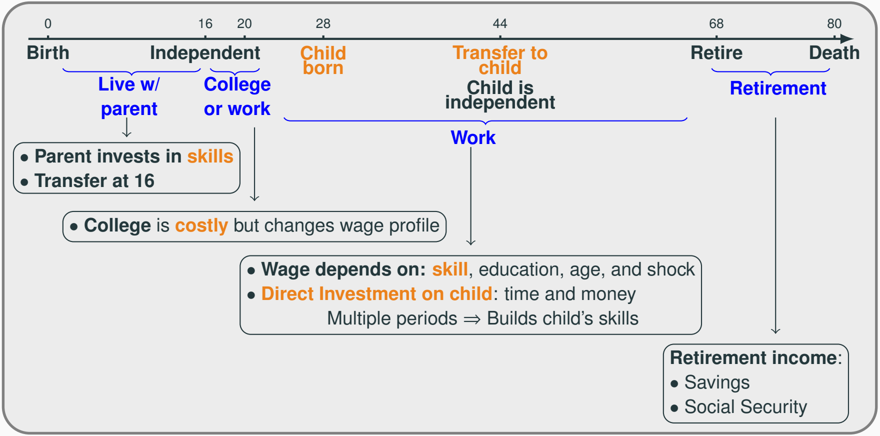
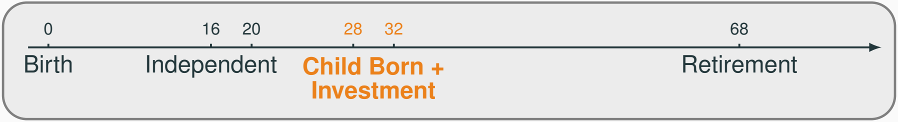



▸ Stationary Equilibrium

# Working Period




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

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

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

where

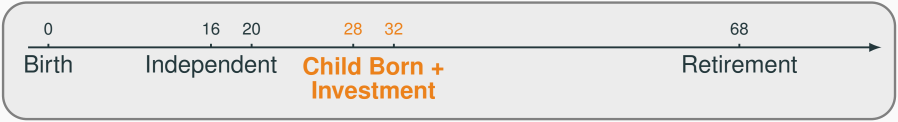
$a$ : assets

$e$ : education

$\eta$ : wage shock

$\theta$ : agent's skills

# Early Childhood Investments

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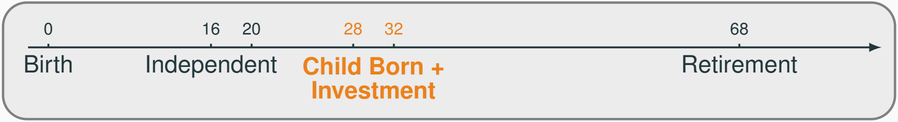


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where

$a$ : assets $\qquad$ $\boldsymbol{\theta}$ : agent's skills $\qquad$ $t$ : time with child

$e$ : education $\qquad$ $\boldsymbol{\theta_k}$ : child's skills $\qquad$ $m$ : money towards child

$\eta$ : wage shock

In the paper: include child consumption $c_k$ in utility, $\delta u\left(c_k,0\right)$

# Early Childhood Investments

| 0 | 16 | 20 | 28 | 32 | 68 |
|---|---|---|---|---|---|
| Birth | Independent | | **Child Born + Investment** | | Retirement |

$$V_j(a,\theta,e,\eta,\theta_k) = \max_{c,a',h,t,m} u(c,h,t) + \beta \mathbb{E}\left[V_{j+1}\left(a',\theta,e,\eta',\theta_k'\right)\right]$$

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

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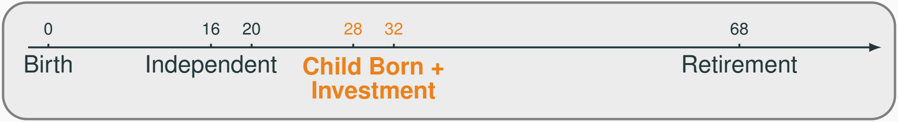


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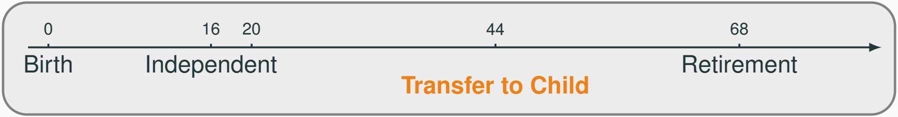
$$I = \bar{A}\left[\alpha_m \underbrace{\left(m+g\right)^{\gamma}}_{\text{Money}} + (1-\alpha_m) \underbrace{t^{\gamma}}_{\text{Time}} \right]^{1/\gamma} \qquad t, m \geq 0$$

# Parent-to-Child Transfer




- Just before child becomes independent, choose transfer $\hat{a}$

$$V_{\text{Transfer}}(a, \theta, e, \eta, \theta_k) = \max_{\hat{a}} \underbrace{V_{44}(a - \hat{a}, \theta, e, \eta)}_{\text{Parents' Continuation}} + \delta \, \underbrace{\mathbb{E}\left[V_{16}\left(\hat{a}, \theta_k, \phi_k\right)\right]}_{\text{Child's Utility}}$$

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

# Role for Government Investments

**Why may government investments $g$ increase welfare?**

Welfare: Consumption equivalence for a newborn under veil of ignorance

1. **Parent can't borrow against child's income created by investing**
   I. **Lack of compensation mechanism**
   II. **Life-cycle borrowing constraints** $\Rightarrow$ Timing of compensation matters

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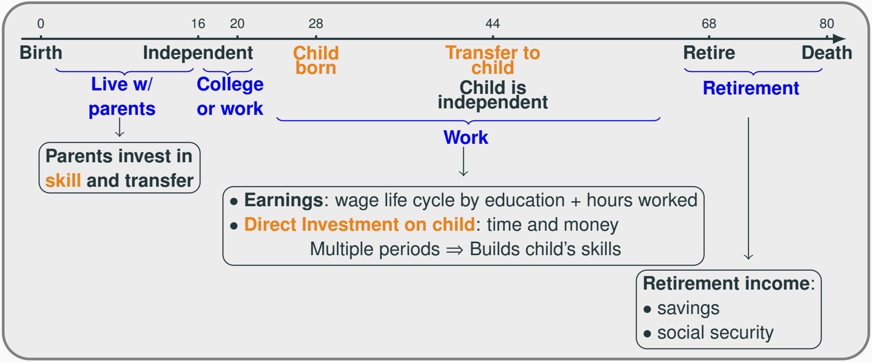
   II. **Life-cycle borrowing constraints** $\Rightarrow$ Timing of compensation matters

2. **Life-cycle borrowing constraints**
   - Parent may not be able to use her own future income

3. **Lack of insurance**
   - Investing in child is risky, so more incentives to consume and invest in safe asset

# Model: Timeline




▸ More Details ▸ College period ▸ Retirement period ▸ Stationary Equilibrium

# Aggregate Production Function

**Cobb-Douglas with constant returns to scale:**

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

where $H$ is the CES aggregator

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

▸ Stationary Equilibrium

# Outline

# Child's Skill Production Function

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

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## Parameter values

- **Baseline estimation from CHS (2010)**
  - Estimated on a representative sample
  - Skills are more malleable when children are young
- **Estimation concerns** (e.g., Agostinelli and Wiswall, 2016)
  - Test robustness of results when we move away from CHS estimation

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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 $I$

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

# Estimation: Simulated Method of Moments

Estimated to **match household level** data

**Important moments** for early childhood development

- **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**

More Details | CDS Results | CHS Multiple Skills | Two Steps

# Estimation: Parameters

| Parameter | Value | Std. Error | Description | Moment | Data | Model |
|---|---|---|---|---|---|---|
| **Preferences** | | | | | | |
| $\mu$ | 176.8 | (9.12) | Mean labor disutility | Avg. hours worked | 65.2 | 65.9 |
| $\delta$ | 0.475 | (0.011) | Altruism | Parent-to-child transfer as share of avg. annual income | 0.75 | 0.73 |
| **School Taste**: | | | | | | |
| $\alpha$ | 5.38 | (1.61) | Avg. taste for college | College share | 33 | 30 |
| $\alpha_{\theta_c}$ | -0.55 | (0.35) | College taste and cog. skills relation | College: cog skills slope | 0.23 | 0.23 |
| $\alpha_{\theta_{nc}}$ | -1.15 | (0.36) | College taste and non-cog. skills relation | College: non-cog skills slope | 0.16 | 0.15 |
| $\sigma_\varepsilon$ | 2.51 | (0.46) | SD of college taste shock | College: residual variance | 0.20 | 0.18 |
| $\bar{\varepsilon}$ | -1.55 | (0.63) | Draw of school taste: mean by parent's education | Intergenerational persistence of education | 0.70 | 0.75 |
| **Skill Formation Productivity:** | | | | | | |
| $\xi$ | 0.12 | (0.03) | Parental time disutility of time with children | Avg. hours with children | 18.0 | 17.2 |
| $\bar{A}$ | 32.4 | (1.30) | Returns to investments | Average log(skill) | 0.0 | 0.0 |
| $\alpha_m$ | 0.91 | (0.02) | Money productivity | Ratio of money to hours | 218 | 183 |
| $\gamma$ | -0.20 | (0.45) | Money-time substitutability | Money-time correlation | 0.93 | 0.88 |
| **Interest rate** | | | | | | |
| $\iota$ ($\times 10^2$) | 4.9 | (1.22) | Borrow-save wedge | Share of borrowers | 4.5 | 4.2 |
| **Government** | | | | | | |
| $\omega$ ($\times 10$) | 2.05 | (0.04) | Lump-sum transfer | Income variance ratio: Disposable to pre-gov | 0.69 | 0.70 |

