# Intergenerational Effects of Child-Related Tax Benefits in the US

Borja Petit
CEMFI

June 2019

# Introduction

- Very low fertility rates in developed countries
  - 1.2 in ITA & ESP, 1.4 in AUT, 1.7 in NOR, 1.8 in US, 1.9 in FRA & SWE
  - Increasing attention to pronatalist policies

    Neyer et al (2017) show that EU activities related to fertility relevant family policies have increased over time
  - Examples: paid parental leaves, subsidized childcare, tax benefits, transfers

    Björklund (2006), Erosa et al. (2010), González (2013), Bick (2016)
- Tax benefits are very extended across countries...

  ... and very generous in the US: $3,400 per family w/ children (Maag, 2013)
- Little work on their effects

▷ TFR ▷ Benefits

# Tax Benefits in the US

Table: Average tax rate, married couples

| HH Income | Tax rate by # of children | | | | Benefits (2 kids) | |
|---|---|---|---|---|---|---|
| ($\times$ avg. income) | 0 | 1 | 2 | 3 | $, 2005 | % |
| 0.50 | 0.06 | 0.05 | 0.02 | 0.00 | 1,791 | 0.68 |
| 1.00 | 0.14 | 0.11 | 0.09 | 0.08 | 3,536 | 0.30 |
| 1.50 | 0.18 | 0.16 | 0.15 | 0.14 | 3,778 | 0.16 |

Source: CPS data, 2000-2010.

- Lower and more progressive taxes for larger families
- Where are benefits coming from:
  - Specific programs: Child Tax Credit, Child and Dependent Care Tax Credit
  - Others: Standard deduction, Personal Exemption, Earned Income Tax Credit

▷ More

# This Paper

- Quantify the impact of child-related tax benefits in the US tax system on fertility and intergenerational mobility within a GE framework
    - Life cycle model with overlapping generations of heterogeneous households
    - Fertility decisions and parental investments in children's human capital
    - Children's skill formation as in Cunha et al (2010)
    - Progressive taxes with child-related benefits

# This Paper

- Quantify the impact of child-related tax benefits in the US tax system on fertility and intergenerational mobility within a GE framework
  - Life cycle model with overlapping generations of heterogeneous households
  - Fertility decisions and parental investments in children's human capital
  - Children's skill formation as in Cunha et al (2010)
  - Progressive taxes with child-related benefits
- Why to use a GE framework?
  - Today's children will be tomorrow's parents: intergenerational effects
  - Demographic structure has GE implications

## This Paper

- Quantify the impact of child-related tax benefits in the US tax system on fertility and intergenerational mobility within a GE framework
  - Life cycle model with overlapping generations of heterogeneous households
  - Fertility decisions and parental investments in children's human capital
  - Children's skill formation as in Cunha et al (2010)
  - Progressive taxes with child-related benefits
- Why to use a GE framework?
  - Today's children will be tomorrow's parents: intergenerational effects
  - Demographic structure has GE implications
- Why to study effects on intergenerational mobility?
  - Family Economics *meets* Macro $\rightarrow$ *Who* have the children matters

# *Who* have the children matters

- Parents in the US face a quantity-quality trade-off
  - Juhn, et al. (2015, 2018): arrival of a sibling decreases performance on cognitive tests, and the quantity-quality trade-off is stronger among low income mothers
- As a result, high educated parents...
  - Have lower fertility: 1.7 children, while HS mothers have 2.1 children (CPS)
  - Spend more time with their children: 12% more time (PSID-CDS)
  - Spend more money with their children: 30% more money (Daruich, 2018)

# *Who* have the children matters

- Parents in the US face a quantity-quality trade-off
  - Juhn, et al. (2015, 2018): arrival of a sibling decreases performance on cognitive tests, and the quantity-quality trade-off is stronger among low income mothers
- As a result, high educated parents...
  - Have lower fertility: 1.7 children, while HS mothers have 2.1 children (CPS)
  - Spend more time with their children: 12% more time (PSID-CDS)
  - Spend more money with their children: 30% more money (Daruich, 2018)
- Therefore:

  (a) If tax benefits increase fertility, do they decrease children's human capital?

  (b) Are poor families more or less affected?

  (c) How do differences in initial conditions change?

  Keane and Wolpin (1997), Hugget, et al. (2011): Large share of inequality explained by differences in initial conditions

# Preview of results

- Tax benefits increase fertility by 16%...

  ... but they increase intergenerational persistence of education by 30%

# Preview of results

- Tax benefits increase fertility by 16%...

  ... but they increase intergenerational persistence of education by 30%

- Mechanism:
  - Number of children increases cost of human capital
  - Benefits are highly progressive: low income families are more affected

# Preview of results

- Tax benefits increase fertility by 16%...

  ... but they increase intergenerational persistence of education by 30%

- Mechanism:
  - Number of children increases cost of human capital
  - Benefits are highly progressive: low income families are more affected

- Results decomposition: long-run effects are quantitatively important

# Preview of results

- Tax benefits increase fertility by 16%...

  ... but they increase intergenerational persistence of education by 30%

- Mechanism:
  - Number of children increases cost of human capital
  - Benefits are highly progressive: low income families are more affected

- Results decomposition: long-run effects are quantitatively important

- Can we foster fertility without damaging mobility?

# Preview of results

- Tax benefits increase fertility by 16%...

  ... but they increase intergenerational persistence of education by 30%

- Mechanism:
  - Number of children increases cost of human capital
  - Benefits are highly progressive: low income families are more affected
- Results decomposition: long-run effects are quantitatively important
- Can we foster fertility without damaging mobility? Education subsidies
  - Cheaper education breaks (to some extend) the quantity-quality trade-off
  - Regressive transfer: high-educated are more affected

## Related Literature

- Macro models with quantity-quality:

  Caucutt et al. (2002), Restuccia and Urrutia (2004), Córdoba et al. (2016), Daruich and Kozlowski (2016), Sommer (2016), Lee and Seshadri (2018), Daruich (2018)

  Contribution: policy & endogenous fertility, parental investments and transfers

- Fertility and Public Policy:

  Milligan (2005), Björklund (2006), Baughman and Dickert-Conlin (2009), Azmat and González (2010), González (2013)

  Contribution: macro framework (GE & intergenerational effects)

  Erosa et al. (2010), Bick (2016)

  Contribution: evaluation of tax benefits, parental investments

# Today's talk

1. Model economy
2. Calibration
3. Policy evaluation
4. Conclusions

# The Model

# Main features

- Life-cycle economy with overlapping generations of married households
  - GE: Aggregate firm combines capital, low-educated labor and high-educated labor
  - LC: childhood, working age (fertile & infertile ages), and retirement

+ Endogenous fertility and initial conditions (investments and transfer)
  - College choice at independence $\rightarrow$ depends on human capital
  - After college, random matching with marital sorting

- Individual heterogeneity: age, gender, education and productivity
  - Spouses share assets, children and children's human capital

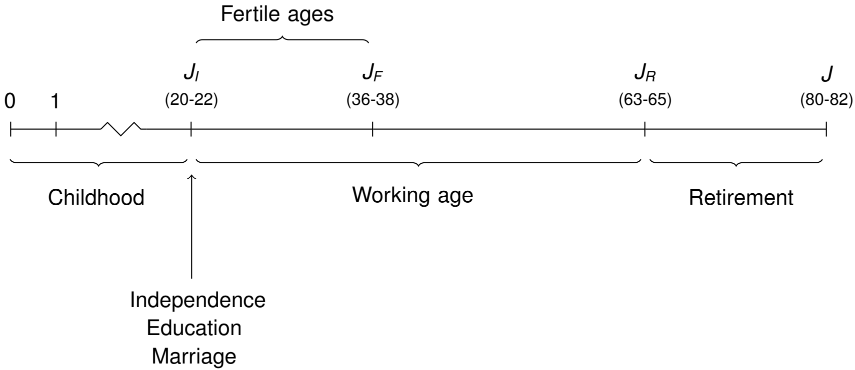
# Main features

- Government taxes income to finance some (exogenous) expenditures
  - Tax rate function depends on income, $y$, and number of kids, $n$: Heathcote, Storesletten, and Violante (2017)

$$T(y,n) = t(y,n)y \quad \Rightarrow \quad t(y,n) \;=\; 1 - \lambda(n)\left(\frac{y}{\bar{y}}\right)^{-\tau(n)}$$

