EDUCATION AND POPULATION GROWTH 1870-2010

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BACKGROUND

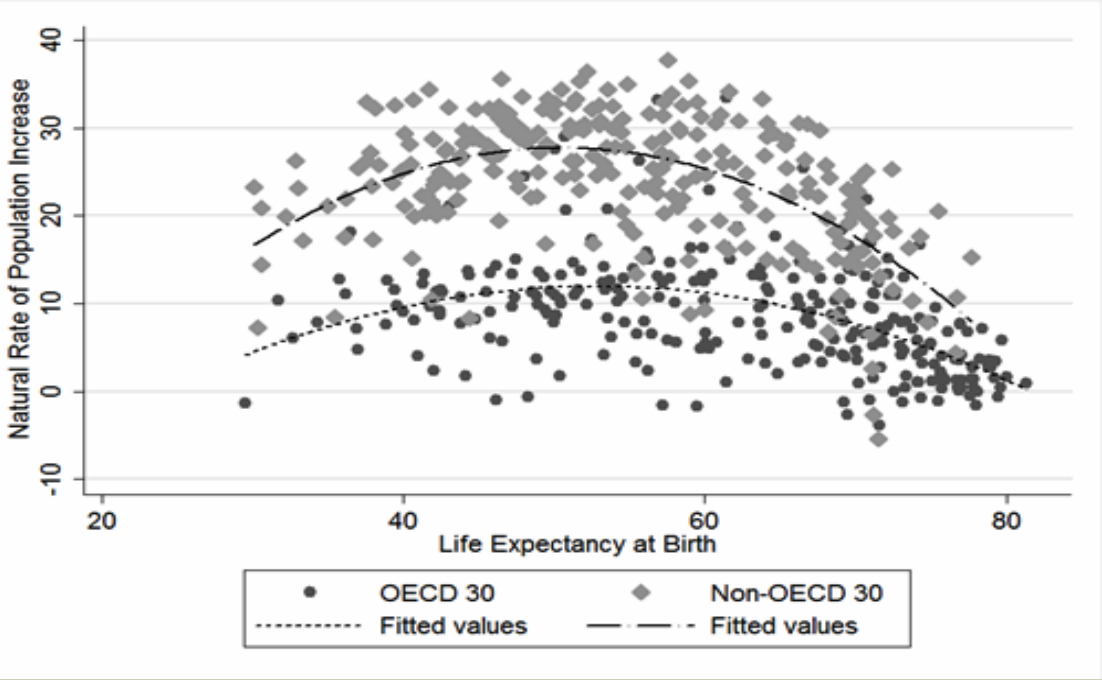
- Well-understood mechanics of the demographic transition:
  1. Effect of mortality on fertility (« replacement effect »): Nerlove (1974), Doepke (2005), Murtin (2013)
  2. Effect of *economic development* (e.g. technological progress, adult/female education, institutional progress such as child labour laws) on relative price of fertility vs. child education: Galor and Weil, 1996, 2000, Hazan and Berdugo, 2002, Doepke, 2004, Doepke, Hazan and Maoz, 2013

- Still debated: effect of income on fertility: Herzer, Strulick and Vollmer, 2013, Murtin, 2013

- Still unknown (?): interaction effects in the process of the demographic transition

STARTING POINT

- Stylized fact: larger population swings among developing countries
- Hypothesis: the demographic transition took place at relatively lower levels of educational attainment among non-OECD countries => higher fertility => higher population increase => larger swings in population



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- Section 1: Introduction
- Section 2: Data and stylized facts
- Section 3: Econometric framework
- Section 4: Results
- Section 5: Conclusion

DATA AND STYLIZED FACTS

- Variables of interest:
  - Crude birth rate (CBR) – Chesnais (1986)
  - Crude death rate (CDR) – Chesnais (1986)
  - Rate of natural increase of population (RNI=CBR-CDR)
  - Life expectancy (LE) – UN, Acemoglu et al. (2007), Crafts (1997), WDI, HSUS
  - Mean years of schooling 15-64 (MYS) – Morrisson et Murtin (2009, 2013)

- Balanced panel of 12 countries
  - 35 countries in 1910
  - 53 countries in 1950
  - 69 overall