▸ Moments' Information ▸ Non-targeted Moments ▸ Back to Robustness ▸ Back to Robustness SR-PE

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Moments' Information | Non-targeted Moments | Back to Robustness | Back to Robustness SR-PE

# Outline

Model

Estimation: USA 2000

Policy

# Early Childhood Investments

## Government investments in early childhood

- Government invests money g directly:

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

# 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 $\approx$ \$13.5k per year for 5 years, i.e., total \$67.5k per child
  - Followed up into adulthood and observe education/income

▸ Non-targeted Moments

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

Non-targeted Moments

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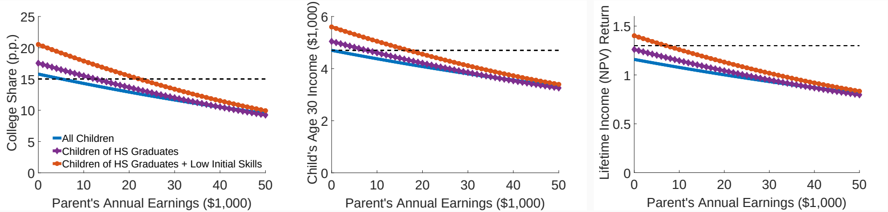
(a) College (b) Income (Age 30) (c) Return per Dollar

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# Large Scale and Permanent Policy

## Evaluate universal version of policy

- **General Equilibrium:** Wages (and interest rate) adjust
- **Budget Balance:** Labor income tax adjusts

## Outcomes of interest

- **Average income**, **inequality**, and **intergenerational mobility**
- **Consumption equivalence under veil of ignorance**

  *How much extra % consumption would an agent have to get in order to be indifferent between being born in initial SS and alternative?*

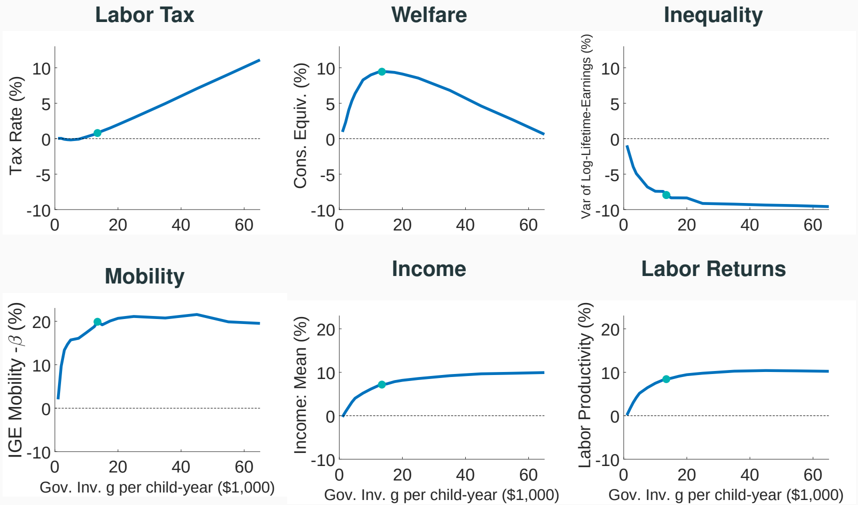
## Outline

1. **Long-run effects**

   (i) Alternative levels of $g$, (ii) Importance of long run, GE, budget-balance...
2. **Transition** (with alternative ways to finance it)

Cons. Equiv.

# Long Run Effects of Early Childhood Investments




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

More Results | Decomposition | ABC/CARE programs

# Results Decomposition

| Alternative Exercises | | | Change from Baseline (%) | | | | |
|---|---|---|---|---|---|---|---|
| **Long Run** | **General Equilibrium** | **Budget Balanced** | **Consumption Equivalence** | **Average Income** | **Labor Returns** | **Inequality** | **Mobility** |
| No | No | No | | | | | |
| Yes | No | No | | | | | |
| Yes | Yes | No | | | | | |
| Yes | Yes | Yes | **9.4** | **7.2** | **8.4** | **-7.9** | **19.9** |

# Results Decomposition

| Alternative Exercises | | | Change from Baseline (%) | | | | |
|---|---|---|---|---|---|---|---|
| Long Run | General Equilibrium | Budget Balanced | Consumption Equivalence | Average Income | Labor Returns | Inequality | Mobility |
| No | No | No | 3.9 | 8.0 | 8.4 | 5.3 | 12.6 |
| Yes | No | No | | | | | |
| Yes | Yes | No | | | | | |
| Yes | Yes | Yes | **9.4** | **7.2** | **8.4** | **-7.9** | **19.9** |

**Short-run small-scale policy would underestimate gains by one-half**

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| Yes | No | No | 9.1 | 11.7 | 13.4 | 5.6 | 25.4 |
| Yes | Yes | No | | | | | |
| Yes | Yes | Yes | **9.4** | **7.2** | **8.4** | **-7.9** | **19.9** |

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**Large-scale GE effects explain most of inequality reduction**

- Increase wage of HS-grads relative to college-grads
- Increase gains by 1/10th

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## Short-run small-scale policy would underestimate gains by one-half

- Long-run intergenerational dynamics generate over 1/2 of welfare gains
- Large-scale higher taxes reduce gains by 1/10th

## Large-scale GE effects explain most of inequality reduction

- Increase wage of HS-grads relative to college-grads
- Increase gains by 1/10th

Cons. Equiv. Decomposition

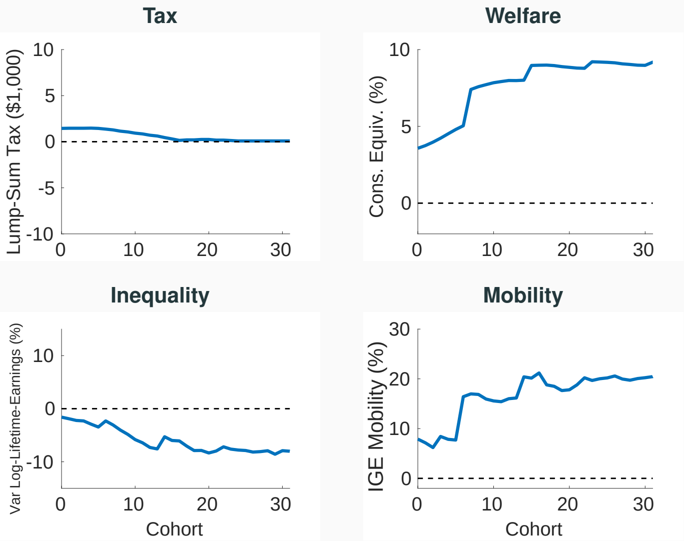
# Transition Dynamics

**Many alternatives** on how to transition to new steady state

First:

- Immediate introduction of investments $g$ and labor-income tax
- Balance budget every period using lump-sum tax