  - $\lambda(n)$ drives the level of taxes
  - $\tau(n)$ drives the degree of progressivity of taxes

# Life-cycle structure



# Childhood


- Children are born with an exogenous level of human capital $q_0$ ▷ Age profile
- Children's human capital exhibits dynamic complementarities
  Cunha et al. (2010), del Boca et al. (2014), Attanasio et al. (2017)

$$q' = \left[ \mu \bar{q}^{\theta} + (1-\mu)\mathcal{I}(n,m,t)^{\theta} \right]^{\frac{1}{\theta}}$$

  - $\bar{q}$ is the average human capital of children in the hh: $\bar{q} = q + (q_0 + q)\frac{n_0}{n}$.
  - $\mu$ controls the persistence of human capital $\rightarrow$ $\Delta q' = \alpha + \beta q + \epsilon$
  - $\theta$ drives how parental investments affect human capital $\rightarrow$ $\Delta q' = \alpha + \beta \ln y + \epsilon$

# Childhood


- Parents invest time and money/goods, $(t, m)$:

$$\mathcal{I}(n, m, t) \;=\; A_{\mathcal{I}} \left[ \varsigma \left( \frac{m}{n^{\psi_1}} \right)^{\gamma} + (1 - \varsigma) \left( \frac{t}{n^{\psi_2}} \right)^{\gamma} \right]^{\frac{1}{\gamma}}$$

  - $A_{\mathcal{I}}$ is a productivity parameter $\rightarrow$ average growth of human capital
  - $\varsigma$ controls the relative weight of money investments $\rightarrow$ ave. time investment
  - $\gamma$ drives the ES between time and money $\rightarrow$ diff. in time investment
  - $\psi_1$ and $\psi_2$ captures economies of scale in time and money investments

# Independence

- Initial state given by (gender, skills, assets) $\equiv (g, q, a)$.
  - $q$ from parental investments
  - $a$ from parental transfer

- College choice:

$$E(g,q,a) \;=\; E_{\xi_E|q,a} \max\left\{ \overbrace{M(g,\overline{e},a)}^{\text{Value of CG}} - \underbrace{\xi_E(g,q)}_{\text{Effort cost}} \,,\, \overbrace{M(g,\underline{e},a)}^{\text{Value of HS}} \right\}$$

effort cost $\xi_E$, decreasing in human capital:

$$\ln \xi_E(g,q) \sim N(\mu_E(g,q),1), \quad \mu_E(g,q) = \mu_E^g \exp(-\mu_E^q q) \geq 0$$

- Then, meet spouse and begin adult life $\rightarrow$ sorting: $\text{Prob}(e_m = e_f) = p_M$

# Adults


- Standard LC problem: consumption, savings and labor supply of spouses
- Wage rates given by age, gender, education and productivity:

$$\ln \omega(g, e, z, j) \;=\; \ln w(e) \;+\; \mu(g, e, j) \;+\; z_g$$

  - $w(e)$: wage rate per efficiency unit of time
  - $\mu(g, e, j)$: deterministic age-profile
  - $z_g$: labor productivity $\rightarrow$ education-specific AR(1)
- Retirees: receive a pension and solve consumption-savings problem

# Adults

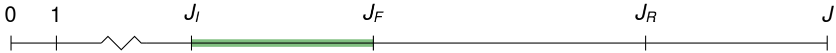

- Gender-specific utility function:

$$U_g(c, l_g, t) \;=\; \frac{c^{1-\sigma_c}}{1-\sigma_c} \;-\; \kappa_g \frac{(l_g + \alpha_g t)^{1+\frac{1}{\psi}}}{1+\frac{1}{\psi}}$$

  - $\psi$ is the Frisch elasticity
  - $\alpha_g \in [0, 1]$ captures the fraction of $t$ spent by gender-$g$ parent

- Household maximize joint utility: $U_m(c, l_m, t) + U_f(c, l_f, t)$

# Fertile ages




- Fertile households make a pregnancy choice: $k \in \{0, 1\}$
  - Fertility risk: pregnant females have a newborn next period w.p. $p_0(j) \in [0, 1]$
  - Labor productivity loss from childbirth: $z_f$ falls by $\delta_0 \in (0, 1)$
- Children stay at home until $J_I$:
  - While at home, parents invest time and money on their children's human capital
  - Stochastic independence: probability $p_I(n, j) \in [0, 1]$

    $\Rightarrow$ Parents make a transfer $b$ to independent children
- But... why do parents want to have children?
  - Parents derive utility from having kids, and from their kids' human capital

# Why do parents have children?

$$U_k(n, q, b) = \eta_n \left( \frac{n^{\sigma_n}}{\sigma_n} \right) + \eta_q n^{\varphi} \left( \frac{q^{\sigma_q}}{\sigma_q} \right) + \eta_b \left( \frac{b^{\sigma_b}}{\sigma_b} \right) - \eta_0 \mathbf{1}\{n > 0\}$$

- Posit a utility function to capture intergenerational altruism:
  - where $b$ is the amount of transfer to independent children
  - $\eta_0$ is a fixed cost (example: quality of leisure) $\rightarrow$ % childless
- Marginal utility from $q$ increasing in number of children (if $\varphi > 0$).
  - The lower the value of $\varphi$ the more costly it is to have another child in terms of $q$
  - $\varphi$ controls the magnitude of the q-q trade-off $\rightarrow$ Differential fertility

# Dynamic program

$$V(e_m, e_f, z_m, z_f, a, n, q, n_0, n_l, j) =$$

$$= \max_{\mathbf{x}} \; U_m(c, l_m, t) + U_f(c, l_f, t) + U_k(n', q', b) +$$

$$+ \beta E_j \left[ V(e_m, e_f, z'_m, z'_f, a', n', q', n'_0, n'_l, j+1) \right]$$

with $n' = n - n_l + n_0$ and $\mathbf{x} = (c, a', l_m, l_f, k, m, t, b)$

# Dynamic program

$$V(e_m, e_f, z_m, z_f, a, n, q, n_0, n_l, j) \;=$$

$$= \max_{\mathbf{x}} \; U_m(c, l_m, t) \;+\; U_f(c, l_f, t) \;+\; U_k(n', q', b) +$$

$$+ \beta E_j \left[ V(e_m, e_f, z_m', z_f', a', n', q', n_0', n_l', j+1) \right]$$

with $n' = n - n_l + n_0$ and $\mathbf{x} = (c, a', l_m, l_f, k, m, t, b)$, and subject to

- Budget contraint: $a' + \Psi(n')c + m + b \;=\; y + (1+r)a - T(y, n') - \tau_{ss} y$

  with labor income given by $y \;=\; \omega_m(e_m, z_m, j)l_m \;+\; \omega_f(e_f, z_f - \delta_0 n_0, j)l_f$

# Dynamic program

$$V(e_m, e_f, z_m, z_f, a, n, q, n_0, n_l, j) =$$

$$= \max_{\mathbf{x}} \; U_m(c, l_m, t) + U_f(c, l_f, t) + U_k(n', q', b) +$$

$$+ \beta E_j \left[ V(e_m, e_f, z'_m, z'_f, a', n', q', n'_0, n'_l, j+1) \right]$$

with $n' = n - n_l + n_0$ and $\mathbf{x} = (c, a', l_m, l_f, k, m, t, b)$, and subject to

- Budget contraint: $a' + \Psi(n')c + m + b = y + (1+r)a - T(y, n') - \tau_{ss} y$

  with labor income given by $y = \omega_m(e_m, z_m, j) l_m + \omega_f(e_f, z_f - \delta_0 n_0, j) l_f$

- Time constraint: $l_g + \alpha_g t \in [0, 1]$

# Dynamic program

$$V(e_m, e_f, z_m, z_f, a, n, q, n_0, n_l, j) \; = $$

$$= \max_{\mathbf{x}} \;\; U_m(c, l_m, t) \; + \; U_f(c, l_f, t) \; + \; U_k(n', q', b) \; +$$

$$+ \; \beta E_j \left[ V(e_m, e_f, z_m', z_f', a', n', q', n_0', n_l', j+1) \right]$$

with $n' = n - n_l + n_0$ and $\mathbf{x} = (c, a', l_m, l_f, k, m, t, b)$, and subject to

- Budget contraint: $a' + \Psi(n')c + m + b \; = \; y + (1+r)a - T(y, n') - \tau_{ss} y$

  with labor income given by $y \; = \; \omega_m(e_m, z_m, j) l_m \; + \; \omega_f(e_f, z_f - \delta_0 n_0, j) l_f$

- Time constraint: $l_g + \alpha_g t \in [0, 1]$

- Other constraints: $k = 0$ if $j > J_F$, $\; m = t = 0$ if $n' = 0$ and $\; b = 0$ if $n_l = 0$

# Calibration

# Data

- Panel Study of Income Dynamics (PSID)
  - Panel of US households. Use waves from 2001 to 2009 (biannual).
  - Information on education, family structure, income.
- Child Development Supplement (CDS)
  - Supplementary study covering children aged 0 to 12 from 1997 PSID families.
  - I use the 2002 and 2007 waves: children aged 5 to 18.
  - Time diary and child's scores in three of the Woodcock Johnson Tests
- Current Population Survey (CPS)
  - Large cross-section of US households.
  - ASEC Supplement for the years 2000 to 2010
  - Information on tax liabilities and income.