DESCRIPTIVE STATISTICS

Table 1: Descriptive Statistics for selected variables, sample averages 1870-2010

	Balanced Panel				All countries			
	1870	1920	1970	2010	1870	1920	1970	2010
Mean Years of Schooling	3.8	6.1	9.5	12.1	1.4	2.5	4.7	7.8
Life Expectancy at Birth	41.2	55.4	72.0	80.9	40.5	51.1	58.8	70.0
Crude Birth Rate	31.8	25.2	15.0	11.2	34.6	31.0	33.8	21.7
Rate of Natural Increase	10.8	9.9	4.7	2.2	11.8	11.7	20.8	13.2

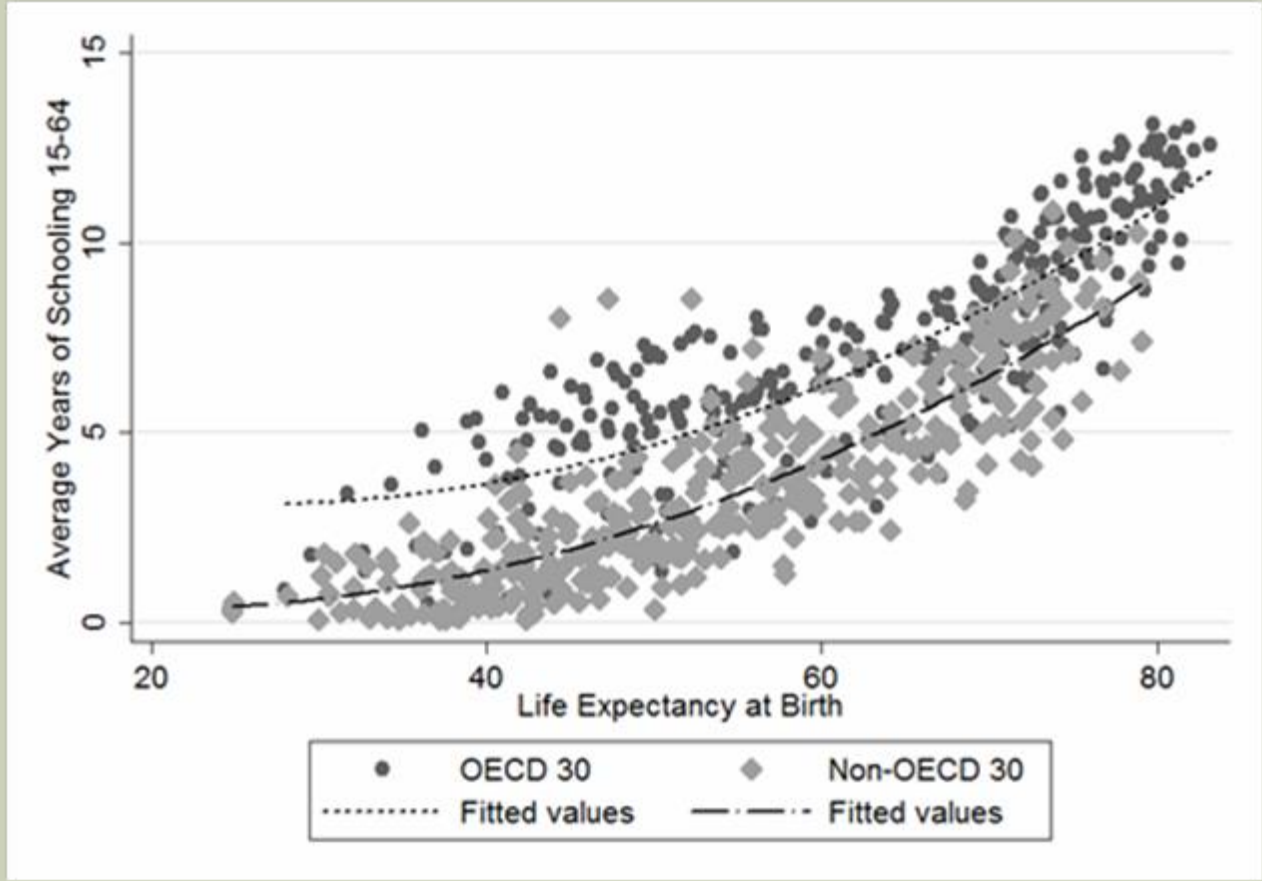
- **Persistent gap in educational attainment between developed and developing countries**
- **Doubling of life expectancy in balanced panel, acceleration with health improvement spreading to developing countries**
- **Convergence in CDR**
- **Non-linear behavior of CBR translates into non-monotonic changes in RNI: health improvement first increase then decrease the RNI**

