The Long-Term Distributional and Welfare Effects of Covid-19 School Closures

Nicola Fuchs-Schundeln Dirk Krueger
Alexander Ludwig Irina Popova

Presented by: Jose Mota

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Motivation

- Governments worldwide reacted to Covid-19 pandemic closing schools
  - And child care centers
- Economic consequences of school closures on affected children are not easily measured
  - Arise in the longer term
- Parents may lessen negative effect of school closures on their children
  - Adjusting time investment into children's education
  - Adjusting monetary investment into children's education
  - Adjusting monetary transfers for their children
- Parental background may matter for these adjustments
  - Assets, income
  - Age of children during the shock

This Paper

- Consequences of the school and child care closures on affected children
  - Human capital as they progress through their school ages
  - Their high-school graduation and college choice
  - Their labor market earnings
  - Welfare
- Build life-cycle model with children's human capital production function
  1. Time and monetary inputs by parents
  2. Governmental investment into schooling as input
- Two main experiments
  1. Model school and child care closures as a reduction in the governmental investment in children
  2. Model a negative income shock to parents due to the Covid-induced economic recession

Outline

1. Model
2. Calibration
3. Results
4. Conclusions

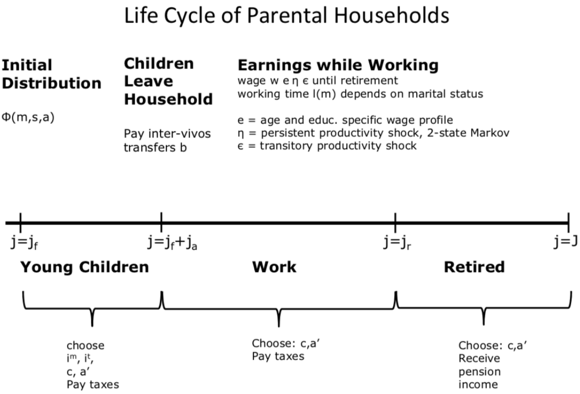
Model overview

- Life cycle of one adult and one children generation
  - in partial equilibrium
- Parental educational investment in children's human capital
  - Monetary and time investment
  - May lessen effects of school closures
- State variables in this economy

Table 1: State Variables

State Var.	Values	Interpretation
k	$k \in \{ch, pa\}$	Generation
m	$m \in \{si, ma\}$	Marital Status
j	$j \in \{0, 1, \ldots, J\}$	Model Age
a	$a \geq -\underline{a}(j, s, k)$	Assets
h	$h > 0$	Human Capital
s	$s \in \{no, hi, co\}$	Education
η	$\eta \in \{\eta_l, \eta_h\}$	Persistent Productivity Shock
ε	$\varepsilon \in \{\varepsilon_1, \ldots, \varepsilon_n\}$	Transitory Productivity Shock

Timeline: Parental households



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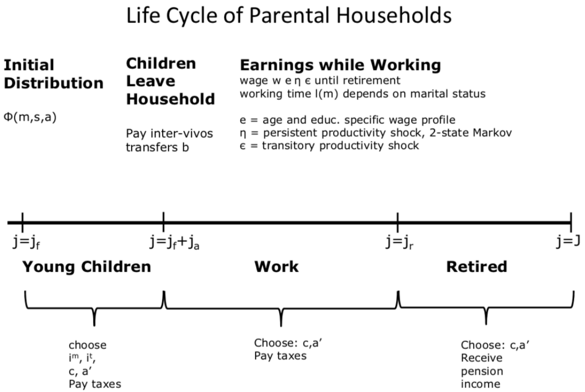
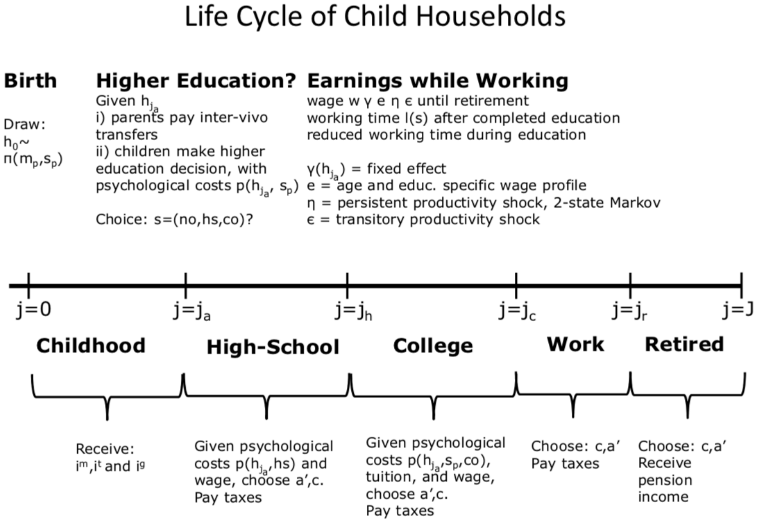