# Calibration

- Measurement with CDS data: children's human capital & time investment
- Estimate directly from data:
  - Tax function: standard parametric function estimated with CPS data.
  - Income process: age profiles and labor productivity process from PSID.
  - Fertility risk as in Sommer (2016)
  - Children's independence: estimate transition probabilities from PSID.
- Set some parameters to standard values or from related papers.
- Calibrate remaining parameters internally.

# Measurement

- Time investments:
    - CDS data contains a detailed time diary: nature and duration of activity, whether parents participate, etc.
    - I define $t$ as the total time parents actively participate in child's activity.

| | Time/day | % Share |
|---|---|---|
| Mother | 1h 6 min | 42% |
| Father | 30 min | 19% |
| Both | 1h 1m | 39% |

▷ Sample ▷ Density $t$

# Measurement

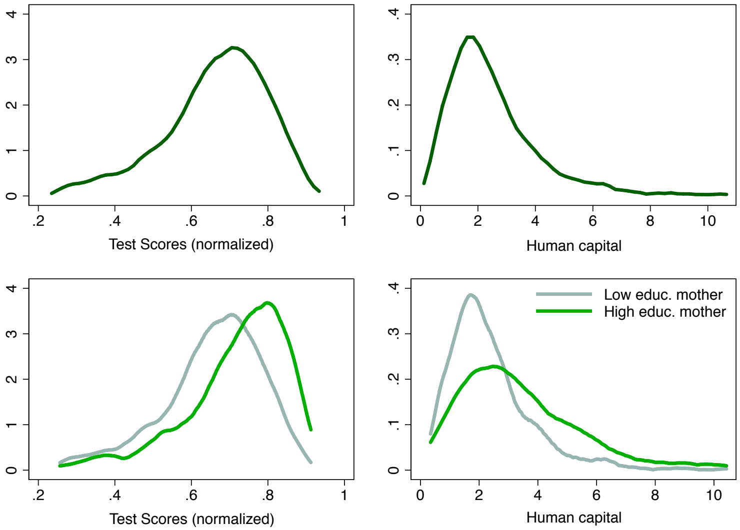
- Children's human capital:
  - CDS data contains children's scores in the Woodcock Johnson Tests.
    - Standard measure of child's skills
      Daruich (2018), Lee and Seshadri (2018), Del Boca et al. (2014)
  - Follow Del Boca et al. (2014): prob. of correct answer, $p_i(q) = q/(1+q)$.
  - Answer to question $i$ is $d_i \in \{0, 1\}$, then:

$$\bar{d} = N^{-1} \sum_{i}^{N} d_i \qquad \Rightarrow \qquad q = \frac{\bar{d}}{1 - \bar{d}}$$

  - Highly correlated with college graduation: $\text{Corr}(e, q) = 0.482$

▷ Sample ▷ Stats $q$ ▷ Age profile

# Children's human capital



# Tax function

Table: Parameters of the tax function

| Number of children | 0 | 1 | 2 | 3 |
|---|---|---|---|---|
| Level, $\lambda$ | 0.858 | 0.880 | 0.893 | 0.910 |
| Progressivity, $\tau$ | 0.097 | 0.101 | 0.114 | 0.119 |
| Obs. (1,000) | 65.9 | 40.3 | 44.9 | 15.8 |

*Note*: standard errors are all less than 0.01. Tax rate computed as total tax liabilities before tax credits over total household income

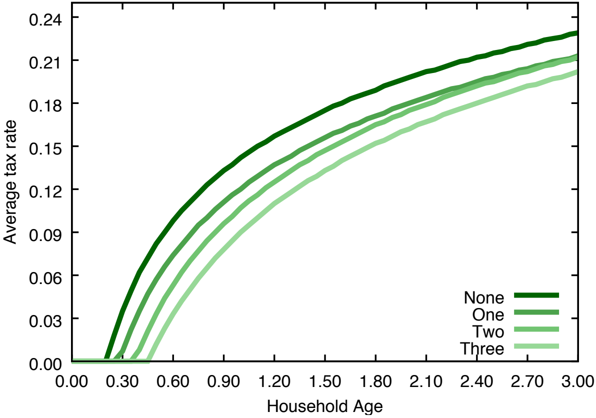
- Parametric tax function:
  Heathcote, Storesletten, and Violante (2017)

$$t(y, n) = 1 - \lambda(n) \left( \frac{y}{\bar{y}} \right)^{-\tau(n)}$$

▷ Summary ▷ Maag (2013) ▷ Sample

# Tax function

Figure: Estimated Tax Functions




▷ Model Fit

# Aggregate production function

- Standard function:

$$Y = AK^{\alpha}L^{1-\alpha}, \qquad \text{with} \quad L = \left[aL_0^b + (1-a)L_1^b\right]^{\frac{1}{b}}$$

  where $K$ is capital, $L_0$ is low-educated labor and $L_1$ is high-educated labor

- Set $\alpha = 0.33$ and choose parameters ($A$, $a$, $b$) such that:
  - Interest rate of 3% (annual)
  - Wage of low educated of 10 (normalization)
  - Relative wage of 1.28 (PSID)

- $A = 47.9$, $a = 0.44$, $b = 0.65$

# Others

- Income process
  - Fit 2nd order polynomial in age by gender and education
  - Use residuals as measure of labor productivity: fit a AR(1) process.

- Fertility risk
  - Follow Sommer (2016) (% of infertile females by age)

$$p_0(j) = 1 - \exp(\alpha_0 + \alpha_1 j)$$

- Children independence
  - Estimate transition probabilities from the data

$$p_0(n, j) = \text{Prob}(n_{i,t} < n_{i,t-3} | n_{i,t-3} = n, \text{age} = j)$$

▷ Income profiles ▷ Fertility risk ▷ Children independence

# Exogenous parameters

| Parameter | | Description | Source |
|---|---|---|---|
| $\beta$ | 0.98 | Discount factor (annual) | Standard value |
| $\sigma_c$ | 0.80 | Curvature utility from consumption | Córdoba et al (2016) |
| $\psi$ | 0.50 | Frisch elasticity of labor supply | Standard value |
| $\alpha_m$ | 0.54 | % time invested by fathers | CDS |
| $\alpha_f$ | 0.82 | % time invested by mothers | CDS |
| $\xi_1$ | 0.92 | Economies of scale, money investments | Sommer (2016) |
| $\xi_2$ | 0.54 | Economies of scale, time investments | Sommer (2016) |
| $q_0$ | 1.42 | Initial level of human capital | 25th percentile of $q$ |
| $\delta_0$ | 0.10 | Child penalty | Kleven et al. (2018) |
| $p_R$ | 0.13 | Replacement rate | 50% labor supply, ages 62-65 |
| $p_M$ | 0.75 | Share of household with $e_m = e_f$ | PSID |

# Exogenous parameters

| Parameter | | Description | Source |
|---|---|---|---|
| $\beta$ | 0.98 | Discount factor (annual) | Standard value |
| $\sigma_c$ | 0.80 | Curvature utility from consumption | Córdoba et al (2016) |
| $\psi$ | 0.50 | Frisch elasticity of labor supply | Standard value |
| $\alpha_m$ | 0.54 | % time invested by fathers | CDS |
| $\alpha_f$ | 0.82 | % time invested by mothers | CDS |
| $\xi_1$ | 0.92 | Economies of scale, money investments | Sommer (2016) |
| $\xi_2$ | 0.54 | Economies of scale, time investments | Sommer (2016) |
| $q_0$ | 1.42 | Initial level of human capital | 25th percentile of $q$ |
| $\delta_0$ | 0.10 | Child penalty | Kleven et al. (2018) |
| $p_R$ | 0.13 | Replacement rate | 50% labor supply, ages 62-65 |
| $p_M$ | 0.75 | Share of household with $e_m = e_f$ | PSID |