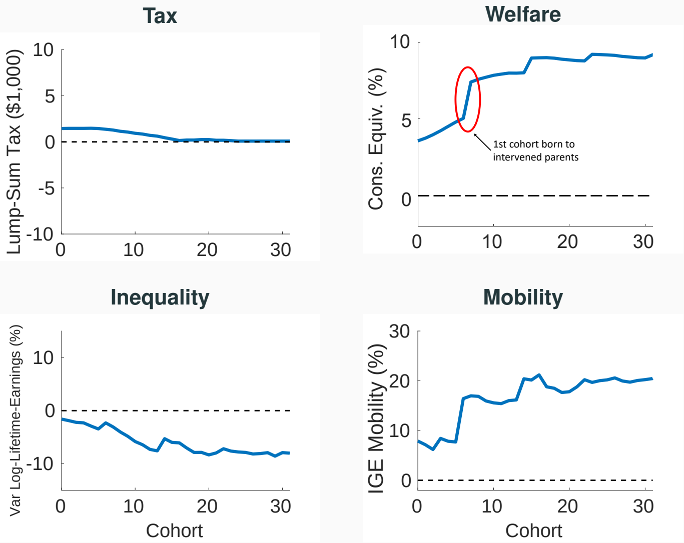
# Transition Dynamics




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

▸ Details ▸ With ECD Market

# Transition Dynamics

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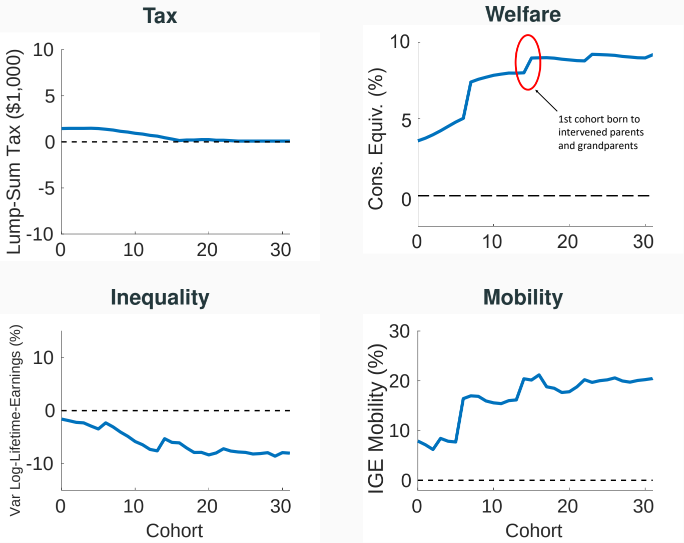
Details | With ECD Market

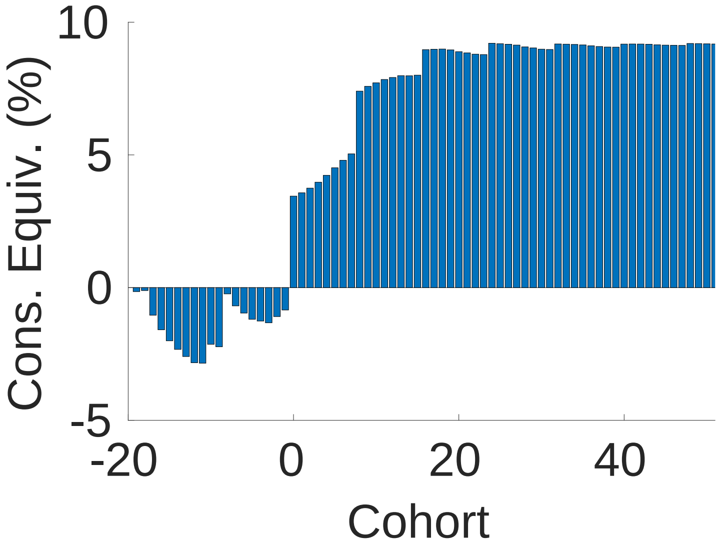
# Transition Dynamics




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

Details
With ECD Market

# Who Loses? Older Agents at Time of Introduction



# Alternative Transitions

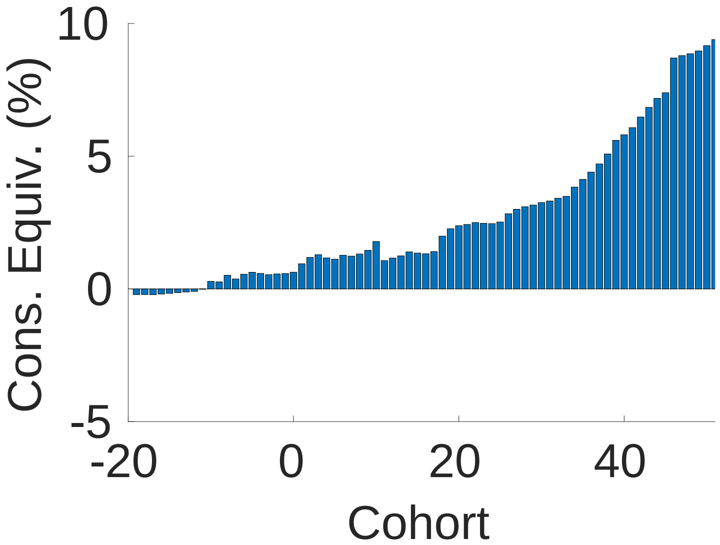
**Two ways to reduce cost paid by older agents and earlier cohorts**

- **Government borrowing** ⇒ Transfer costs to future cohorts
- **Slow introduction of investments** ⇒ Reduce earlier costs

**Combination makes gains more homogenous across cohorts**

▸ Gov. Borrowing ▸ Slow Intro + Gov. Borrowing

# Transition: Only Intervened Pay + Slow Intro



# Results Robustness: Estimated Parameters Importance

## Move each parameter one std. dev. above and below

- Calculate steady-state and introduce same policy as before

| | | **Cons. Equiv. Change from Baseline Long-Run GE** | | |
|---|---|---|---|---|
| | | Down | Up | **Total** |
| $\delta$ | Altruism | | | |
| $\mu$ | Labor Disutility | | | |
| $\alpha$ | Avg. distaste for College | | | |
| $\alpha_{\theta_c}$ | College taste-Cog Skills relation | | | |
| $\alpha_{\theta_{nc}}$ | College taste-NonCog Skills relation | | | |
| $\bar{\varepsilon}$ | Mean college taste shock | | | |
| $\sigma_{\varepsilon}$ | SD of college taste shock | | | |
| $\bar{A}$ | Returns to investments | | | |
| $\alpha_m$ | Money productivity | | | |
| $\gamma$ | Money-Time substitutability | | | |
| $\xi$ | Parental time disutility | | | |
| $\iota$ | Borrow-save wedge | | | |
| $\omega$ | Lump-sum transfer | | | |
| **Baseline** | | | **9.4** | |

▸ Standard Deviation ▸ Short-Run PE

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| | | Cons. Equiv. Change from Baseline Long-Run GE | | |
|---|---|---|---|---|
| | | Down | Up | **Total** |
| $\delta$ | Altruism | 0.34 | -0.19 | 0.53 |
| $\mu$ | Labor Disutility | 0.13 | -0.06 | 0.07 |
| $\alpha$ | Avg. distaste for College | -0.66 | 0.81 | 1.47 |
| $\alpha_{\theta_c}$ | College taste-Cog Skills relation | 0.00 | -0.56 | 0.56 |
| $\alpha_{\theta_{nc}}$ | College taste-NonCog Skills relation | -0.13 | -0.14 | 0.01 |
| $\bar{\varepsilon}$ | Mean college taste shock | -0.21 | -0.20 | 0.02 |
| $\sigma_\varepsilon$ | SD of college taste shock | 0.70 | -0.78 | 1.48 |
| $\bar{A}$ | Returns to investments | -0.11 | -0.23 | 0.11 |
| $\alpha_m$ | Money productivity | -0.38 | -0.02 | 0.36 |
| $\gamma$ | Money-Time substitutability | -0.21 | -0.20 | 0.01 |
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Standard Deviation
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Standard Deviation
Short-Run PE

# Results Robustness: CHS Parameters Importance

## Move each parameter one std. dev. above and below

- Re-estimate, obtain steady-state, and introduce same policy as before

| | | Cons. Equiv. Change from Baseline Long-Run GE | | |
|---|---|---|---|---|
| | | Down | Up | **Total** |
| $\alpha_1$ | Child's Skills Importance | | | |
| $\alpha_2$ | Parents' Skills Importance | | | |
| $\alpha_3$ | Investments Importance | | | |
| $\rho$ | Substitutability | | | |
| $\sigma_\nu$ | Std. Dev. of Shock | | | |
| $Var(\theta_{k_0})$ | Var of Initial Skills | | | |
| $Corr(\theta, \theta_{k_0})$ | IGE Corr of Initial Skills | | | |
| **Baseline** | | | **9.4** | |

