Longevity, Fertility and Human Capital

Hazan and Zoabi, *JOEG* 2006
Hazan, *Econometrica* 2009
Hazan and Zoabi, 2013

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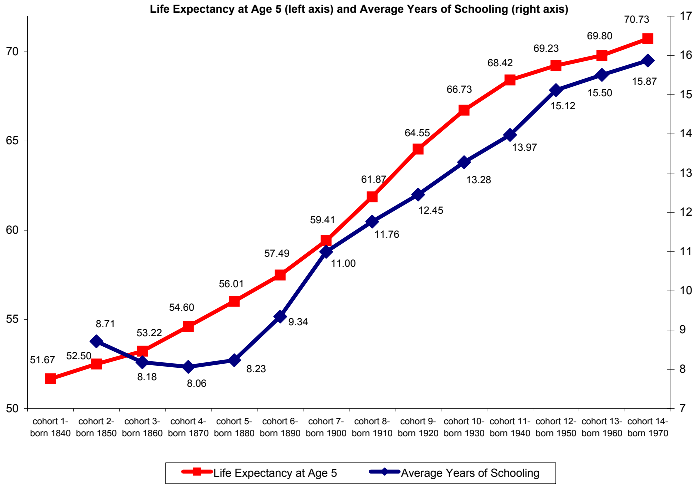
July 9, 2013

Life expectancy at age 5 and average years of schooling



The Conventional Wisdom

- Gains in longevity increase the horizon over which investment in schooling will be paid off, spur investment in HC and cause growth
- This mechanism appears in Kalemli-Ozcan, Ryder & Weil, *JDE* 2000; Boucekkine, de la Croix & Licandro, *JET* 2002; Soares, *AER* 2005; Cervellati & Sunde, *AER* 2005, . . .
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Analytical Framework

- Preferences:

$$V = \int_0^\infty e^{-\rho t} F(t)[u(c(t)) + v(l(t))]dt.$$

- $F(t)$ is the probability surviving to age t; $F(0) = 1$, $F'(\cdot) \leq 0$, $\lim_{t\to\infty} F(t) = 0$
- $c(t)$ and $l(t)$ are consumption and leisure at t, respectively
- $u(\cdot)$ and $v(\cdot)$ are strictly increasing and strictly concave

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- Time line: the individual goes to school for $0 \leq t \leq S$ and works for $S \leq t \leq R$
- $s(t) \equiv 1 - l(t)$ is school intensity for $t \leq S$
- $L(t) \equiv 1 - l(t)$ is labor supply for $t \geq S$
- The human capital is determined according to:

$$h = e^{\theta(\bar{s})}; \qquad \bar{s} = \int_0^S s(t)dt$$

- $\theta'(\cdot) > 0; \qquad \theta''(\cdot) \leq 0$
- Assume that productivity equals the individual's human capital

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Analytical Framework

- Budget Constraint: with perfect capital markets, the budget constraint is given by:

$$\int_S^R e^{-rt}F(t)L(t)e^{\theta(\bar{s})}dt = \int_0^\infty e^{-rt}F(t)c(t)dt.$$

Analytical Framework

- The optimization problem is:

$$\max_{c(t),l(t),S} V = \int_0^\infty e^{-\rho t} F(t)[u(c(t)) + v(l(t))]dt$$

subject to

$$\int_S^R e^{-rt} F(t) L(t) e^{\theta(\bar{s})} dt = \int_0^\infty e^{-rt} F(t) c(t) dt.$$

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- The FOC w.r.t. schooling choice is given by:

$$s(S)\int_S^R e^{-rt}F(t)L(t)\theta'(\bar{s})e^{\theta(\bar{s})}dt = L(S)e^{-rS}F(S)e^{\theta(\bar{s})}$$

- The LHS is the discounted lifetime gain in income in response to a "small" increase in schooling
- The RHS is the loss in income at date S in response to a "small" increase in schooling

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- The FOC w.r.t. schooling choice can be written as:

$$\frac{\int_S^R e^{-rt} F(t) L(t) dt}{e^{-rS} F(S)} = \frac{1}{\theta'(\bar{s})}$$

- The numerator on the LHS is the discounted lifetime working hours; the denominator is the "effective" discount rate from age 0 till age S
- The RHS is the inverse of the marginal return of schooling

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Analytical Framework

Comparative Statics:

- Notice that "longevity" is represented by the $F(\cdot)$ function. An increase in longevity that can increase time spent in schooling should occur during the working period, $t \in [S, R]$.
- One possible increase in longevity is a change in F that shifts the function F to F' such that $F' \geq F$ for all $t \in [S, R]$ and $F' > F$ for some $t \in [S, R]$
- When this happens, the LHS – the discounted lifetime working hours – increases and therefore, $\frac{1}{\theta'(\bar{s})}$ must increase. If $\theta''(\cdot) < 0$ then $\bar{s}$ must increase

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Theoretical Critique

Based on
Hazan M. and Zoabi H. (2006), "Does Longevity Cause Growth? A Theoretical Critique" *Journal of Economic Growth*

- Robustness of the mechanism to the question who chooses schooling
- Robustness of the mechanism to the fertility margin

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Theoretical Critique

Kalemli-Ozcan, Ryder & Weil, *JDE* 2000

> *In a more complex model, education choices would be made by parents who maximize an intergenerational utility function, and choices over education would be integrated with the fertility decision. The key effect on which we focus – that increasing life expectancy would raise the period over which investments in schooling are paid off, and thus raise the optimal quantity of schooling – would still be present in such a model.*

Theoretical Critique

Galor & Weil, *AER* 1999

> *The effect of lower mortality in raising the expected rate of return to human capital investments will nonetheless be present, leading to more schooling and eventually to a higher rate of technological progress. This will in turn raise income and further lower mortality*

Theoretical Critique

A "Model"

- two periods: childhood and adulthood
- as a child, consumes parent's time
- as an adult, works, raises children and consumes

let

- τ be the time needed to raise a child irrespective of quality
- s_{t+1} be the time devoted to each child's schooling
- n_t be the number of children
- $h_t = h(s_t)$ be the human capital of an adult in period t
- T_t be the longevity of an adult in period t

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- Preferences:

$$W_t = U(c_t) + V(n_t T_{t+1} h(s_{t+1}))$$

- Budget constraint:

$$T_t h_t = c_t + (\tau + s_{t+1}) n_t h_t$$

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Theoretical Critique

Case 1: Assume fertility is exogenous and set $n_t = 1$

- The F.O.C. w.r.t. s_{t+1} (assuming interior solution) is:

$$U'(c_t)h_t = V'(T_{t+1}h(s_{t+1}))T_{t+1}h'(s_{t+1})$$

Theoretical Critique

Proposition 1: *"The Modified Ben-Porath Mechanism"*
When fertility is exogenous, an increase in children's longevity increases the optimal schooling level if and only if:

$$-V''(T_{t+1}h(s_{t+1}))\frac{(T_{t+1}h(s_{t+1}))}{V'((T_{t+1}h(s_{t+1}))} < 1$$

→ When schooling is chosen by parents, greater longevity of the children does not imply automatically more schooling

→ Need additional assumption on the utility function – marginal utility from children's full income must not decrease "too" fast. In the CRRA family, need to be between the linear and the log-linear range

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Theoretical Critique

Case 2: Assume fertility is endogenous: Same Preferences and Budget Constraint as before

- The F.O.C. w.r.t. s_{t+1} is:

$$U'(c_t)n_t h_t = V'(n_t T_{t+1} h(s_{t+1}))n_t T_{t+1} h'(s_{t+1})$$

- The F.O.C. w.r.t. n_t is:

$$U'(c_t)(\tau + s_{t+1})h_t = V'(n_t T_{t+1} h(s_{t+1}))T_{t+1} h(s_{t+1})$$

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Theoretical Critique

Proposition 2: *"The Neutrality Result"*

When fertility is endogenous, an increase in children's longevity has no effect on the optimal level of education.

Historical Evidence

Based on
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- Recall the necessary condition from the standard model:

$$\frac{\int_S^R e^{-rt}F(t)L(t)dt}{e^{-rS}F(S)} = \frac{1}{\theta'(\bar{s})}$$

- The evidence below is based on the assumption that $r = 0$ and $F(S) = 1$.

- Qualitative results are unaltered if $F(S)$ is taken from the data and $r \leq 0.05$ (annual rate)

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Historical Evidence

- Estimating the lifetime labor supply of consecutive cohorts of American men born between 1840 and 1970
- Main result: Men born 1840 were expected to work 20-25 percent **more** than their counterparts born 100 years later
- Similarity in the trends and magnitudes of the determinants of lifetime labor supply between the U.S. and many European countries.
- the Ben-Porath mechanism didn't contribute much to the accumulation of HC during the 19th and 20th centuries.