# Exogenous parameters

| Parameter | | Description | Source |
|---|---|---|---|
| $\beta$ | 0.98 | Discount factor (annual) | Standard value |
| $\sigma_c$ | 0.80 | Curvature utility from consumption | Córdoba et al (2016) |
| $\psi$ | 0.50 | Frisch elasticity of labor supply | Standard value |
| $\alpha_m$ | 0.54 | % time invested by fathers | CDS |
| $\alpha_f$ | 0.82 | % time invested by mothers | CDS |
| $\xi_1$ | 0.92 | Economies of scale, money investments | Sommer (2016) |
| $\xi_2$ | 0.54 | Economies of scale, time investments | Sommer (2016) |
| $q_0$ | 1.42 | Initial level of human capital | 25th percentile of $q$ |
| $\delta_0$ | 0.10 | Child penalty | Kleven et al. (2018) |
| $p_R$ | 0.13 | Replacement rate | 50% labor supply, ages 62-65 |
| $p_M$ | 0.75 | Share of household with $e_m = e_f$ | PSID |

# Exogenous parameters

| Parameter | | Description | Source |
|---|---|---|---|
| $\beta$ | 0.98 | Discount factor (annual) | Standard value |
| $\sigma_c$ | 0.80 | Curvature utility from consumption | Córdoba et al (2016) |
| $\psi$ | 0.50 | Frisch elasticity of labor supply | Standard value |
| $\alpha_m$ | 0.54 | % time invested by fathers | CDS |
| $\alpha_f$ | 0.82 | % time invested by mothers | CDS |
| $\xi_1$ | 0.92 | Economies of scale, money investments | Sommer (2016) |
| $\xi_2$ | 0.54 | Economies of scale, time investments | Sommer (2016) |
| $q_0$ | 1.42 | Initial level of human capital | 25th percentile of $q$ |
| $\delta_0$ | 0.10 | Child penalty | Kleven et al. (2018) |
| $p_R$ | 0.13 | Replacement rate | 50% labor supply, ages 62-65 |
| $p_M$ | 0.75 | Share of household with $e_m = e_f$ | PSID |

# Calibrated Parameters

- Calibrate 19 parameters using SMM.
  - Preference parameters.
  - Human capital technology and investment function.
  - College effort cost.
- Targets key moments:
  - Fertility, child's human capital and time investments profiles by maternal education.
  - Labor supply by gender.
  - Dynamics of child's human capital.
  - Share of college graduates and elasticity of education to human capital.

# Calibrated Parameters

## Preferences

| Parameter | | Description | Moment | Model | Data |
|---|---|---|---|---|---|
| $\kappa_m$ | 4.74 | Disutility labor, males | Average labor supply, male | 0.36 | 0.35 |
| $\kappa_f$ | 4.32 | Disutility labor, females | Average labor supply, female | 0.24 | 0.23 |
| $\eta_n$ | 1.05 | Utility *n*, weight | Completed fertility, HS mother | 2.41 | 2.52 |
| $\sigma_n$ | 0.51 | Utility *n*, slope | % of households with $2+$ children | 0.53 | 0.52 |
| $\eta_q$ | 0.96 | Utility *q*, weight | Average human capital, HS mother | 2.75 | 2.67 |
| $\sigma_q$ | 0.76 | Utility *q*, slope | Differential *q* by maternal educ. | 0.44 | 0.56 |
| $\varphi$ | 0.16 | Utility *q*, fam. size param. | Differential fertility by maternal educ. | -0.26 | -0.23 |
| $\eta_b$ | 0.40 | Utility from *b*, weight | Rel. wealth at age $J_l$, HS mother | 0.11 | 0.11 |
| $\sigma_b$ | 0.51 | Utility from *b*, slope | Rel. wealth at age $J_l$, CG mother | 0.16 | 0.17 |
| $\eta_0^0$ | 2.70 | Fixed cost, HS mothers | % of childless HS mothers | 0.08 | 0.08 |
| $\eta_0^1$ | 2.80 | Fixed cost, CG mothers | % of childless CG mothers | 0.12 | 0.13 |

# Calibrated Parameters

## Preferences

| Parameter | | Description | Moment | Model | Data |
|---|---|---|---|---|---|
| $\kappa_m$ | 4.74 | Disutility labor, males | Average labor supply, male | 0.36 | 0.35 |
| $\kappa_f$ | 4.32 | Disutility labor, females | Average labor supply, female | 0.24 | 0.23 |
| $\eta_n$ | 1.05 | Utility $n$, weight | Completed fertility, HS mother | 2.41 | 2.52 |
| $\sigma_n$ | 0.51 | Utility $n$, slope | % of households with 2+ children | 0.53 | 0.52 |
| $\eta_q$ | 0.96 | Utility $q$, weight | Average human capital, HS mother | 2.75 | 2.67 |
| $\sigma_q$ | 0.76 | Utility $q$, slope | Differential $q$ by maternal educ. | 0.44 | 0.56 |
| $\varphi$ | 0.16 | Utility $q$, fam. size param. | Differential fertility by maternal educ. | -0.26 | -0.23 |
| $\eta_b$ | 0.40 | Utility from $b$, weight | Rel. wealth at age $J_I$, HS mother | 0.11 | 0.11 |
| $\sigma_b$ | 0.51 | Utility from $b$, slope | Rel. wealth at age $J_I$, CG mother | 0.16 | 0.17 |
| $\eta_0^0$ | 2.70 | Fixed cost, HS mothers | % of childless HS mothers | 0.08 | 0.08 |
| $\eta_0^1$ | 2.80 | Fixed cost, CG mothers | % of childless CG mothers | 0.12 | 0.13 |

# Calibrated Parameters

## Preferences

| Parameter | | Description | Moment | Model | Data |
|---|---|---|---|---|---|
| $\kappa_m$ | 4.74 | Disutility labor, males | Average labor supply, male | 0.36 | 0.35 |
| $\kappa_f$ | 4.32 | Disutility labor, females | Average labor supply, female | 0.24 | 0.23 |
| $\eta_n$ | 1.05 | Utility $n$, weight | Completed fertility, HS mother | 2.41 | 2.52 |
| $\sigma_n$ | 0.51 | Utility $n$, slope | % of households with 2+ children | 0.53 | 0.52 |
| $\eta_q$ | 0.96 | Utility $q$, weight | Average human capital, HS mother | 2.75 | 2.67 |
| $\sigma_q$ | 0.76 | Utility $q$, slope | Differential $q$ by maternal educ. | 0.44 | 0.56 |
| $\varphi$ | 0.16 | Utility $q$, fam. size param. | Differential fertility by maternal educ. | -0.26 | -0.23 |
| $\eta_b$ | 0.40 | Utility from $b$, weight | Rel. wealth at age $J_l$, HS mother | 0.11 | 0.11 |
| $\sigma_b$ | 0.51 | Utility from $b$, slope | Rel. wealth at age $J_l$, CG mother | 0.16 | 0.17 |
| $\eta_0^0$ | 2.70 | Fixed cost, HS mothers | % of childless HS mothers | 0.08 | 0.08 |
| $\eta_0^1$ | 2.80 | Fixed cost, CG mothers | % of childless CG mothers | 0.12 | 0.13 |

# Calibrated Parameters

## Human capital, Investment and College choice

| Parameter | | Description | Moment | Model | Data |
|---|---|---|---|---|---|
| *Law of motion of human capital:* | | | | | |
| $\mu$ | 0.30 | Share parameter, $q$ | Slope: $\Delta q = \alpha + \beta q + u$ | 0.22 | 0.25 |
| $\theta$ | -1.84 | Elasticity parameter | Slope: $\Delta q = \alpha + \beta \ln(y) + u$ | 0.18 | 0.14 |
| *Investment function:* | | | | | |
| $A_{\mathcal{I}}$ | 6.31 | Productivity of investments | Average growth rate of $q$ | 0.22 | 0.25 |
| $\varsigma$ | 0.58 | Share parameter, $m$ | Time investment, HS mothers | 0.23 | 0.25 |
| $\gamma$ | 0.31 | Elasticity parameter | Time investment, CG mothers | 0.25 | 0.28 |
| *College choice:* | | | | | |
| $\mu_E^f$ | 0.96 | Fixed effort cost, females | Share of high educated females | 0.27 | 0.26 |
| $\mu_E^m$ | 11.6 | Fixed effort cost, males | Share of high educated males | 0.29 | 0.27 |
| $\mu_E^1$ | 0.23 | Variable cost of education | Slope of $e = \alpha + \beta q + u$ | 0.11 | 0.12 |