Multiple Skills
Only Cognitive Skills
Short-Run PE

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| | | Down | Up | **Total** |
| $\alpha_1$ | Child's Skills Importance | 1.64 | -2.70 | 4.34 |
| $\alpha_2$ | Parents' Skills Importance | 0.98 | -1.48 | 2.46 |
| $\alpha_3$ | Investments Importance | 0.03 | -0.89 | 0.92 |
| $\rho$ | Substitutability | -1.26 | 0.96 | 2.21 |
| $\sigma_\nu$ | Std. Dev. of Shock | 0.07 | -0.66 | 0.73 |
| $Var\left(\theta_{k_0}\right)$ | Var of Initial Skills | -0.66 | -0.67 | 0.01 |
| $Corr\left(\theta, \theta_{k_0}\right)$ | IGE Corr of Initial Skills | -0.69 | -0.44 | 0.25 |
| **Baseline** | | | **9.4** | |

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| **Baseline** | | | **9.4** | |

Multiple Skills
Only Cognitive Skills
Short-Run PE

# Alternative Policy: Parenting Education Program

## Parenting education program

- Extend model to allow parents to acquire minimum parenting skills
- Use experimental evidence to estimate costs and gains of programs

## Two alternative implementations

1. **Paid by Government**
   - Welfare benefits of 8%
   - Reduces inequality by 5% and increases mobility by 15%

2. **Paid by Households**
   - Welfare benefits of 7%
   - Reduces inequality by 5% and increases mobility by 13%

**As with ECD investments:** long-run large-scale gains are larger than short-run small-scale ones

▸ Parenting Education

# Conclusion

**Consequences of large-scale early childhood policies depend on**

- (i) GE effects; (ii) cost of raising taxes; (iii) intergenerational dynamics

**Model**

- Introduce **endogenous parental investments** into a GE OLG incomplete markets model with distortionary taxes

**Government early childhood investments increase welfare by 9%**

- **Small-scale short-run programs underestimate gains**
  - Large-scale higher taxes reduce gains by 1/10th
  - Large-scale GE reduces inequality and increases gains by 1/10th
  - Long-run intergenerational dynamics generate over 1/2 of welfare gains
- **Effects on inequality and mobility**
  - Large enough to close gap with Canada by 50%

# Some suggestions

## Computation and data skills are very valuable

- Software: your choice
- Guides: Judd's or Miranda-Fackler's books, Violante's notes
- Practice is key so start early

## For heterogeneous-agents models

- Endogeneous grid method–look at Pijoan-Mas notes
- Simulation using kronecker products
- But these methods evolve quickly...
  - Maybe approximation methods based on machine learning?

## Take advantage of HPC

- Provides lots of computational power
- May need advisor/professor's sponsorship

# APPENDIX

# Outline

Early Childhood Programs

Model: More Details

Estimation: More Details

Data

Moment's Information

Additional Results

# 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, 2020)

Back to Policy

# Evidence on Early Childhood Programs

## It is important to observe adult follow-ups (Garcia et al, 2020)

- 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 (2020)

## 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)

Back to Intro

# Outline

# Model: More Details

Model Time Line

# Preliminaries: Skills and Wages

**Labor income** of individual of age $j$, education $e$, and skills $\theta$ is product of:

1. Wage of your education group: $w_e$.
2. **Labor efficiency units**: $E_{i,e,j} = \epsilon_{e,j}\psi_{i,e,j}$.
3. Hours worked: $h$.

**Labor efficiency units** evolve stochastically as sum of three components:

$$log\left(E_{i,e,j}\right) = \log(\epsilon_{e,j}) + \lambda_e log\left(\theta_{ic}\right) + \eta_{i,e,j}$$

where

- $\lambda_e$ is education-specific return to skills.
- $\epsilon_{e,j}$ is education-specific age profile.
- $\psi_{i,e,j}$ 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 $\iota$ is the wedge between borrowing and lending capital.

# Preliminaries: Market Structure

## During working years

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## College Loans

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

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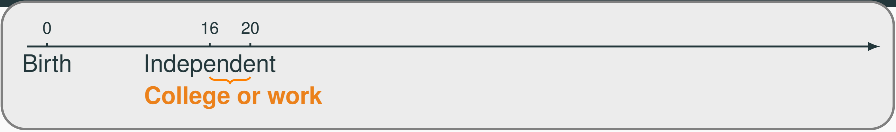
## College Loans

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

**Today:** Presentation of model abstracts from different interest rates.

# College Choice




**Work** $(e = 0)$

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

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

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

▸ Model Time Line

# College Choice


## Work $(e = 0)$

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

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## College $(e = 1)$

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

$$c + a' + p^s = y + a(1 + r) - T(y, a, c)$$

$$y = w_0 E_{e,j}(\theta)\, h, \quad a' \geq \underline{a}_{e,j}, \quad 0 \leq h \leq 1 - \bar{h}$$

▸ Model Time Line

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$$y = w_0 E_{e,j}(\theta) h, \quad a' \geq \underline{a}_{e,j}, \quad 0 \leq h \leq 1 - \bar{h}$$

**Work or college**:

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

Model Time Line

# Retirement


**Social Security**: Received every period, relative to education $e$ and permanent skill $\theta$.

$$V_j(a, \theta, e) = \max_{c, a'} u(c, 0) + \beta V^w_{j+1}(a', \theta, e),$$

$$c + a' = \pi(\theta, e) + a(1 + r) - T(0, a, c),$$

$$a' \geq 0$$

▸ Replacement rate ▸ Model Time Line

# 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 1 Back to Timeline 2 Back to Agg. Prod.

# Outline

# 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 (e.g., parental investments).
   - Estimated to match household level data. ▸ Details

▸ Back

# Parametrization: Preferences

Utility function is:

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

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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: $\gamma_c = 2$, $\gamma_h = 3$.
- To estimate: $\mu$ and $\xi$.

# Parental investments

| | All | Parents Together 2 Children |
|---|---|---|
| *Sample Means* | | |
| **Weekly Hours** | 18.0 | 20.6 |
| | (0.3071) | (0.6721) |
| **Yearly Expenditures** | 1,966 | 1,553 |
| | (35.53) | (57.31) |
| *Regression Coefficients* | | |
| **Hours on College** | 3.734*** | 2.473** |
| | (0.518) | (1.179) |
| **Log(Hours) on Log(Income)** | 0.123*** | 0.0481 |
| | (0.0234) | (0.0760) |
| **Expenditures on College** | 732.4*** | 665.7*** |
| | (67.80) | (106.75) |
| **Log(Expenditures) on Log(Income)** | 0.391*** | 0.634*** |
| | (0.0285) | (0.0624) |

Expenditures: child-care expenditures in CEX.
Weekly Hours: based on time reading and playing in PSID-CDS.

Back

# Government Taxes

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

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   Back to Short-Run PE

# Cunha, Heckman and Schennach (2010) — Only Cognitive

| | Cognitive Skills | |
|---|---|---|
| | 1st Stage | 2nd Stage |
| **Current Cognitive Skills** | 0.303 | 0.448 |
| **Investments** | 0.319 | 0.098 |
| **Parent's Cognitive Skills** | 0.378 | 0.454 |
| | | |
| **Complementarity parameter** | -0.180 | -0.781 |
| **Variance of Shocks** | 0.193 | 0.050 |

| | Cognitive Skills | | Non-Cognitive Skills | |
|---|---|---|---|---|
| | 1st Stage | 2nd Stage | 1st Stage | 2nd Stage |
| **Current Cognitive Skills** | 0.479 | 0.831 | 0.000 | 0.000 |
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Back

# Outline

# Child Development Data: PSID + CDS

- **Panel Study of Income Dynamics (PSID):**
  - Longitudinal household survey.
  - Information on education, income, marriage, children,... and expenditures on children: toys, vacations, school supplies, clothes, food and medical.
  - Sampling: Core sample of approximately 5k families, in 1968.
    Over time it includes those born in these families.

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  - Sampling: Core sample of approximately 5k families, in 1968.
    Over time it includes those born in these families.

- **Child Development Supplement (CDS):**
  - Multiple **Assessments of Child Skills**:
    (1) Multiple tests: Letter-Word, Applied Problem Solving (and more).
    (2) Multiple ages: 2002, 2007.
  - **Time Diary**: Detailed description of child's activities (weekday and weekend). Information on active and passive participation of parents.

▸ Summary Stats ▸ CDS by Age

# Active time with parents

- Using time diaries I calculate “active” time with parents.
- “Active:” parent is performing activity with kid.
  Assumption: If two parents are active, double the hours.

# Parental investments

| | All | Parents Together 2 Children |
|---|---|---|
| ***Sample Means*** | | |
| **Weekly Hours** | 18.0 | 20.6 |
| | (0.3071) | (0.6721) |
| **Yearly Expenditures** | 1,966 | 1,553 |
| | (35.53) | (57.31) |
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Expenditures: child-care expenditures in CEX.

