Pollution, Public Health Care, and Life Expectancy when Inequality Matters

Andreas Schäfer* and Alexia Prskawetz**

* Leipzig University – Institute of Theoretical Economics

** Institute of Mathematical Methods in Economics, Vienna University of Technology,

Wittgenstein Centre for Demography and Global Human Capital (IIASA, VID/ÖAW, WU)

Health, Education and Retirement over the Prolonged Life Cycle

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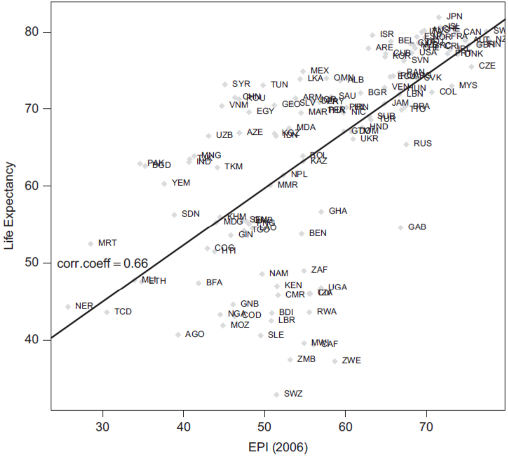
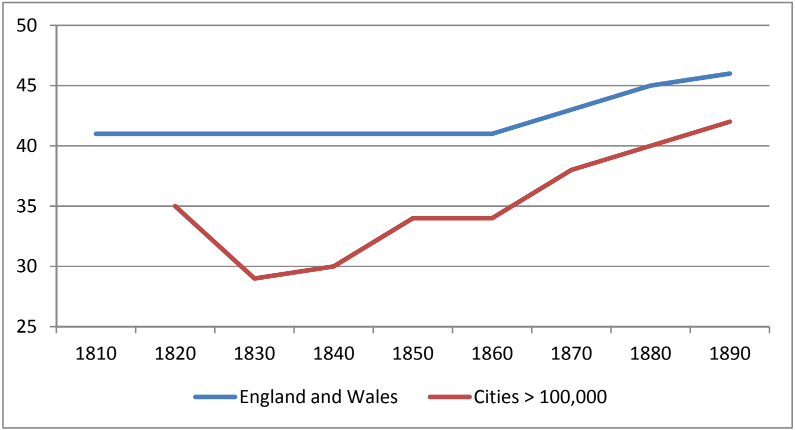
Life expectancy and environmental quality (Mariani, Perez-Barahona, and Natacha Raffin, 2010):



Introduction

Life expectancy at birth (Szreter, 1997):



Our frame

- Human capital investments are positively affected by life expectancy
- Life expectancy depends on health expenditures and is adversely affected by the degradation of the environment
- The productivity of health expenditures depends on the level of environmental pollution
- In addition, the distribution of wealth triggers the skill composition of the labor force (Galor and Zeira, 1993)
- Interaction between longevity, pollution and health has been analyzed by Raffin and Segmüller (2012)
- Link between longevity and environmental traps (no policy) by Mariani, Perez-Barahona, and Natacha Raffin (2010)
- We analyze the link between inequality, pollution and life expectancy within a Galor/Zeira framework

Description of the model

- Small open economy populated by a continuum of overlapping generations
- Agents live for two periods
- In the second period of life, agents derive utility out of consumption and (inter vivo) bequests
- Survival in the second period of life is uncertain
- In their first period of life, agents decide whether or not to invest in skills
- Unskilled households work in both periods while skilled households work in their last period only
- Capital market imperfection with respect to human capital investments
- Production generates income and pollution pollution
- Government collects taxes in order to finance abatement measures and health expenditures

Production

- Production takes place in a skilled and in an unskilled sector u, s:

$$
\begin{aligned}
Y_t^u &= aL_t^u, \qquad a > 0, & (1)\\
Y_t^s &= b(K_t)^\gamma (L_t^s)^{1-\gamma}, \qquad b > 0,\ \gamma \in (0,1) & (2)
\end{aligned}
$$