# Calibrated Parameters

## Human capital, Investment and College choice

| Parameter | | Description | Moment | Model | Data |
|---|---|---|---|---|---|
| *Law of motion of human capital:* | | | | | |
| $\mu$ | 0.30 | Share parameter, $q$ | Slope: $\Delta q = \alpha + \beta q + u$ | 0.22 | 0.25 |
| $\theta$ | -1.84 | Elasticity parameter | Slope: $\Delta q = \alpha + \beta \ln(y) + u$ | 0.18 | 0.14 |
| *Investment function:* | | | | | |
| $A_{\mathcal{I}}$ | 6.31 | Productivity of investments | Average growth rate of $q$ | 0.22 | 0.25 |
| $\varsigma$ | 0.58 | Share parameter, $m$ | Time investment, HS mothers | 0.23 | 0.25 |
| $\gamma$ | 0.31 | Elasticity parameter | Time investment, CG mothers | 0.25 | 0.28 |
| *College choice:* | | | | | |
| $\mu_E^f$ | 0.96 | Fixed effort cost, females | Share of high educated females | 0.27 | 0.26 |
| $\mu_E^m$ | 11.6 | Fixed effort cost, males | Share of high educated males | 0.29 | 0.27 |
| $\mu_E^1$ | 0.23 | Variable cost of education | Slope of $e = \alpha + \beta q + u$ | 0.11 | 0.12 |

# Model evaluation

| Nontargeted moments | Data | Model | Source |
| --- | --- | --- | --- |

# Model evaluation

| Nontargeted moments | Data | Model | Source |
|---|---|---|---|
| Intergenerational persistence of education | 0.16 | 0.15 | PSID |

# Model evaluation

| Nontargeted moments | Data | Model | Source |
|---|---|---|---|
| Intergenerational persistence of education | 0.16 | 0.15 | PSID |
| Income elasticity of fertility, HS mother | -0.21 | -0.17 | PSID |
| Income elasticity of fertility, CG mother | -0.02 | -0.01 | PSID |

# Model evaluation

| Nontargeted moments | Data | Model | Source |
|---|---|---|---|
| Intergenerational persistence of education | 0.16 | 0.15 | PSID |
| Income elasticity of fertility, HS mother | -0.21 | -0.17 | PSID |
| Income elasticity of fertility, CG mother | -0.02 | -0.01 | PSID |
| Correlation time and goods investments | 0.88 | 0.87 | Daruich (2018) |
| Share of expenditures spent on children ($n = 1$) | 0.26 | 0.22 | Lino et al. (2015) |
| Share of expenditures spent on children ($n = 2$) | 0.39 | 0.39 | Lino et al. (2015) |

# Model evaluation

| Nontargeted moments | Data | Model | Source |
|---|---|---|---|
| Intergenerational persistence of education | 0.16 | 0.15 | PSID |
| Income elasticity of fertility, HS mother | -0.21 | -0.17 | PSID |
| Income elasticity of fertility, CG mother | -0.02 | -0.01 | PSID |
| Correlation time and goods investments | 0.88 | 0.87 | Daruich (2018) |
| Share of expenditures spent on children ($n = 1$) | 0.26 | 0.22 | Lino et al. (2015) |
| Share of expenditures spent on children ($n = 2$) | 0.39 | 0.39 | Lino et al. (2015) |

| Replicating Spanish transfer policy * | Data | Model | Source |
|---|---|---|---|
| Fertility increase (%) | 6.32 | 7.50 | González (2013) |

(*) A universal transfer of 2.1 median female monthly income per birth. Spain 2007

# Policy Evaluation

# Policy Evaluation

- Question: what are the effects of child-related tax benefits?
  - Do they increase fertility?
  - If so, do they generate a fall in human capital?
  - How is intergenerational mobility affected?

- Policy implementation: eliminate child-dependent benefits

$$t^*(y, n) = t(y, 0) - \tau_0$$

where $\tau_0 = 0.05$ is such that the policy is revenue neutral

$$\int_{\mathcal{S}} t(y, n) y(\mathbf{s}) dF(\mathbf{s}) = \int_{\mathcal{S}} [t(y, 0) - \tau_0] y(\mathbf{s}) dF^*(\mathbf{s})$$

# Aggregate effects

| | No Benefits | Tax Benefits (Baseline) | % Change |
|---|---|---|---|
| Completed fertility | 1.81 | 2.11 | 16.3 |
| *Fertility of mothers* | 2.08 | 2.32 | 12.0 |
| *Share of mothers* | 0.87 | 0.91 | 3.82 |
| Human capital at $J_l$ | 6.11 | 5.07 | -17.1 |
| College graduation rate | 0.37 | 0.28 | -25.0 |

# Aggregate effects

| | No Benefits | Tax Benefits (Baseline) | % Change |
|---|---|---|---|
| Completed fertility | 1.81 | 2.11 | 16.3 |
| *Fertility of mothers* | 2.08 | 2.32 | 12.0 |
| *Share of mothers* | 0.87 | 0.91 | 3.82 |
| Human capital at $J_l$ | 6.11 | 5.07 | -17.1 |
| College graduation rate | 0.37 | 0.28 | -25.0 |

- Tax benefits are effective at fostering fertility. Two channels
  - Effect (a): Benefits reduce the cost of children
  - Effect (b): $\uparrow$ Fertility $\rightarrow$ $\uparrow$ Labor share $\rightarrow$ $\downarrow K/L$ $\rightarrow$ $\downarrow$ Wages $\rightarrow$ $\uparrow$ Fertility

    Why? parents cannot afford sufficiently high level of human capital $\rightarrow$ more kids
- Both intensive and extensive margin

# Aggregate effects

| | No Benefits | Tax Benefits (Baseline) | % Change |
|---|---|---|---|
| Completed fertility | 1.81 | 2.11 | 16.3 |
| *Fertility of mothers* | 2.08 | 2.32 | 12.0 |
| *Share of mothers* | 0.87 | 0.91 | 3.82 |
| Human capital at $J_I$ | 6.11 | 5.07 | -17.1 |
| College graduation rate | 0.37 | 0.28 | -25.0 |

- But they decrease children's human capital...
  - Families are now larger: lower productivity of parental investments
    - $\Rightarrow$ Number of children is a key determinant of the cost of human capital
  - Lower income: money investments relatively more expensive
- Reduction in college graduation rate: higher effort cost

# Heterogeneous effects

| | High School | | | College Graduate | | |
|---|---|---|---|---|---|---|
| | No | Tax | % Chg | No | Tax | % Chg |
| Completed fertility | 1.86 | 2.21 | 18.8 | 1.74 | 1.90 | 8.74 |
| *Fertility of mothers* | 2.10 | 2.41 | 14.9 | 2.05 | 2.14 | 4.92 |
| *Share of mothers* | 0.90 | 0.92 | 3.41 | 0.86 | 0.88 | 3.63 |
| Human capital at $J_l$ | 5.54 | 4.61 | -19.1 | 6.59 | 6.12 | -9.36 |
| College graduation | 0.30 | 0.23 | -29.1 | 0.41 | 0.39 | -12.3 |

# Heterogeneous effects

| | High School | | | College Graduate | | |
|---|---|---|---|---|---|---|
| | No | Tax | % Chg | No | Tax | % Chg |
| Completed fertility | 1.86 | 2.21 | 18.8 | 1.74 | 1.90 | 8.74 |
| *Fertility of mothers* | 2.10 | 2.41 | 14.9 | 2.05 | 2.14 | 4.92 |
| *Share of mothers* | 0.90 | 0.92 | 3.41 | 0.86 | 0.88 | 3.63 |
| Human capital at $J_l$ | 5.54 | 4.61 | -19.1 | 6.59 | 6.12 | -9.36 |
| College graduation | 0.30 | 0.23 | -29.1 | 0.41 | 0.39 | -12.3 |