Weekly Hours: based on time reading and playing in PSID-CDS.

# Estimation: Labor income risk

**Labor income** of individual of age $j$, education $e$, and skills $\theta$ is product of:

1. Wage of your education group: $w_e$.
2. **Labor efficiency units**: $E_{i,e,j} = \epsilon_{e,j}\psi_{i,e,j}$.
3. Hours worked: $h$.

**Labor efficiency units** evolve stochastically as sum of three components:

$$log\left(E_{i,e,j}\right) = \log(\epsilon_{e,j}) + \lambda_e log\left(\theta_{ic}\right) + \eta_{i,e,j}$$

where

- $\lambda_e$ is education-specific return to skills.
- $\epsilon_{e,j}$ is education-specific age profile.
- $\psi_{i,e,j}$ is stochastic component with persistent cdf $\Gamma_{j,e}$. Details

Back

# Estimation: Return to Skill

| | (1) High School | (2) College |
|---|---|---|
| log(AFQT) | 0.471*** | 1.008*** |
| | (0.0335) | (0.0768) |
| Observations | 7,015 | 3,378 |
| R-squared | 0.045 | 0.082 |
| # of households | 988 | 487 |

*Source: NLSY. Robust standard errors in parentheses. *, **, *** denote statistical significance at the 10, 5, and 1 percent, respectively. log(AFQT) refers to the natural logarithm of the AFQT89 raw score. The regression includes year fixed effects. Methodology is explained in the main text.*

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

▸ Back

# Age Profile

| VARIABLES | (1)<br>HS Grad | (2)<br>College |
|---|---|---|
| Age | 0.0312*** | 0.0557*** |
| | (0.00387) | (0.00577) |
| $Age^2$ | -0.000271*** | -0.000530*** |
| | (4.65e-05) | (6.89e-05) |
| 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

$$\eta_{i,e,j} = \rho_e \eta_{i,e,j-1} + z_{i,e,j}, \quad z_{i,e,j} \overset{iid}{\sim} N\left(0, \sigma_{e,z}\right), \eta_0^e \qquad \sim N\left(0, \sigma_{\eta_0}^e\right)$$

| | (1)<br>High School | (2)<br>College |
|---|---|---|
| $\rho_e$ | 0.924 | 0.966 |
| $\sigma_{e,z}$ | 0.029 | 0.046 |
| $\sigma_{e,\eta_0}$ | 0.050 | 0.047 |

*Source: NLSY. A period is 4 years long. Methodology is explained in the main text.*

Back **Source**: PSID + NLSY.

# Other elements of estimation

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

# Aggregate Production Function

- Cobb-Douglas Form with constant returns to scale:

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

where $H$ is the nested CES aggregator

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

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

Back

# Borrowing limits

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

- Interest rate $r^b = r + \iota$ where $r$ is the returns to saving and $\iota$ 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

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

- Interest rate $r^b = r + \iota$ where $r$ is the returns to saving and $\iota$ 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 is allowed for **college** at **subsidized interest rate** $r^c$:

- Pay interest rate $r^c = r + \iota^c$ where $\iota^c$ 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.

Back to model Back to calibration Model Time Line Model Inputs

# Estimation: Age

| Parameter | Value | Description |
|---|---|---|
| Jb | 16 | Independent - start with 12 years of education |
| Je | 20 | Max educ - average years of schooling 13.42 |
| Jc | 28 | Fertility |
| Jk | 36 | Transfer to children |
| Jt | 40 | Transfers to parents |
| Jr | 68 | Retire |
| Jd | 80 | Death |

# Outline

# Estimation: 2-Steps Methodology

## Step 1: Target moments

- Estimate target moments using whole sample
- Using bootstrap, obtain moments $M_n$ for $n = 1, ..., N$

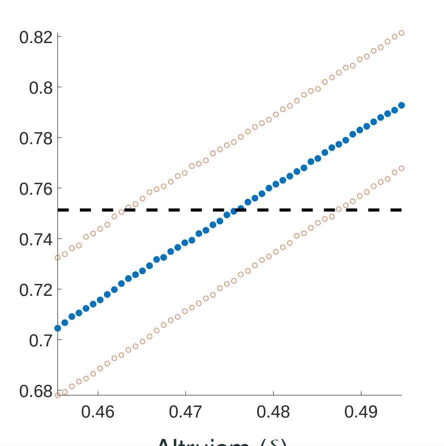
## Step 2: Global estimation

- 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

## Transfers to children

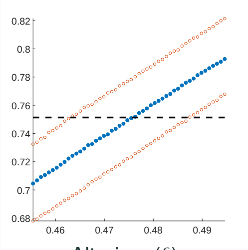



Altruism ($\delta$)

▸ Back to Methodology ▸ Back to Parameters

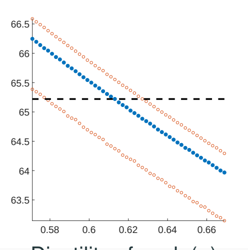
# Preferences

### Transfers to children



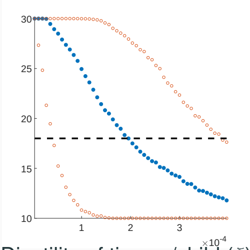

Altruism ($\delta$)

### Hours worked




Disutility of work ($\mu$)

### Hours with child

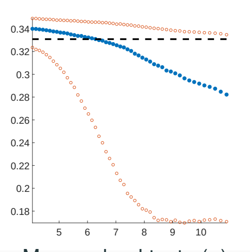



Disutility of time w/child ($\xi$)

▸ Back to Methodology ▸ Back to Parameters

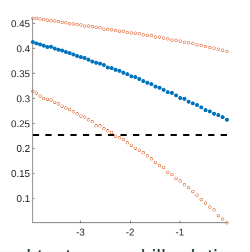
# School Taste

**Share of college grads (%)**



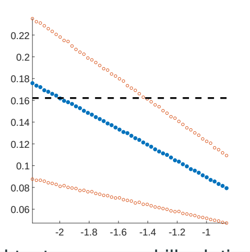

Mean school taste ($\alpha$)

**College: cog skills slope**



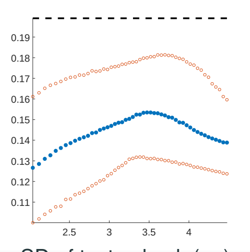

School taste-cog skill relation ($\alpha_c$)

**College: noncog skills slope**




School taste-noncog skill relation ($\alpha_{nc}$)

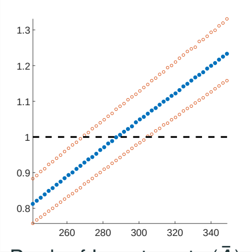
**College: residual variance**




SD of taste shock ($\sigma_\phi$)

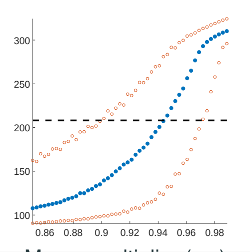
# Skill Formation Productivity

**High-Low skilled ratio**



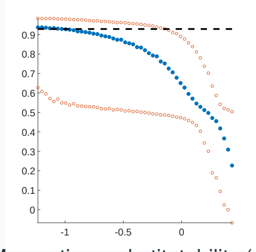

Prod. of Investments ($\bar{A}$)

**Ratio money-time**



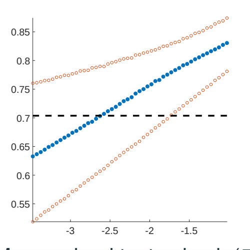

Money multiplier ($\alpha_m$)

**Money-time correlation**



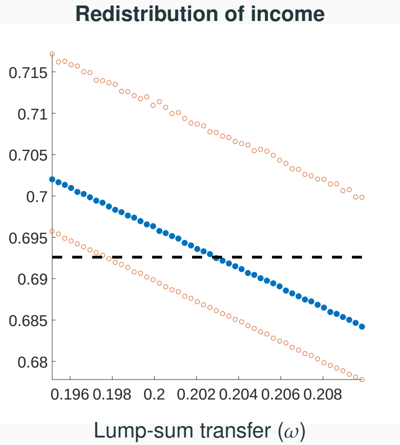

Money-time substitutability ($\gamma$)

**IGE persistence of education**




Mean school taste shock ($\bar{\varepsilon}$)