- Aggregate output is given by

$$
Y_t = Y_t^s + Y_t^u. \tag{3}
$$

- SOE assumption implies $r = \bar{r}$ and a constant $k_t = K_t/L_t^s$ such that

$$
\bar{r} = \gamma b k_t^{\gamma-1} - \delta \Rightarrow Y_t^s = b^{\frac{1}{1-\gamma}} \left(\frac{\gamma}{\bar{r}+\delta}\right)^{\frac{\gamma}{1-\gamma}} L_t^s, \tag{4}
$$

and

$$
\begin{aligned}
w_t^s &= (1-\gamma) b k_t^\gamma = (1-\gamma) b^{\frac{1}{1-\gamma}} \left(\frac{\gamma}{\bar{r}+\delta}\right)^{\frac{\gamma}{1-\gamma}}, & (5)\\
w_t^u &= a. & (6)
\end{aligned}
$$

The government

- The pollution stock evolves over time according to

$$P_{t+1} = (1-\eta)P_t + \varepsilon_0 Y_t - \varepsilon_1 A_t, \qquad 0 < \varepsilon_1 < \varepsilon_0,\ \eta \in (0,1), \tag{7}$$

- Government raises income taxes $\tau \in (0,1)$ in order to finance public health expenditures H_t and abatement measures A_t.
- Abstracting from intertemporal debts and assuming constant expenditure shares for public health, ν, and abatement measures, $1-\nu$, a balanced budget in each period requires

$$H_t = \nu G_t, \tag{8}$$

$$A_t = (1-\nu)G_t, \qquad \nu \in (0,1). \tag{9}$$

Households

- An individual born in $t-1$ expects to live for $1+\phi_t$ periods, with $0 \leq \phi_t \leq 1$
- ϕ_t is a non-decreasing function in public health care expenditures, H_t, and a non-increasing function in the pollution stock P_t, such that

$$\frac{\partial \phi(H_t, P_t)}{\partial H_t} \geq 0, \ \frac{\partial \phi(H_t, P_t)}{\partial P_t} \leq 0. \tag{10}$$

  Moreover, the cross-derivative is non-positive, i.e. $\frac{\partial^2 \phi(H_t, P_t)}{\partial H_t \partial P_t} \leq 0$.
- utility in t of an agent j born in $t-1$ reads

$$\bar{u}_t^j = \phi_t[\alpha \ln c_t^j + (1-\alpha) \ln x_t^j] \tag{11}$$

- Given income taxes $\tau \in (0,1)$ and lifetime income y_t^j, we obtain

$$c_t^j = \alpha(1-\tau) y_t^j, \tag{12}$$
$$x_t^j = (1-\alpha)(1-\tau) y_t^j. \tag{13}$$

Demographics

$$u_t^j = \phi_t \left\{ \overbrace{\alpha \ln c_t^j + (1-\alpha) \ln x_t^j}^{\bar{\alpha} + \ln[(1-\tau) y_t^i]} \right\}$$

$t-1$ $\quad$ t

$$u_{t+1}^j = \phi_{t+1} \left\{ \overbrace{\alpha \ln c_{t+1}^j + (1-\alpha) \ln x_{t+1}^j}^{\bar{\alpha} + \ln[(1-\tau) y_{t+1}^i]} \right\}$$

t $\quad$ $t+1$

The credit market

- The credit market is subject to imperfections as in Galor and Zeira (1993) $\Rightarrow$ borrowers' interest rate, i_t, exceeds the world market interest rate, $\bar{r}$.
- In contrast to Galor and Zeira (1993), i_t depends inversely on agents' life expectancy, ϕ_t. Moreover, i_t is not time invariant and affected by public health expenditures and abatement measures

$$i_t = \frac{\beta}{(\beta - 1)} \frac{(1 + \bar{r})}{\phi_t} - 1, \qquad \beta > 1. \tag{14}$$

- Since $\beta > 1$ it follows that $i_t > \bar{r}$.
- Moreover, $\frac{\partial i_t}{\partial \phi_t} < 0$, such that higher health risks increase lenders' credit costs.