- $h' = g(j, h, i^m, i^t, i^g)$: Children's human capital production function
- i^m, i^t: Monetary and time investment into children's human capital
- i^g: Government investment into children's education
- $y(j, s, m) = w \cdot \epsilon(j, s, m) \cdot \eta \cdot \varepsilon \cdot l(m)$: Labor income of parents
- $\epsilon(j, s, m)$: Age, education, marital specific wage profile

Timeline: Child households



- $y(j,s,m=si,h) = w \cdot \gamma(s,h) \cdot \epsilon(j,s,m) \cdot \eta \cdot \varepsilon \cdot l(si)$: Labor income of children
- $\gamma(s,h)$: Idiosyncratic permanent productivity state

Calibration

- Two stages
  1. Parameters calibrated exogenously not using the model
  2. Parameters calibrated endogenously by matching moments in the data

Calibration

- Two stages
  1. Parameters calibrated exogenously not using the model
  2. Parameters calibrated endogenously by matching moments in the data
- I focus on human capital production function parameters
  - At birth age $j = 0$, children draw innate ability $h_0 \sim \Psi(h(j = 0)|s_p, m_p)$
    - Letter Word test score distribution in the PSID
  - At ages $j_0, ..., j_{a-1}$ children receive education investments
    - $h' = g(j, h, i^m, i^t, i^g)$

Human Capital Production Function

$$h'(j) = \left(k_j^h h^{1-\frac{1}{\sigma^h}} + (1-k_j^h) i(j)^{1-\frac{1}{\sigma^h}}\right)^{\frac{1}{1-\frac{1}{\sigma^h}}} \tag{1}$$

$$i(j) = \bar{A}\left(k_j^g \left(\frac{i^g}{\bar{i}^g}\right)^{1-\frac{1}{\sigma^g}} + (1-k_j^g)\left(\frac{i^p(j)}{\bar{i}^g}\right)^{1-\frac{1}{\sigma^g}}\right)^{\frac{1}{1-\frac{1}{\sigma^g}}} \tag{2}$$

$$i^p(j) = \left(k_j^m \left(\frac{i^m}{\bar{i}^{m,d}}\right)^{1-\frac{1}{\sigma^m}} + (1-k_j^m)\left(\frac{i^t(j)}{\bar{i}^{t,d}}\right)^{1-\frac{1}{\sigma^m}}\right)^{\frac{1}{1-\frac{1}{\sigma^m}}} \tag{3}$$

- $\bar{x}$: unconditional mean

Calibration: Human Capital Production Function

$$h'(j) = \left(k_j^h h^{1-\frac{1}{\sigma^h}} + (1-k_j^h) i(j)^{1-\frac{1}{\sigma^h}} \right)^{\frac{1}{1-\frac{1}{\sigma^h}}} \tag{4}$$

1. $\sigma^h = 1$: mean value for young and old children in Cunha et al. (2010)
2. k_j^h: to match time investment by age of the child, modeled as

$$ln\left(\frac{1-k_j^h}{k_j^h}\right) = \alpha_0^{k^h} + \alpha_1^{k^h} \cdot j + \alpha_2^{k^h} \cdot j^2$$

- $\alpha_1^{k^h}, \alpha_2^{k^h}$: by indirect inference
  - Log per child time investments in the data equals the pattern in the model
  - Ages 6 to 14
- $\alpha_0^{k^h}$: To match monetary investments

Calibration: Human Capital Production Function

$$i(j) = \bar{A}\left(k_j^g\left(\frac{i^g}{\bar{i}^g}\right)^{1-\frac{1}{\sigma^g}} + (1-k_j^g)\left(\frac{i^p(j)}{\bar{i}^g}\right)^{1-\frac{1}{\sigma^g}}\right)^{\frac{1}{1-\frac{1}{\sigma^g}}} \quad (5)$$

1. $\sigma^g = 2.43$: from Kotera and Seshadri (2017)
2. $k_j^g = \bar{k_j^g}$ for $j > 0$: Kotera and Seshadri (2017)
   - $k_0^g = 0.44$: To match average time investments into age 4 child
3. $\bar{A}$: Normalization so that average human capital equals 1