- HS mothers are relatively more affected: 18.8% vs. 8.7%
  - Effect (a): Tax benefits are highly progressive
  - Effect (b): Wage of low educated fall relatively more (13% vs. 7%)

# Heterogeneous effects

| | High School | | | College Graduate | | |
|---|---|---|---|---|---|---|
| | No | Tax | % Chg | No | Tax | % Chg |
| Completed fertility | 1.86 | 2.21 | 18.8 | 1.74 | 1.90 | 8.74 |
| *Fertility of mothers* | 2.10 | 2.41 | 14.9 | 2.05 | 2.14 | 4.92 |
| *Share of mothers* | 0.90 | 0.92 | 3.41 | 0.86 | 0.88 | 3.63 |
| Human capital at $J_l$ | 5.54 | 4.61 | -19.1 | 6.59 | 6.12 | -9.36 |
| College graduation | 0.30 | 0.23 | -29.1 | 0.41 | 0.39 | -12.3 |

- Consequently, human capital of children with HS mothers fall relatively more
  - Increase in differential human capital
  - Increase in differential college graduation rate
- Intergenerational persistence of education increases from 0.11 to 0.15

# Policy Evaluation

- Two forces at play:
  (a) Relative Price Effect:
  Taxes distort relative price between number of children and their human capital.
  (b) Income Effect:
  Decreases in income induce parents to substitute children by children's human capital (quantity-quality trade-off)
- Disentangle relative importance:
  - Taking the economy without tax benefits as starting point...
    1. Add tax benefits without adjusting prices nor taxes $\rightarrow$ effect (a)
    2. Let prices and taxes adjust $\rightarrow$ effect (b)

# Results decomposition

| | No Ben. | | Benefits | | Prices | | Tax Ben. |
|---|---|---|---|---|---|---|---|
| Completed fertility | 1.81 | $+$ | 0.62 | $-$ | 0.32 | $=$ | 2.11 |
| *Fertility mothers* | 2.08 | $+$ | 0.18 | $+$ | 0.06 | $=$ | 2.32 |
| *Share of mothers* | 0.87 | $+$ | 0.17 | $-$ | 0.13 | $=$ | 0.91 |
| *Differential fertility* | -0.12 | $-$ | 0.23 | $+$ | 0.03 | $=$ | -0.32 |
| Human capital at $J_l$ | 6.11 | $-$ | 0.43 | $-$ | 0.61 | $=$ | 5.07 |
| *Differential human capital* | 1.05 | $+$ | 0.30 | $+$ | 0.16 | $=$ | 1.51 |
| College graduation rate | 0.37 | $-$ | 0.04 | $-$ | 0.05 | $=$ | 0.28 |

# Results decomposition

| | No Ben. | | Benefits | | Prices | | Tax Ben. |
|---|---|---|---|---|---|---|---|
| Completed fertility | 1.81 | $+$ | 0.62 | $-$ | 0.32 | $=$ | 2.11 |
| *Fertility mothers* | 2.08 | $+$ | 0.18 | $+$ | 0.06 | $=$ | 2.32 |
| *Share of mothers* | 0.87 | $+$ | 0.17 | $-$ | 0.13 | $=$ | 0.91 |
| *Differential fertility* | -0.12 | $-$ | 0.23 | $+$ | 0.03 | $=$ | -0.32 |
| Human capital at $J_l$ | 6.11 | $-$ | 0.43 | $-$ | 0.61 | $=$ | 5.07 |
| *Differential human capital* | 1.05 | $+$ | 0.30 | $+$ | 0.16 | $=$ | 1.51 |
| College graduation rate | 0.37 | $-$ | 0.04 | $-$ | 0.05 | $=$ | 0.28 |

- GE and intergenerational effects (“Prices”) are quantitatively important:
  - Significant reduction in the share of mothers
  - 25% of the effects on fertility of mothers
  - More than 50% of the effects on children’s human capital

# Results decomposition

| | No Ben. | | Benefits | | Prices | | Tax Ben. |
|---|---|---|---|---|---|---|---|
| Completed fertility | 1.81 | $+$ | 0.62 | $-$ | 0.32 | $=$ | 2.11 |
| *Fertility mothers* | 2.08 | $+$ | 0.18 | $+$ | 0.06 | $=$ | 2.32 |
| *Share of mothers* | 0.87 | $+$ | 0.17 | $-$ | 0.13 | $=$ | 0.91 |
| *Differential fertility* | -0.12 | $-$ | 0.23 | $+$ | 0.03 | $=$ | -0.32 |
| Human capital at $J_I$ | 6.11 | $-$ | 0.43 | $-$ | 0.61 | $=$ | 5.07 |
| *Differential human capital* | 1.05 | $+$ | 0.30 | $+$ | 0.16 | $=$ | 1.51 |
| College graduation rate | 0.37 | $-$ | 0.04 | $-$ | 0.05 | $=$ | 0.28 |

- GE and intergenerational effects (“Prices”) are quantitatively important:
  - 25% of the effects on fertility
  - More than 50% of the effects on children’s human capital
- Most of the inequality effect due to design of benefits

# Education subsidies

- Problem:

  Tax benefits foster fertility at the expense of lower interg. mobility

- Question:

  Is there a policy able to foster both fertility and children's human capital?

  - Subsidies to education reduce the cost of children's human capital, which in turn, reduces the cost of children.

- Implementation:

$$\mathcal{I}(n,m,t) = A_{\mathcal{I}}\left[\varsigma\left(\frac{m(1+\tau)}{n^{\psi_1}}\right)^{\gamma} + (1-\varsigma)\left(\frac{t}{n^{\psi_2}}\right)^{\gamma}\right]^{\frac{1}{\gamma}}$$

Key difference: CG parents spend more on children's human capital (regressive transfer)

# Education subsidies

| | No Benefits | Tax Benefits | Subsidy |
|---|---|---|---|
| Completed fertility | 1.82 | 2.11 | 2.01 |
| *Differential fertility* | -0.12 | -0.32 | -0.10 |
| *Share of mothers* | 0.87 | 0.91 | 0.95 |
| Human capital at $J_l$ | 6.11 | 5.07 | 6.30 |
| *Differential human capital* | 1.05 | 1.51 | 1.06 |
| College graduation | 0.37 | 0.28 | 0.38 |
| Interg. Persist. education | 0.11 | 0.15 | 0.10 |

# Education subsidies

| | No Benefits | Tax Benefits | Subsidy |
|---|---|---|---|
| Completed fertility | 1.82 | 2.11 | 2.01 |
| *Differential fertility* | -0.12 | -0.32 | -0.10 |
| *Share of mothers* | 0.87 | 0.91 | 0.95 |
| Human capital at $J_l$ | 6.11 | 5.07 | 6.30 |
| *Differential human capital* | 1.05 | 1.51 | 1.06 |
| College graduation | 0.37 | 0.28 | 0.38 |
| Interg. Persist. education | 0.11 | 0.15 | 0.10 |

- Effective at increasing fertility: 62% of the increase with tax benefits
  - Regressive transfer: 12% increase among CG and 10% among HS
  - Education subsidies reduce the cost of children for CG relatively more.
- More effective than tax benefits at the extensive margin
  - Cost of education is an important barrier for parenthood

# Education subsidies

| | No Benefits | Tax Benefits | Subsidy |
|---|---|---|---|
| Completed fertility | 1.82 | 2.11 | 2.01 |
| *Differential fertility* | -0.12 | -0.32 | -0.10 |
| *Share of mothers* | 0.87 | 0.91 | 0.95 |
| Human capital at $J_l$ | 6.11 | 5.07 | 6.30 |
| *Differential human capital* | 1.05 | 1.51 | 1.06 |
| College graduation | 0.37 | 0.28 | 0.38 |
| Interg. Persist. education | 0.11 | 0.15 | 0.10 |

- As opposed to tax benefits, education subsidies do not reduce human capital
  - Reduce the cost of children by reducing the cost of human capital
  - Parents spend less money, and the government more than compensates
- No cost in terms of intergenerational mobility

# Conclusions

# Conclusions

- I propose a GE life cycle model with fertility choices and parental investments in children's human capital, estimated with US data
  - Rich degree of heterogeneity
  - Suitable for family-policy analysis
- Evaluate quantitative impact of child-related tax benefits:
  - Significant effects on fertility and parental investments
  - Stronger for low income families: reduces the gap in initial conditions
  - Both relative price distortion and GE effects are important
- Education subsidies increases fertility w/o damaging intergenerational mobility
- **Take-aways**
  1. We should evaluate pronatalist policies beyond their effects on fertility
  2. Short-run inequality *versus* long-run inequality