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Formation of Expectations

- Static Expectations: hours, death rates and LFP rates are taken from the cross-section at the year the expectations are formed. Henceforth, estimates built on this assumption will be labelled "**period estimates**"
- Perfect Foresight: Actual hours, death rates and LFP rates are used for each cohort. Henceforth, estimates built on this assumption will be labelled "**cohort estimates**"

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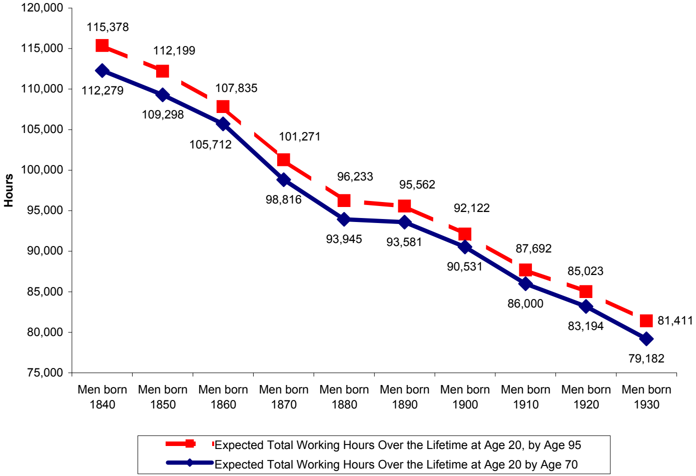
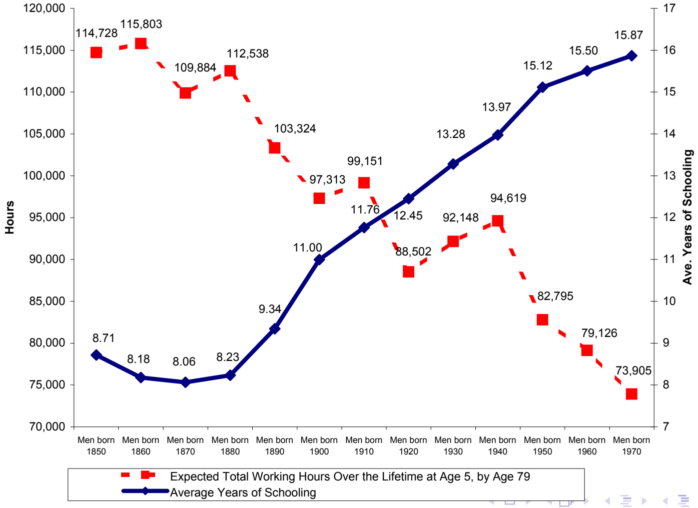
Lifetime labor supply – cohort estimates



Schooling and lifetime labor supply – period estimates



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Concluding Remarks – Longevity and Human Capital

- Did longevity cause growth? No, or much less than previously thought
  - Theoretically there are offsetting effects
  - Empirically, human capital utilization (expected and actual lifetime labor supply) has declined
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Conventional Wisdom

Based on Hazan and Zoabi (2013) “Do Highly Educated Women Choose Smaller Families?”

Income (and education) and fertility are negatively correlated. This is true:

- In a cross-section of countries (Weil 2005)
- Over time within countries and regions (Galor 2005)
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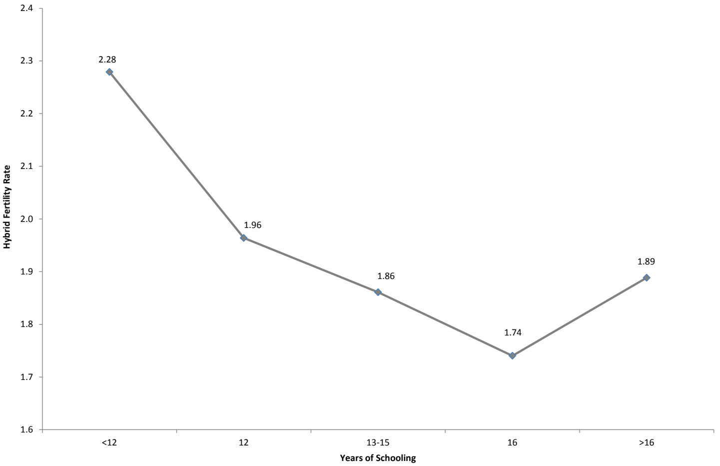
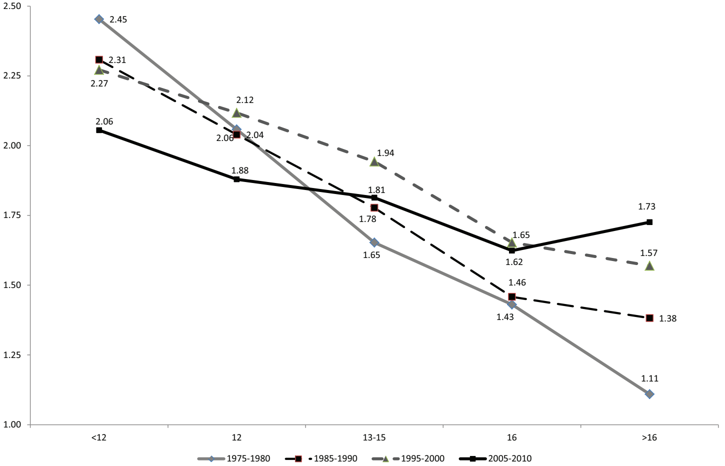
Cross-Sectional Relationship between Women's Education and Fertility – U.S. 2001-11