The evolution of wealth

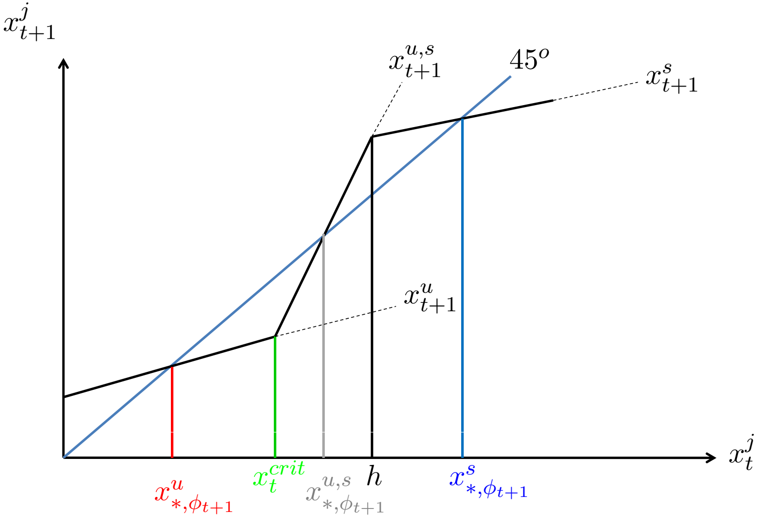
- Whether or not to invest in human capital depends on the level of inherited bequests, i.e. $x_t^j \gtrless h$, and life expectancy ϕ_{t+1}
- Households with $x_t^j \geq h$ invest in human capital, if $u_{t+1}^s \geq u_{t+1}^u$

$$\underbrace{\phi_{t+1} w^s + (x_t^j - h)(1+\bar{r})}_{y_{t+1}^s} \geq \underbrace{\phi_{t+1} w^u + ((1-\tau) w^u + x_t^j)(1+\bar{r})}_{y_{t+1}^u} \quad (15)$$

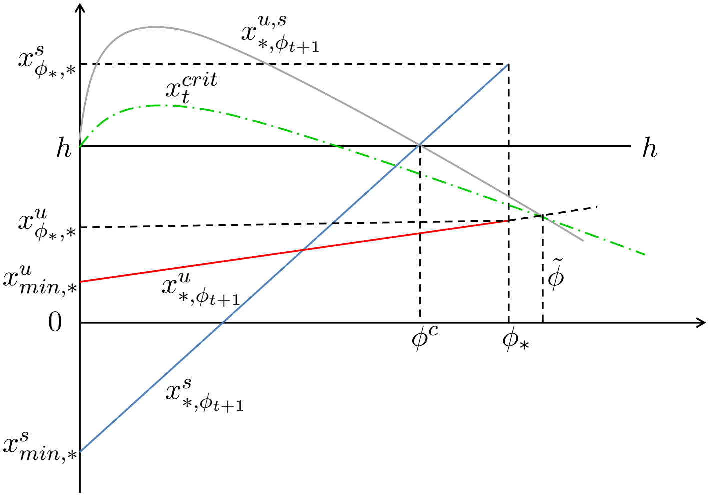
- Households with $x_t^j < h$ wish to invest in human capital, if $u_{t+1}^{u,s} \geq u_{t+1}^u \rightarrow y_{t+1}^{u,s} \geq y_{t+1}^u$
- $y_{t+1}^{u,s} = y_{t+1}^u$ implies a minimum level of inherited wealth necessary to become a skilled worker, $x_t^j = x_t^{crit}$

$$x_t^{crit} = \frac{1}{i_{t+1} - \bar{r}} \Big[(1-\tau) w^u (1+\bar{r}) + h(1+i_{t+1}) - \phi_{t+1}(w^s - w^u) \Big] \quad (16)$$