Thanks for your attention

# Some references


- Caucutt, Guner and Knowles (2002). “Why Do Women Wait? Matching, Wage Inequality, and the Incentives for Fertility Delay”, Review of Economic Dynamics, 5, 815?855
- Cunha, Heckman and Schennach (2010). “Estimating the Technology of Cognitive and Noncognitive Skill Formation”. Econometrica, 78(3), 883–931.
- Daruich and Kozlowski (2016). “Explaining Income Inequality and Intergenerational Mobility: The Role of Fertility and Family Transfers”. Mimeo.
- Daruich (2018). “The Macro Consequences of Early Childhood Development Policies”. Mimeo.
- Del Boca, Flinn and Wiswall (2014). “Household Choices and Child Development”, The Review of Economic Studies, 81(1), 137–185,
- González (2013). “The Effects of a Universal Child Benefit on Conceptions, Abortions and Early Maternal Labor Supply”. American Economic Journal: Economic Policy 5(3), 160–188

  Guvenen, Kuruscu, and Ozkan (2013). “Taxation of Human Capital and Wage Inequality: A Cross-country Analysis”. The Review of Economic Studies 81(2), 818–850.
- Guner, Kaygusuz and Ventura (2014). “Income taxation of U.S. households: Facts and parametric estimates”, Review of Economic Dynamics 17, 559?581
- Huggett, Ventura and Yaron (2011). “Sources of Lifetime Inequality”. American Economic Review 101(7), 2923–2954.
- Kleven, Landais and Sazgaard (2018). “Children and Gender Inequality: Evidence from Denmark”. forthcoming in American Economic Journal: Applied Economics.

# Some references (cont.)


- Lee and Seshadri (2018). “On the Intergenerational Transmission of Economic Status”, forthcoming in Journal of Political Economy.
- Maag (2013). “Child-Related Benefits in the Federal Income Tax”. Brief 27, Urban Institute.
- Milligan (2005). “Subsidizing the Stork: New Evidence on Tax Incentives and Fertility”. The Review of Economics and Statistics 87(3), 539–555.
- Neyer, Caporali, and Sánchez-Gassen (2017). “EU-Policies and Fertility: The Emergence of Fertility-Related Family Policies at the Supra-National Level”. Families & Societies WP 79.
- Restuccia and Urrutia (2004). “Intergenerational Persistence of Earnings: The Role of Early and College Education”. American Economic Review 94(5), 1354–1378.
- Sommer (2016). “Fertility Choice in a Life Cycle Model with Idiosyncratic Uninsurable Earnings Risk”. Journal of Monetary Economics 83, 27–38.

# Additional material

# Low fertility rates

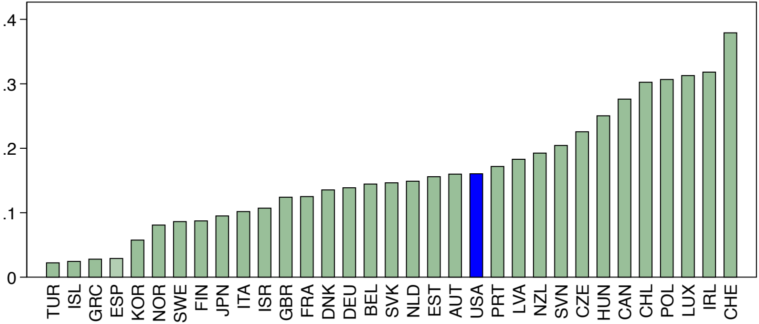
Figure: Total Fertility Rate (2016)


*Source*: OECD Family Database.

▷ Back

# Tax benefits are widely extended

Figure: Tax Benefits for families with 2 children (2017)




*Source*: OECD Family Database.
*Notes*: Tax benefits measured as the relative difference in tax rates between a married household with 133% of the average income and 2 children and a family with the same level of income but no children. *Example*: in Italy, the tax benefits are of 10%, meaning that a family with 2 kids and 133% of the average Italian household income pays 10% lower taxes than a family with the same level of income and no children.

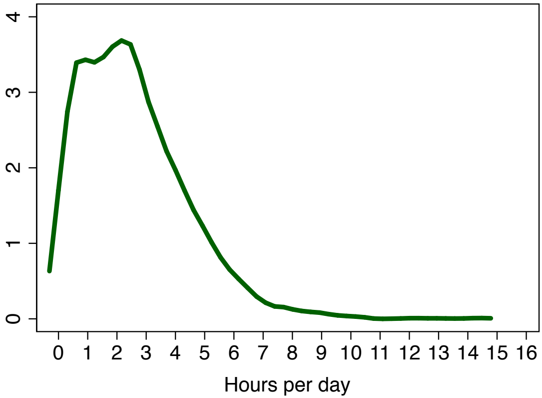
▷ Back

## CDS Sample

- Start in 1997 collecting info on children aged 0 to 12 from PSID families, and follow them over time.
- I use the 2002 and 2007 waves (children aged 6 to 18).
- Time diary:
  - Detailed info on child's activities: nature, duration, whether parents participate, etc.
- Test scores (Woodcock Johnson Tests)
  - Standard measure of child's cognitive skills.
  - Large number of yes-or-no questions.
- Includes individual identifiers for children and parents: link with PSID data.
- Information on 4,530 children: 1,892 also in PSID when adult.

▷ Back *t* ▷ Back *q*

# Time Investments




▷ Back

# Children's Human Capital

Table: Children's (normalized) scores in the Woodcock Johnson Tests

| | Obs. | Mean | Std | Min | Max |
|---|---|---|---|---|---|
| Applied Problem Solving | 4,125 | 0.608 | 0.144 | 0.050 | 1.000 |
| Passage Comprehension | 4,047 | 0.590 | 0.159 | 0.023 | 1.000 |
| Letter-Word | 4,125 | 0.741 | 0.170 | 0.086 | 0.983 |

▷ Back

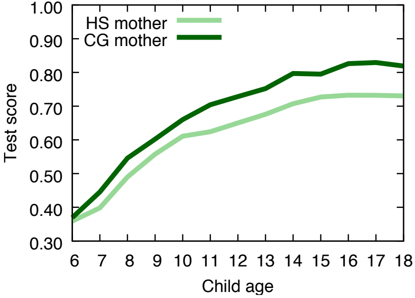
# Children's Human Capital

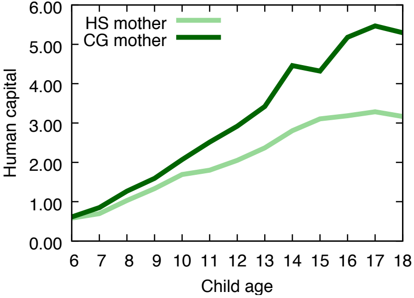
Table: Summary statistics, children's human capital measures

| | Obs | Mean | Std | Corr($q$,$e$) |
|---|---|---|---|---|
| Applied Problem Solving | 4,122 | 2.091 | 2.358 | 0.449 |
| Passage Comprehension | 4,037 | 1.875 | 1.678 | 0.300 |
| Letter-Word | 4,109 | 6.303 | 8.274 | 0.336 |
| All test | 4,024 | 2.590 | 1.981 | 0.482 |

▷ Back

# Human capital by age




▷ Back - Model ▷ Back - Calibration

# Income taxes in the US

| | |
|---|---|
| | Gross income |
| $-$ | Adjustments to gross income |
| $=$ | Adjusted gross income |
| $-$ | Standard deduction |
| $-$ | Personal exemptions, or Itemized deductions |
| $=$ | Taxable Income |
| $-$ | Taxes |
| $=$ | Tax imposed |
| $-$ | Nonrefundable credits |
| $-$ | Refundable credits. |
| $=$ | Tax liability after credits |