THE LONGETIVITY PROFILE OF POPULATION GROWTH

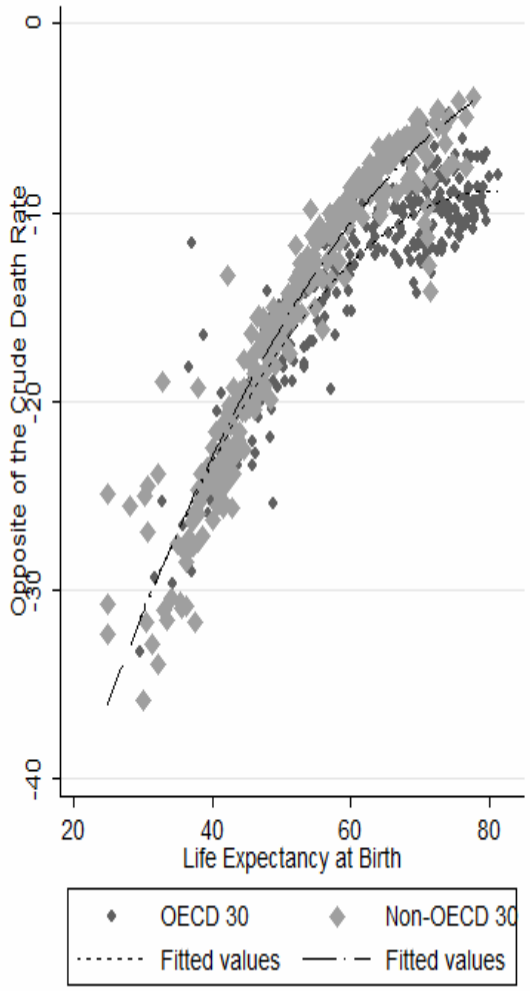
- U-shaped curve with tipping point around 50 years of age
- Higher average level of RNI in developing countries
- Hypothesis: education cushioned the demographic transition

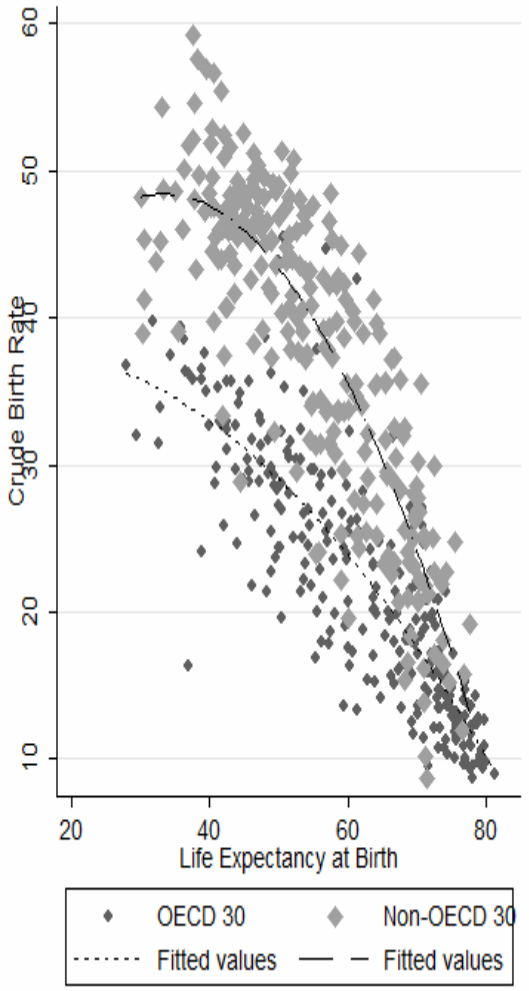
CRUDE DEATH RATE AND CRUDE BIRTH RATE

- Education has been more advanced in OECD countries



CRUDE DEATH RATE AND CRUDE BIRTH RATE





- Health technology transfers: education differential only partially translates into mortality differential
- Education differential imply a wide gap in fertility rates
- This suggests the existence of an interaction effect between longevity and education upon population natural growth rate