# Tax Progressivity

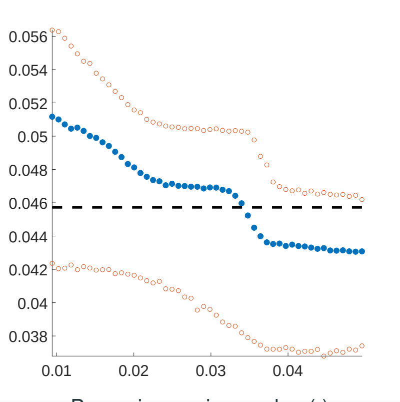



Back to Methodology

Back to Parameters

# Financial Services

**Share of borrowers**




Borrowing-saving wedge ($\iota$)


Back to Methodology
Back to Parameters

# Outline

# Validation: Not Targeted Moments

| Moment | Data | | Model |
|---|---|---|---|
| **Regression of parental investments to parents' characteristics** (PSID-CDS and CEX) | | | |
| | All Families | Homogeneous Families | |
| Hours on college ed. parent | 3.7 | 2.5 | 4.5 |
| Expenditures on college ed. parent | 732 | 666 | 752 |
| Log hours on log parent income | 0.12 | 0.05 | 0.07 |
| Log expenditures on log parent income | 0.39 | 0.63 | 0.87 |
| **Intergenerational Mobility** (Chetty et al, 2016 and PSID-CDS) | | | |
| Rank-Rank coefficient | 0.26–0.29 | | 0.29 |
| Regression of college to log-parent income | 0.24 | | 0.18 |
| **Inequality** (PSID) | | | |
| Gini | 0.32 | | 0.27 |
| Top-Bottom | 3.7 | | 3.1 |
| **Savings** (Inklaar and Timmer, 2013) | | | |
| Capital-Output Ratio (annualized) | $\approx 3$ | | 2.8 |
| **Return to College** (PSID and Heckman et al, 2006) | | | |
| Income Ratio: College – HS Graduate | 1.6 | | 1.7 |
| Yearly return | $\approx 10\%$ | | 12% |

▸ Back to estimation ▸ Back to RCT

# Welfare

## Consumption equivalence under veil of ignorance

Let utility under policy $P$ with extra % consumption $\lambda$ be:

$$\tilde{V}^P_{J_i}\left(a,\theta,\phi,\lambda\right) = \mathbb{E}^P\left\{\sum_{j=J_i}^{j=J_d}\beta^{(j-J_i)}u(c^P_j(1+\lambda),h^P_j) + \beta^{J_c}b\,\tilde{V}^P_{J_i}\left(\varphi,\theta_k,\phi,\lambda\right)\right\}$$

So average utility is:

$$\bar{V}^P\left(\lambda\right) = \int_{a,\theta,\phi}\tilde{V}^P_{J_i}\left(a,\theta,\phi,\lambda\right)\mu_P\left(a,\theta,\phi\right)$$

Then, welfare gain from going from policy $P=0$ to $P=p$ is given by $\lambda^p$ where:

$$\bar{V}^0\left(\lambda^p\right) = \bar{V}^p\left(0\right)$$

By definition, welfare gains come from 2 sources

- **Changes in values** of becoming independent in each state, i.e., $\tilde{V}^P_{J_i}\left(a,\theta,\phi,0\right)$
- **Changes in probabilities** of each state, i.e., $\mu_P\left(a,\theta,\phi\right)$

Back to Policy Back to Decomposition

# Decomposition

**By definition, welfare gains come from 2 sources**

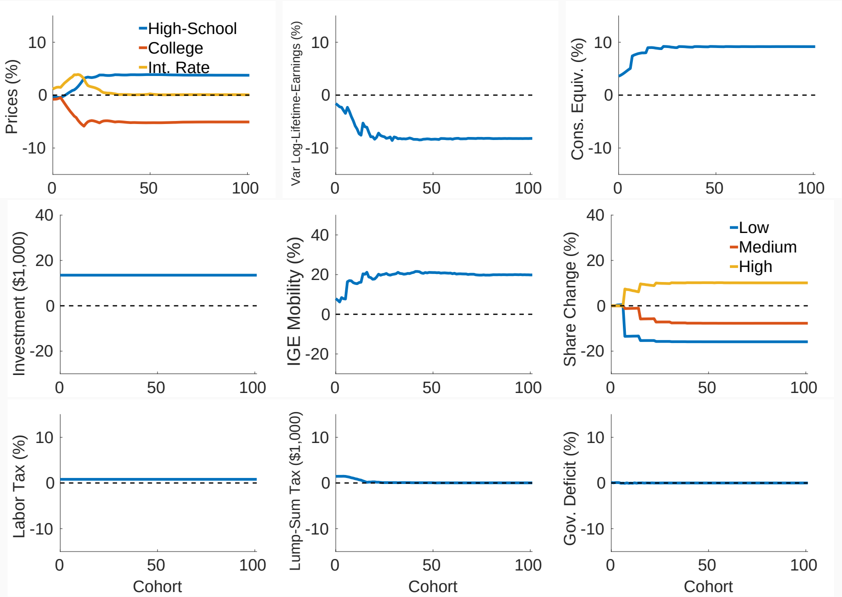
- **Changes in values** of becoming independent in each state, i.e., $V(a, \theta, \varphi)$
- **Changes in probabilities** of each state, i.e., $\mu(a, \theta, \varphi)$

**Most welfare gains are driven by change in distribution $\mu$**

- **Fixing $\mu$:** Gains are 2.5%
- **Fixing $V$:** Gains are 7.3%

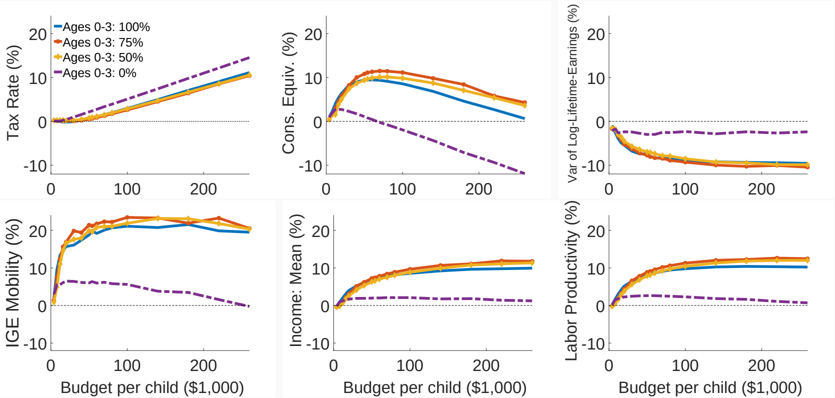
▸ Cons. Equiv. ▸ Back to Policy ▸ Back to Decomposition ▸ Back to More Results