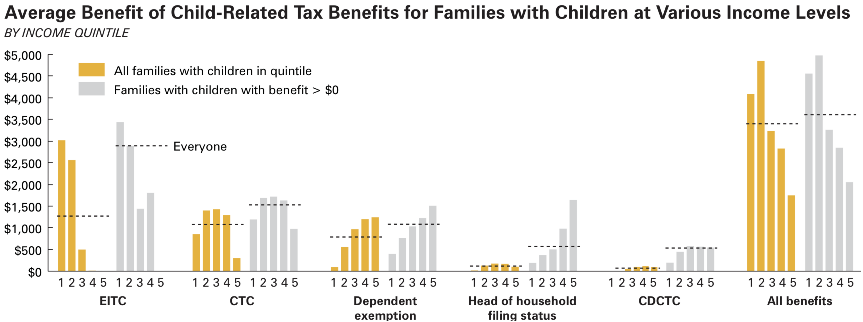
# Income taxes in the US

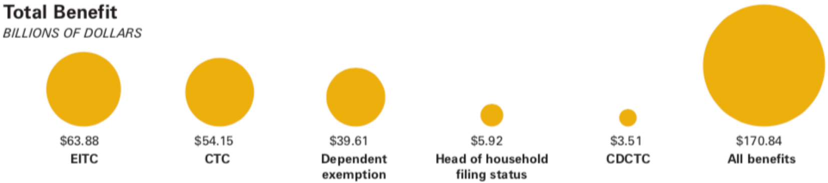
## Sources of child-depdendencies

- Standard deduction: singles w/ children can claim “head of household” filling status, who enjoy higher standard deduction.
- Personal exemptions: extra amount per dependent child (phase out)
- Itemized deductions: interests paid on education loans, and higher education expenses (both limited and for higher education).
- Children and dependent care tax credit (CDCTC): non-refundable credit for the care of dependents (phase out)
- Child tax credit (CTC): refundable credit of $1,000 per eligible child (phase out)
- Earned income tax credit (EITC): higher credit rate, maximum credit and phase out threshold.
- Tax rates: heads of households enjoy lower tax rates.

▷ Intro ▷ Estimation

# Maag (2013)




▷ Intro ▷ Estimation

## CPS Sample

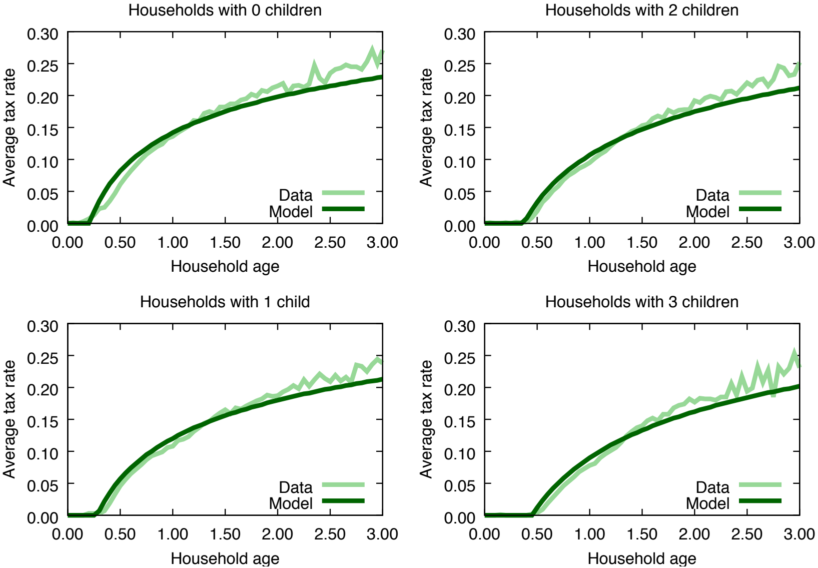
- Annual Survey of Economic Conditions Supplement to the CPS.
  - Years 2000 to 2010.
  - Large sample size:

    Allows for clustering by the number of children in the household.
- Tax-related variables from the Census Bureau's tax model
  - Using info from: IRS, the American Housing Survey, and the State Tax Handbook.
- Sample selection:

  Keep married households filling joint returns and positive income.

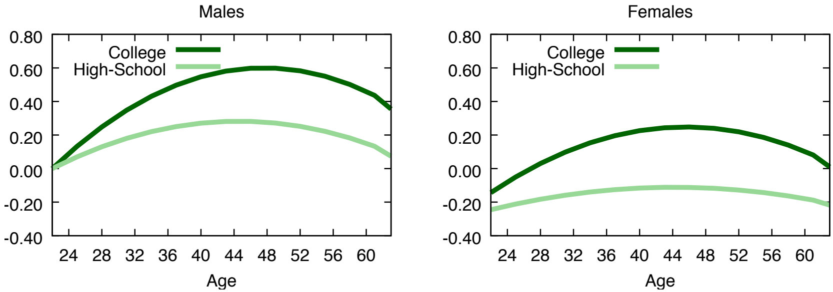
▷ Back

# Tax function




▷ Back

# Income profiles




- Construct hourly wages for full-time workers.
- Fit 2nd order polynomial in age, by education and gender.
- Normalize $\mu(m, \overline{e}, J_l) = \mu(m, \underline{e}, J_l) = 0$.

▷ Back

# Income profiles

- Take residuals as our measure of labor productivity. Estimate (by education):

$$z_{i,t} = \alpha + \rho z_{i,t-2} + \epsilon_{i,t}$$

- Measurement error: instrument $z_{i,t-2}$ with $z_{i,t-4}$ (biannual observations)

Table: Labor productivity process estimation

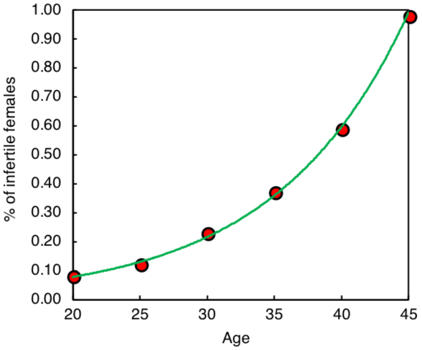
| | Low educated | High educated |
|---|---|---|
| Autocorrelation, $\rho_e$ | 0.824 | 0.902 |
| Std of innovations, $\sigma_e$ | 0.406 | 0.392 |

▷ Back

# Fertility risk

- Follow Sommer (JME 2016): use data from medical literature on infertility.

$$p_0(b,j) = \begin{cases} 1 - \exp(\alpha_0 + \alpha_1 j) & \text{if } b = 1 \text{ and } j \leq J_F \\ 0 & \text{otherwise} \end{cases}$$




▷ Back

# Children independence

- Probability that a child becomes adult given by:

$$p_l(n,j) = \frac{\sum_{i=1}^{N} \mathbf{1}\{n_{i,t} < n \wedge n_{i,t-3} = n \wedge \text{age} = j\}}{\sum_{i=1}^{N} \mathbf{1}\{n_{i,t-3} = n \wedge \text{age} = j\}}$$

- Results (PSID data):

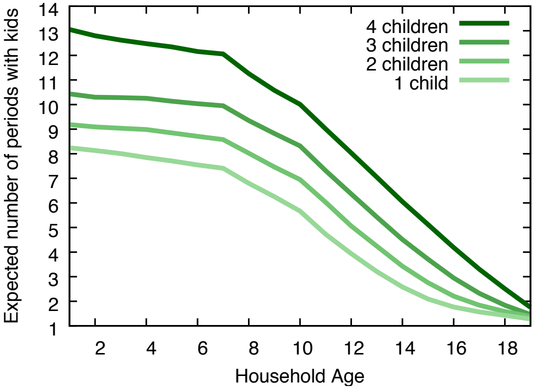
Table: Children ageing process

| | Mother's age | | | |
|---|---|---|---|---|
| Age<br>Model age ($j$) | 20-28<br>1-3 | 29-37<br>4-6 | 38-46<br>7-9 | $>$46<br>$>$9 |
| $p_l(n=1,j)$ | 0.029 | 0.037 | 0.288 | 0.501 |
| $p_l(n=2,j)$ | 0.025 | 0.041 | 0.309 | 0.579 |
| $p_l(n=3,j)$ | 0.049 | 0.105 | 0.399 | 0.718 |
| $p_l(n\geq 4,j)$ | 0.125 | 0.140 | 0.455 | 0.720 |

▷ Back

# Children independence

Figure: Expected number of years with children, by age and number of children




▷ Back

## Computation

- High dimensional problem: more than 120,000 grid points in the state space
- Choice set depends on the state
  - Young households choose whether to have a kid
  - Parents decide on investments
  - etc.
- Up to 6 continuous choice variables (+1 discrete)
- Value function is not differentiable: solution requires global methods
- Solution:
  - Parallel computing (`OpenMP`)
  - Solve household problem using Nelder–Mead method

▷ Back