Calibration: Human Capital Production Function

$$i^p(j) = \left(k_j^m \left(\frac{i^m}{\bar{i}^{m,d}} \right)^{1-\frac{1}{\sigma^m}} + (1 - k_j^m) \left(\frac{i^t(j)}{\bar{i}^{t,d}} \right)^{1-\frac{1}{\sigma^m}} \right)^{\frac{1}{1-\frac{1}{\sigma^m}}} \tag{6}$$

1. $\sigma^m = 1$: from Lee and Seshadri (2019)
2. k_j^m: to match monetary investment by age of the child, modeled as

$$ln \left(\frac{1 - k_j^m}{k_j^m} \right) = \alpha_0^{k^m} + \alpha_1^{k^m} \cdot j$$

- $\alpha_1^{k^m}$: by indirect inference
  - To match monetary investment profile
- $\alpha_0^{k^m}$: To normalize $k_3^m = 0.5$

Calibration: Human Capital Production Function

$$i^p(j) = \left(k_j^m \left(\frac{i^m}{\bar{i}^{m,d}} \right)^{1-\frac{1}{\sigma^m}} + (1 - k_j^m) \left(\frac{i^t(j)}{\bar{i}^{t,d}} \right)^{1-\frac{1}{\sigma^m}} \right)^{\frac{1}{1-\frac{1}{\sigma^m}}} \tag{6}$$

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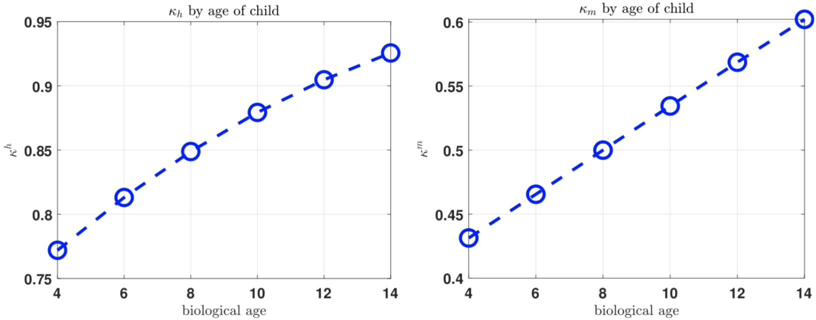
- $\alpha_0^{k^m}$: To normalize $k_3^m = 0.5$

- **Why $i^p(j)$ does not depend on parental education?**

Calibration: Human Capital Production Function

Figure 2: Age Dependent Parameters κ_j^h, κ_j^m over Child Age



(a) Weight κ_j^h (b) Weight κ_j^m

Experiment

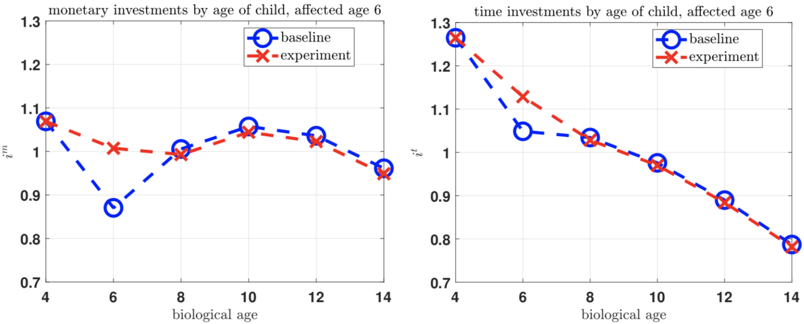
1. Impact of school closures that last for half a year
   - Corresponds to a reduction of government time investments i^g by 25%
   - The model has two year periods
2. In addition parents receive negative income shocks
   - Mainly driven by a reduction of hours worked
   - Reductions are more severe for parents with lower educational attainment

Impact of school closures that last for half a year

1. On average (across children aged 4 to 14 when the shock occurs)
   - Increase in future share of children without a high school degree of 7%
   - Decrease in future share of children with a college degree of −3.2%
2. On average, earnings losses of −0.95%
   - Induced by reduced human capital and lower educational attainment
3. These effects materialize despite a significant endogenous adjustment of parental investments into their children
   - Time inputs rise by 7.3% and monetary inputs by 14.7%
4. Large welfare loss of children from school closures of −0.55%
   - Measured as consumption-equivalent variation
   - Adding income changes marginally welfare loss to −0.56%
5. Heterogenous welfare lost by parental characteristics
   - Smallest welfare losses (−0.4%) for children of college-educated parents
   - Larger losses (−0.7%) for children whose parents are high school dropouts

Investment in human capital over life-cycle for children of age 6

Figure 5: Money and Time Investments and Human Capital over Remaining Child Life-Cycle for Children of Age 6