ECONOMETRIC MODEL

$$NRI_{i,t} = \rho NRI_{i,t-1} + a_i + \delta_t + \lambda(X_{i,t})LE_{i,t} + \mu(X_{i,t})LE_{i,t}^2 + X_{i,t}\pi + u_{i,t}$$

- Λ (.) and μ (.) are two functions of a vector X capturing the level of economic development with indicators such as education or income levels
- The squared life expectancy accounts for the non-monotonic variation in the RNI

$$\frac{dNRI_{i,t}}{dLE} = \left(\frac{1}{1-\rho}\right) \cdot \left[\lambda(X_{i,t}) + 2\mu(X_{i,t})LE_{i,t}\right]$$

- The marginal effect of longevity on the *steady-state* RNI depends both on the level of life expectancy (phase of demographic transition) and on economic development standards

BASELINE REGRESSION - OLS

$$NRI_{i,t} = a_i + \delta_t + \beta_1 LE_{i,t} + \beta_2 LE_{i,t}^2 + u_{i,t}$$

Table 2: The Determinants of the Rate of Natural Increase 1870-2010

	(1)	(2)	(3)	(4)	(5)	(6)
	Dependent variable: rate of natural increase					
Mean years of schooling			-0.837***			-1.109***
Life expectancy at birth	2.207***	0.984***	0.951***	1.719***	1.512***	1.494***
Squared life expectancy	-0.0242***	-0.0105***	-0.00879***	-0.0155***	-0.0135***	-0.0129***
Log GDP per working-age adult			0.0460			0.330
Demographic controls	No	Yes	Yes	No	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effects	No	No	No	Yes	Yes	Yes
R^2	0.66	0.79	0.81	0.90	0.91	0.92
N	609	605	601	609	605	601

PERSISTENCE EFFECTS

Table 4: The Determinants of the Rate of Natural Increase with Persistence Effects

	Panel Fixed-effects			SYS-GMM		
	(1)	(2)	(3)	(4)	(5)	(6)
	Dependent variable: rate of natural increase					
Mean years of schooling			-0.559**			-1.748***
Lagged rate of natural increase	0.512***	0.496***	0.473***	0.770***	0.848***	0.535***
Life expectancy at birth	0.499***	0.724***	0.788***	-0.618*	0.134	1.033
Squared life expectancy	-0.00482***	-0.00678***	-0.00717***	0.00304	-0.00268	-0.00967
Log GDP per working-age adult			0.568			3.284
Demographic controls	No	Yes	Yes	No	Yes	Yes
Time fixed-effects	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed-effects	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.93	0.94	0.94			
N	571	567	563	571	567	563
AR(1) p-values				0.000	0.000	0.000
AR(2) p-values				0.285	0.006	0.096
Hansen test				0.250	0.135	0.264
Diff-in Hansen test				0.997	0.876	0.831
Number of instruments				62	62	62
Number of countries				69	69	68