Cross-Sectional Relationship between Women's Education and Fertility – U.S. 1970s, 1990s 2010s



Basic Assumptions

Similar setup to Doepke and de la Croix (2003) and Moav (2005):

- A continuum of individuals that differ in their human capital, h_i (market productivity)
- Each Individual forms a household, works, chooses consumption, her number of children and their level of education
- To focus on the cross-sectional relationship assume for simplicity a one period model

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Preferences, Budget Constraint and H.C. Production Function

- utility function:

$$u_i = \ln(c_i) + \ln(n_i h'_i)$$

- budget constraint:

$$h_i = p_{ci} c_i + p_{ni} n_i + n_i p_{ei} e_i$$

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- The average level of human capital among teachers is $\bar{h}$
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Raising Children (Quantity)

- In Doepke and de la Croix (2003) and Moav (2005), it's the parent's time that is needed to raise children
- Hence, education is getting *relatively* cheaper as parent's productivity increases
- This generates a q-q tradeoff and therefore the cross-sectional relationship between parent's human capital and fertility is negative
- But in the real world, parents can substitute their time with others, e.g., a baby-sitter

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- t_M^n is time of the mother
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- Assumption: price of one unit of time bought in the market is some level of human capital denoted by $\underline{h}$.

$\Rightarrow$

$$TC^n(n, \underline{h}, h^i) = p_{ni}n = \varphi \underline{h}^{1-\phi} h_i^{\phi} n; \qquad \varphi \equiv \left(\frac{\phi}{1-\phi}\right)^{1-\phi} + \left(\frac{1-\phi}{\phi}\right)^{\phi}$$

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Consumption

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$$c = m^{1-\alpha}\left[(t_M^c)^\sigma + (t_H^c)^\sigma\right]^{\alpha/\sigma}, \qquad \sigma \in (0,1)$$

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Equilibrium

Education:

$$e_i = \frac{\theta\varphi\underline{h}^{1-\phi}h_i^{\phi} - \eta\bar{h}}{\bar{h}(1-\theta)}$$

Proposition 1: The educational choice, e^*, strictly increases with h_i

Evidence: Bailey and Dynarski (2012)

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$$n_i = \frac{h_i(1-\theta)}{2(\varphi \underline{h}^{1-\phi} h_i^{\phi} - \eta \bar{h})}$$

Proposition 2: The fertility choice, n^* is U-shaped as a function of h_i

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Mother's time spent in child raising:

$$t_M^n = \left(\frac{\phi}{1-\phi} \frac{\underline{h}}{h_i} \right)^{1-\phi} \frac{h_i(1-\theta)}{2(\varphi \underline{h}^{1-\phi} h_i^{\phi} - \eta \bar{h})}$$

Proposition 3: Mother's time spent on raising children, t_M^n, strictly decreases with h_i

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Mother's time spent in home production:

$$t_M^c = \frac{\alpha}{2\left(1 + \left(h_i/\hat{h}\right)^{\frac{\sigma}{1-\sigma}}\right)}$$

Proposition 4: Mother's time spent in home production, t_M^c, strictly decreases with h_i

Evidence: Immigration wave of the 1980s and 1990s reduced by a city-average of 138 minutes the time very skilled American women spent weekly on household chores (Cortes and Tessada 2011)

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Proposition 5: The labor supply strictly increases with h_i

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Equilibrium

Babysitting services purchased in the market:

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Proposition 6: Purchase of babysitter services:

- Strictly increases with h_i if $\theta < \frac{1}{1+\phi}$
- Strictly increases with h_i when η increases
- Evidence: see below