# Transition Dynamics



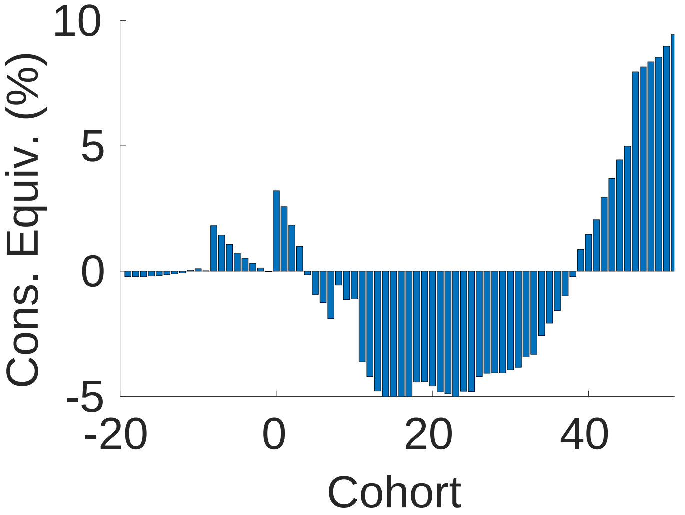

Back

# Early Childhood Investments



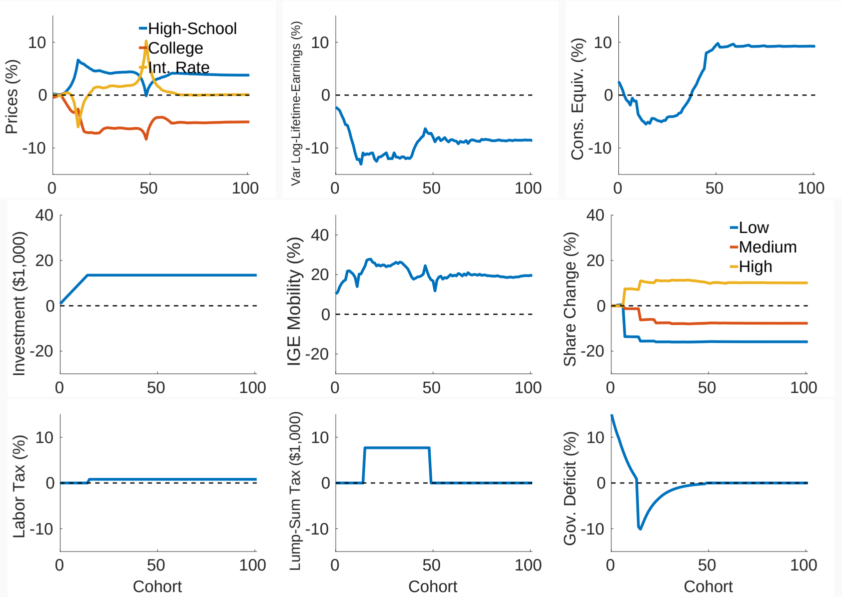

Back

# Transition: Only Intervened Pay



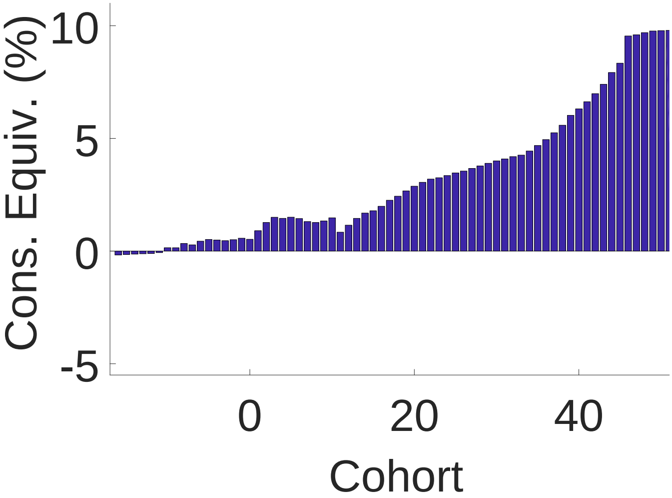

Back

# Transition: Only Intervened Pay



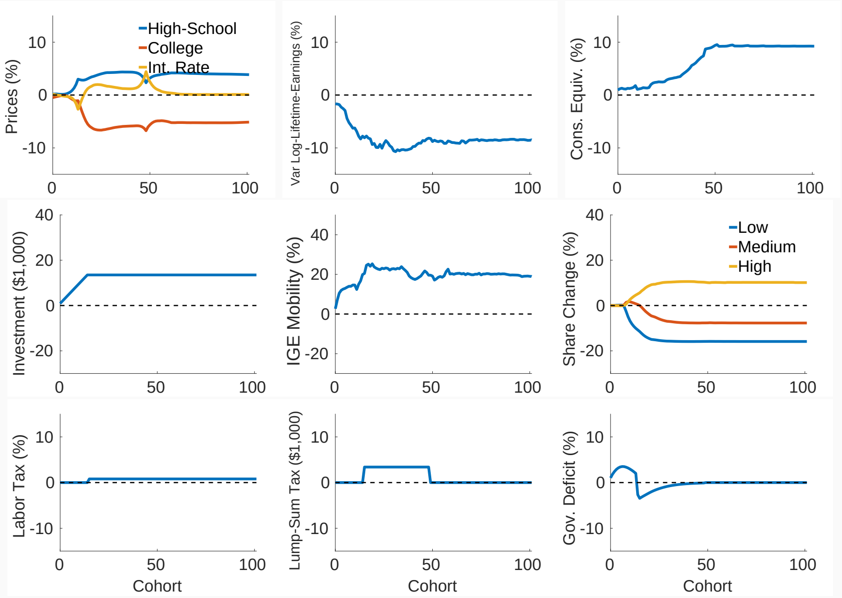

Back

# Transition: Only Intervened Pay + Slow Intro



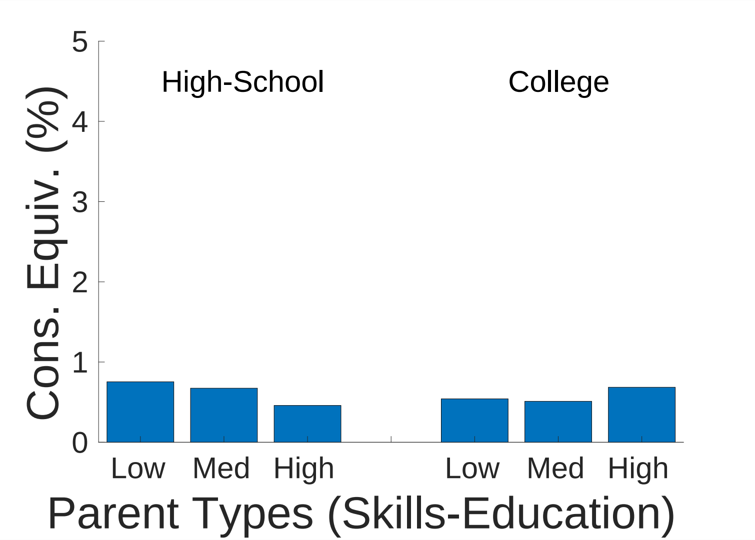

Back

# Transition: Only Intervened Pay + Slow Intro




Heterogeneity 1st cohort
Back

# Transition: Only Intervened Pay + Slow Intro




Back

# With Early Childhood Production Function

# With Early Childhood Production Function

**Assume early childhood good's only input is college labor**

- Price of early childhood is now wage of college graduate

# With Early Childhood Production Function

## Assume early childhood good's only input is college labor

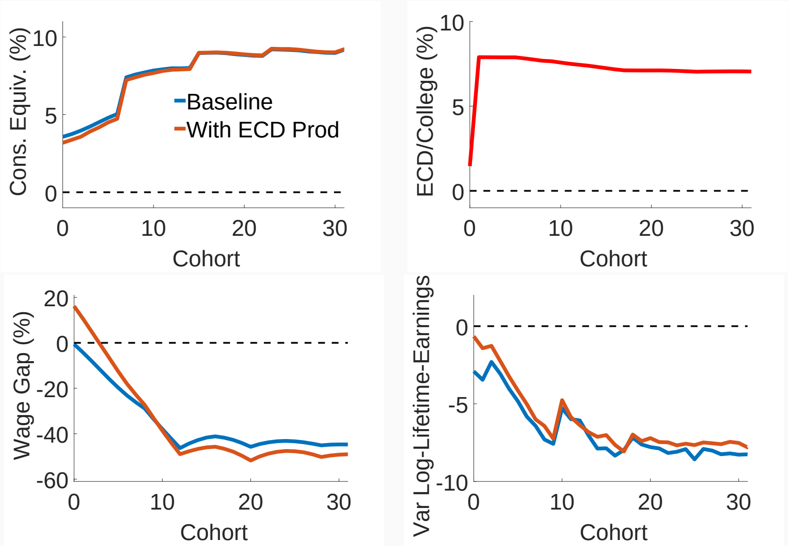
- Price of early childhood is now wage of college graduate

## Short-run vs Long-run

1. **Short run:** scarcity of college graduates increases costs
2. **Long run:** increased supply of college reduces costs

▸ Back to More Results ▸ Back to Transition

# With Early Childhood Production Function




Back to Transition

# Parenting Education

# Parenting Education

**Endogenous parental investments allows for new policy:**

- **Parenting Education**: teach techniques and games to solve discipline problems, foster confidence and capability,...
- **Estimated cost of program:** $11,400 per family ▸ Details

▸ Back

# Parenting Education in the Model

**Recall production function is:**

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

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## With parenting education:

$$\underbrace{\theta_k'}_{\text{Next period child's skills}} = \left[\alpha_{1j} \underbrace{\theta_k^{\rho_j}}_{\text{Current child's skills}} + \alpha_{2j} \underbrace{\max\{\theta, \theta_{PE}\}^{\rho_j}}_{\text{Program provides basic skills } \theta_{PE}} + \alpha_{3j} \underbrace{I^{\rho_j}}_{\text{Parental investments}} \right]^{1/\rho_j} \exp(\nu)$$

Back

# Benchmarking productivity of parenting education

## Gertler et al (2013) study effect of parenting education in Jamaica

- **RCT** on growth-stunted and poor children, **ages 0–2**, in 1986
- Children **around age 22** $\Rightarrow$ **income grew by 12%** (at least)

# Benchmarking productivity of parenting education

## Gertler et al (2013) study effect of parenting education in Jamaica

- **RCT** on growth-stunted and poor children, **ages 0–2**, in 1986
- Children **around age 22** $\Rightarrow$ **income grew by 12%** (at least)

## Mimic RCT in model

- **Small scale** and **one-time policy**
- Focus on children with low initial draws of skills
  And of low-income, low-skilled, low-educated parents