(a) Money Investments

(b) Time Investments

Investment in human capital over life-cycle for children of age 6

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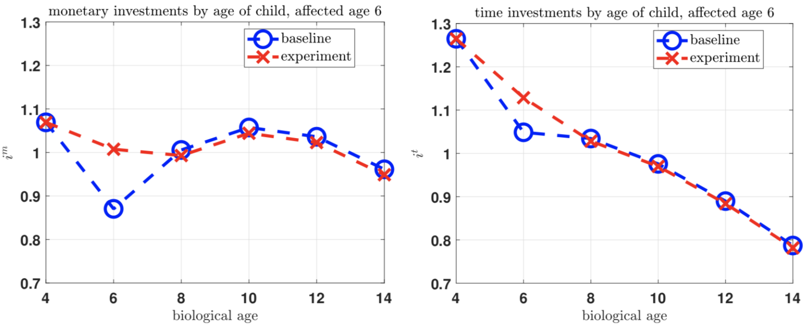

(a) Money Investments (b) Time Investments

- Larger welfare losses for younger children
- Aged 6 at the time of the crisis amount to -0.71%

Conclusions

- Interesting paper to study the effects of school closures (not only Covid-related)
- Useful framework to think about the importance of opening schools in areas where children don't have access to it
  - These are usually poor areas
  - Parents do not have good inputs to mitigate the lack of schools
- Author should think about heterogeneity in parents time inputs for education
  - Less educated parents are likely less effective educating their children
  - Adding this feature would magnify effects on disadvantaged children
- Authors do not model the health benefits of the school closures
  - This would reduce the net costs of school closure
  - Health costs should be more important for parental generation
    - Probability of dying of Covid is higher for old people

Thanks

Annex

Education Decision

$$s = \begin{cases} no & \text{if } V(j_a, s = no; a, h) \geq \max\{V(j_a, s = hs, s_p; a, h), V(j_a, s = co, s_p; a, h)\} \\ hs & \text{if } V(j_a, s = hs, s_p; a, h) \geq \max\{V(j_a, s = no; a, h), V(j_a, s = co, s_p, a, h)\} \\ co & \text{if } V(j_a, s = co; s_p, a, h) \geq \max\{V(j_a, s = no; a, h), V(j_a, s = hs, s_p; a, h)\}, \end{cases} \tag{3}$$

Children Problem

$$V(j, no, \eta, \varepsilon; a, h) = \max_{c,a'} \left\{ u(c) - v(\ell(si)) + \beta \sum_{\eta'} \pi(\eta' \mid \eta) \sum_{\varepsilon'} \psi(\varepsilon') V(j+1, no, \eta', \varepsilon'; a', h) \right\}$$

subject to

$$\begin{aligned} a' + c(1+\tau^c) &= a(1 + r(1-\tau^k)) + y(1-\tau^p) - T(y(1-0.5\tau^p)) \\ y &= w\gamma(no, h)\epsilon(no, j, si)\eta\varepsilon\ell(si) \\ a' &\geq 0 \end{aligned}$$

Parents Problem

$$V(j,s,m,\eta,\varepsilon;a,h) = \max_{c,i^m,i^t,a',h'} \Bigg\{ u\left(\frac{c}{1+\zeta_c\xi(m,s)+\mathbf{1}_{m=ma}\zeta_a}\right) - v\left(\frac{\ell(m)+\kappa\cdot\xi(m,s)\cdot i^t}{1+\mathbf{1}_{m=ma}}\right) + \beta\sum_{\eta'}\pi(\eta'|\eta)\sum_{\varepsilon'}\psi(\varepsilon')V(j,s,m,\eta',\varepsilon';a',h')\Bigg\}$$

subject to

$$a' + c(1+\tau^c) + \xi(m,s)i^m = a(1+r(1-\tau^k)) + y(1-\tau^p) - T(y(1-0.5\tau^p))$$

$$y = w\epsilon(s,j,m)\eta\varepsilon\ell(m)$$

$$a' \geq -\underline{a}(j,s,k)$$

$$h' = g(j,h,i(i^m,i^t,i^g))$$

Parental decisions by age of children during shock

Table 12: Parental Decisions in Period of Covid-19 Impact

	baseline	%-Change for Children of Biological Age						
		average	4	6	8	10	12	14
Panel A: Lockdown of Schools								
av mon inv	$1,385	14.67	10.03	15.74	15.21	15.21	15.61	16.24
av time inv	25.17	7.27	4.75	7.62	7.40	7.51	7.87	8.46

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