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Housekeeping services purchased in the market:

$$\frac{\left(\frac{\alpha}{1-\alpha}\right)^{1-\alpha} h_i^{\alpha+\frac{\sigma}{1-\sigma}}}{\hat{h}^{\frac{1}{1-\sigma}}\left(1+\left(\frac{h_i}{\hat{h}}\right)^{\frac{\sigma}{1-\sigma}}\right)^{1+\alpha\left(\frac{1}{\sigma}-1\right)}}\frac{\omega}{2}h_i^{1-\alpha}\left(1+\left(\frac{h_i}{\hat{h}}\right)^{\frac{\sigma}{1-\sigma}}\right)^{\alpha\left(\frac{1}{\sigma}-1\right)}$$

Proposition 7: Purchase of housekeeping services strictly increases with h_i

Evidence: Expenditures on household services increased, despite a reduction in the prices of these services (Cortes 2008, Cortes and Tessada 2011)

Equilibrium

Housekeeping services purchased in the market:

$$\frac{\left(\frac{\alpha}{1-\alpha}\right)^{1-\alpha} h_i^{\alpha+\frac{\sigma}{1-\sigma}}}{\hat{h}^{\frac{1}{1-\sigma}}\left(1+\left(\frac{h_i}{\hat{h}}\right)^{\frac{\sigma}{1-\sigma}}\right)^{1+\alpha\left(\frac{1}{\sigma}-1\right)}} \frac{\omega}{2} h_i^{1-\alpha}\left(1+\left(\frac{h_i}{\hat{h}}\right)^{\frac{\sigma}{1-\sigma}}\right)^{\alpha\left(\frac{1}{\sigma}-1\right)}$$

Proposition 7: Purchase of housekeeping services strictly increases with h_i

Evidence: Expenditures on household services increased, despite a reduction in the prices of these services (Cortes 2008, Cortes and Tessada 2011)

Equilibrium

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Highly educated women:

1. Provide each of their children with more education
2. Have larger families than women with intermediate level of education
3. Allocate less time to child raising and to home production (but see extension in the paper)
4. Work more in the labor market
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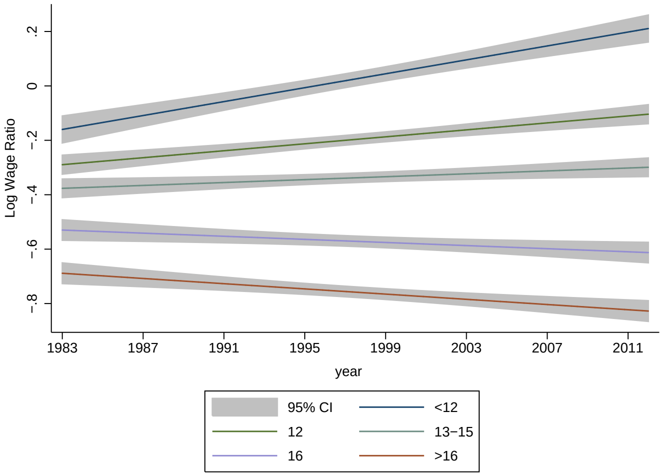
Relative Cost of Child-Care



The partial association between fertility and child-care cost

- Consider the following regression model:

$$b_{ist} = \alpha + \beta \ln\left(\frac{w^{cc}_{st}}{w_{ist}}\right) + \kappa N_{ist} + X'_{ist} \cdot \gamma + \delta_a + \delta_m + \delta_t + \delta_s + \epsilon_{ist},$$

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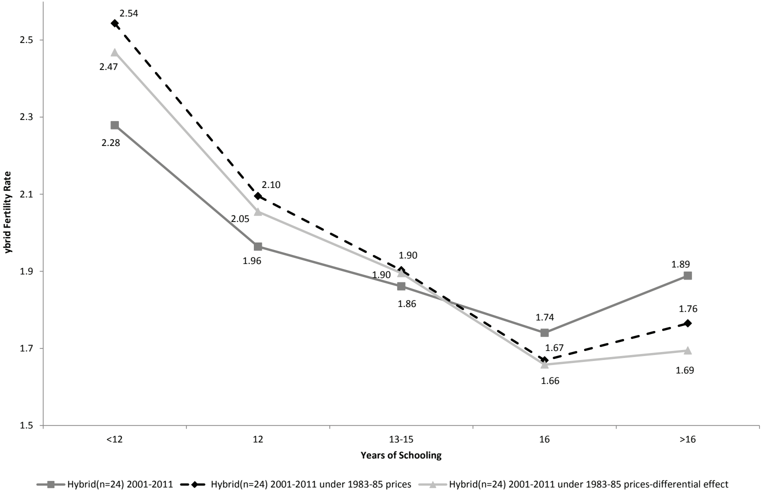
Counterfactual Fertility



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Ongoing Research:

- Study the implications for the relationship between income inequality and growth
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