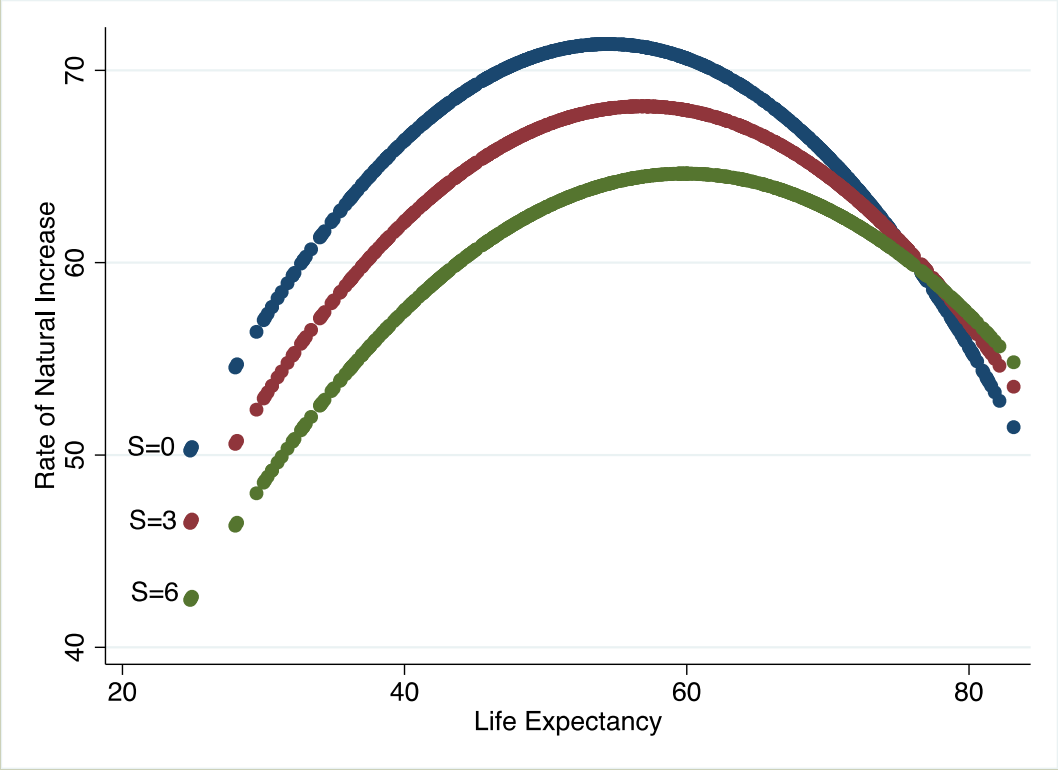
INTERACTION EFFECTS

Table 5: Interaction Effects between Education and Life Expectancy, 1870-2010

	OLS (1)	OLS (2)	OLS (3)	FE (4)	FE (5)	FE (6)	FE (7)	FE (8)	FE (9)	SYS-GMM (10)	SYS-GMM (11)	SYS-GMM (12)
MYS			3.045			5.680**			5.058**			9.440
Lagged RNI							0.469***	0.450***	0.447***	0.577***	0.574***	0.534***
LE	2.746***	2.758***	2.927***	3.040***	2.726***	2.979***	1.853***	1.750***	2.007***	1.592***	1.671**	2.277**
LE2	-0.0267***	-0.0269***	-0.0278***	-0.0274***	-0.0249***	-0.0259***	-0.0176***	-0.0166***	-0.0178***	-0.0159***	-0.0157**	-0.0202**
MYS x LE	-0.0774***	-0.111***	-0.206***	-0.0972***	-0.0859***	-0.256***	-0.0684***	-0.0595***	-0.212***	-0.0974***	-0.0870***	-0.375*
MYS x LE2	0.0008***	0.0015***	0.0022***	0.0012***	0.0011***	0.0024***	0.001***	0.0008***	0.0019***	0.0012***	0.0011**	0.0032**
Log GDP			-0.556			-0.186			0.130			0.663
Demographic	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.709	0.827	0.830	0.914	0.924	0.926	0.940	0.942	0.944			
N	609	605	601	609	605	601	571	567	563	571	567	563
AR(1) p-values										0.000	0.000	0.000
AR(2) p-values										0.303	0.052	0.084
Hansen test										0.428	0.244	0.276
Diff-in Hansen										0.916	0.873	0.590
Instruments										62	62	62
Countries										69	69	68

LONGEVITY AND POPULATION GROWTH

Longevity's effect on population growth during the demographic transition



- **Educational levels have a strong impact on the average RNI of population during the demographic transition**

CONCLUSION

- Significant interaction effects between longevity and education
- Marginal effects positive before 55 years, negative afterwards
- Larger marginal effects when educational attainment is lower

→ Education dampens the effect of longevity on population growth in the course of the demographic transition

WAYS OF IMPROVING THE PAPER

- Other data for life expectancy in 1870?
- Testing alternative hypothesis? E.g. income x life expectancy
- More on instrumentation of life expectancy?
- …

THANK YOU!