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| $\theta_{PE}$ Std. Dev. of $\theta$ | Change from Baseline (%) Income Bottom |
|---|---|
| -1.6 SD | 0.00 |
| -1.0 SD | 2.13 |
| -0.4 SD | 5.22 |
| 0.0 SD | 7.22 |
| +0.4 SD | 9.48 |
| +0.8 SD | 11.48 |
| +1.0 SD | 12.31 |
| +1.2 SD | 13.10 |

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| $\theta_{PE}$ Std. Dev. of $\theta$ | Change from Baseline (%) Income Bottom |
|---|---|
| -2.6 SD | 0.00 |
| -2.0 SD | 2.13 |
| -1.4 SD | 5.22 |
| -1.0 SD | 7.22 |
| -0.6 SD | 9.48 |
| -0.2 SD | 11.48 |
| Benchmark = 0 | 12.31 |
| +0.2 SD | 13.10 |

# Parenting Education: Long Run, GE

| $\theta_{PE}$ relative to benchmark | Change from Baseline (%) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Cons. Equiv. | Avg. Income | Inequality | Mobility | College | Tax Revenue | Tax Rate |
| -1.4 SD | 2.87 | 2.29 | -3.12 | 9.29 | 2.61 | 2.60 | -0.28 |
| -1.0 SD | 3.79 | 2.85 | -4.29 | 11.03 | 3.32 | 2.93 | -0.44 |
| -0.6 SD | 5.48 | 4.36 | -4.79 | 13.85 | 5.00 | 3.39 | -0.76 |
| -0.2 SD | 6.95 | 5.39 | -4.98 | 15.32 | 6.30 | 3.64 | -1.05 |
| **Benchmark** | **7.65** | **5.68** | **-5.14** | **15.47** | **6.40** | **3.95** | **-1.16** |
| 0.2 SD | 8.19 | 6.05 | -5.35 | 16.70 | 6.87 | 4.06 | -1.26 |

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# Parenting Education: Long Run, GE

| $\theta_{PE}$ relative to benchmark | Change from Baseline (%) | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Cons. Equiv.** | **Avg. Income** | **Inequality** | **Mobility** | **College** | **Tax Revenue** | **Tax Rate** |
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- Even if parenting education **is 1.4 standard deviation less effective** it still has positive welfare effect in the long run
- Large effect on **Intergeneration mobility** and **inequality**

Partial Equilibrium Back

# Parenting Education Market: Long Run, GE

## Now program can be purchased by families

| | Change from Baseline (%) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Cons. Equiv. | Avg. Income | Inequality | Mobility | College | Tax Revenue | Tax Rate | Take-Up Low | Take-Up Medium | Take-Up High |
| -1.4 SD | 1.61 | 1.66 | -2.08 | 5.63 | 1.47 | 0.45 | -0.35 | 82.54 | 0.00 | 0.00 |
| -1.0 SD | 3.15 | 2.75 | -2.72 | 6.54 | 2.49 | 0.78 | -0.68 | 93.93 | 0.00 | 0.00 |
| -0.6 SD | 4.87 | 3.87 | -4.20 | 10.42 | 4.23 | 1.47 | -0.98 | 100.00 | 0.00 | 0.00 |
| -0.2 SD | 6.28 | 4.82 | -5.29 | 11.90 | 5.58 | 1.72 | -1.28 | 100.00 | 19.80 | 0.00 |
| **Benchmark** | **7.02** | **5.43** | **-4.85** | **13.40** | **6.45** | **1.82** | **-1.44** | **100.00** | **33.41** | **0.00** |
| 0.2 SD | 7.64 | 5.95 | -5.16 | 13.17 | 6.91 | 2.10 | -1.54 | 100.00 | 50.17 | 0.00 |

- Market provided program provides slightly smaller gains.

Back

# Resources Available

**Cost of parenting education program is hard to estimate**

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**Cost of parenting education program is hard to estimate**

- Estimate from Colombia (Attanasio et al, 2016) $\Rightarrow$ US$450-750 per child.
- Program employed mostly women with high-school degree education. Assuming requires college graduate in US, would suggest costs per child of $3,400-5,700 in the US.
- **Choose upper bound**: $2 \times \$5,700$ per family (2 children).

# Parenting Education: Short Run, PE

| $\theta_{PE}$ relative to benchmark | Change from Baseline (%) Cons. Equiv. | Avg. Income | Inequality | Mobility | College | Tax Revenue | Tax Rate |
|---|---|---|---|---|---|---|---|
| -1.4 SD | 1.38 | 3.02 | 2.59 | 7.09 | 8.46 | 3.91 | 0.00 |
| -1.0 SD | 1.86 | 4.17 | 3.79 | 9.77 | 11.33 | 5.33 | 0.00 |
| -0.6 SD | 2.84 | 6.18 | 5.88 | 12.91 | 16.39 | 8.20 | 0.00 |
| -0.2 SD | 3.69 | 7.92 | 7.54 | 15.99 | 20.70 | 10.69 | 0.00 |
| **Benchmark** | **4.06** | **8.66** | **8.21** | **16.98** | **22.57** | **11.78** | **0.00** |
| 0.2 SD | 4.40 | 9.34 | 8.79 | 17.83 | 24.28 | 12.78 | 0.00 |

Back

# Robustness and Parameters Importance

# Results Robustness: Estimated Parameters Importance

## Move each parameter one std. dev. above and below

- Calculate steady-state and introduce same policy as before

| | Cons. Equiv. Change from Baseline | | | | | |
|---|---|---|---|---|---|---|
| | Short-Run PE | | | Long-Run GE | | |
| | Down | Up | **Total** | Down | Up | **Total** |
| $\delta$ | 0.06 | -0.02 | 0.09 | 0.34 | -0.19 | 0.53 |
| $\mu$ | -0.01 | 0.00 | 0.01 | -0.13 | -0.06 | 0.07 |
| $\alpha$ | 0.06 | -0.22 | 0.28 | -0.66 | 0.81 | 1.47 |
| $\alpha_{\theta_c}$ | 0.09 | -0.12 | 0.21 | 0.00 | -0.56 | 0.56 |
| $\alpha_{\theta_{nc}}$ | 0.01 | -0.02 | 0.03 | -0.13 | -0.14 | 0.01 |
| $\bar{\varepsilon}$ | -0.01 | -0.02 | 0.01 | -0.21 | -0.20 | 0.02 |
| $\sigma_\varepsilon$ | -0.16 | 0.03 | 0.19 | 0.70 | -0.78 | 1.48 |
| $\bar{A}$ | 0.01 | -0.02 | 0.02 | -0.11 | -0.23 | 0.11 |
| $\alpha_m$ | -0.05 | 0.04 | 0.10 | -0.38 | -0.02 | 0.36 |
| $\gamma$ | -0.00 | -0.04 | 0.03 | -0.21 | -0.20 | 0.01 |
| $\xi$ | -0.00 | -0.00 | 0.00 | -0.19 | -0.21 | 0.02 |
| $\iota$ | -0.00 | 0.00 | 0.00 | -0.07 | -0.19 | 0.12 |
| $\omega$ | 0.02 | -0.02 | 0.04 | -0.09 | -0.27 | 0.17 |
| **Baseline** | **3.9** | | | **9.4** | | |

Standard Deviation  Back

# Results Robustness: CHS Parameters Importance

**Move each parameter one std. dev. above and below**

- Re-estimate, obtain steady-state, and introduce same policy as before

| | **Change from Baseline** | | | | | |
|---|---|---|---|---|---|---|
| | **Cons. Equiv. SR-PE** | | | **Cons. Equiv. LR-GE** | | |
| | Down | Up | **Total** | Down | Up | **Total** |
| $\alpha_1$ | 0.51 | -0.56 | 1.07 | 1.64 | -2.70 | 4.34 |
| $\alpha_2$ | 0.48 | -0.44 | 0.92 | 0.98 | -1.48 | 2.46 |
| $\alpha_3$ | 0.11 | -0.20 | 0.31 | 0.03 | -0.89 | 0.92 |
| $\rho$ | -0.32 | 0.39 | 0.71 | -1.26 | 0.96 | 2.21 |
| $\sigma_\nu$ | 0.18 | -0.08 | 0.26 | 0.07 | -0.66 | 0.73 |
| $Var(\theta_{k_0})$ | -0.06 | -0.07 | 0.01 | -0.66 | -0.67 | 0.01 |
| $Corr(\theta, \theta_{k_0})$ | -0.06 | -0.07 | 0.00 | -0.69 | -0.44 | 0.25 |
| **Baseline** | | **3.9** | | | **9.4** | |