Dynamics and (conditional) steady states



The evolution of conditional steady states

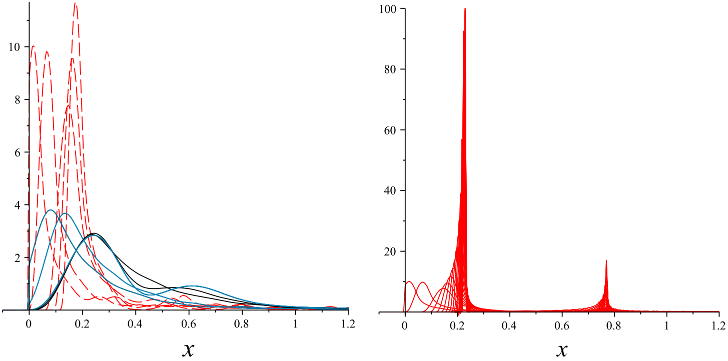


Policy

- change in τ:
  - benefits both population groups, if
    the marginal gain in life expectancy $>$ marginal income loss
  - the marginal gain of the skilled is larger

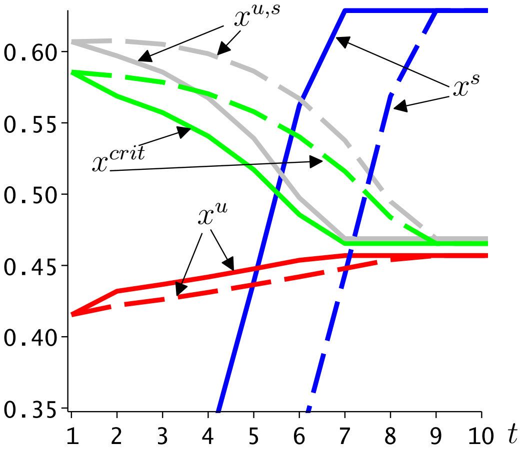
- change in ν
  - benefits both population groups
  - benefits the skilled by more than the unskilled population group

The evolution of the distribution of wealth



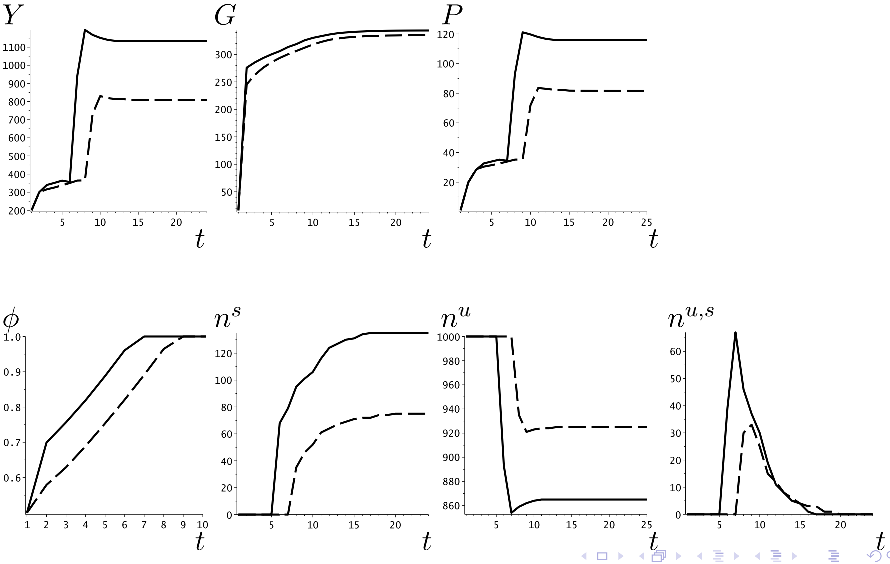
Higher initial inequality

low inequality: solid; high inequality: dashed



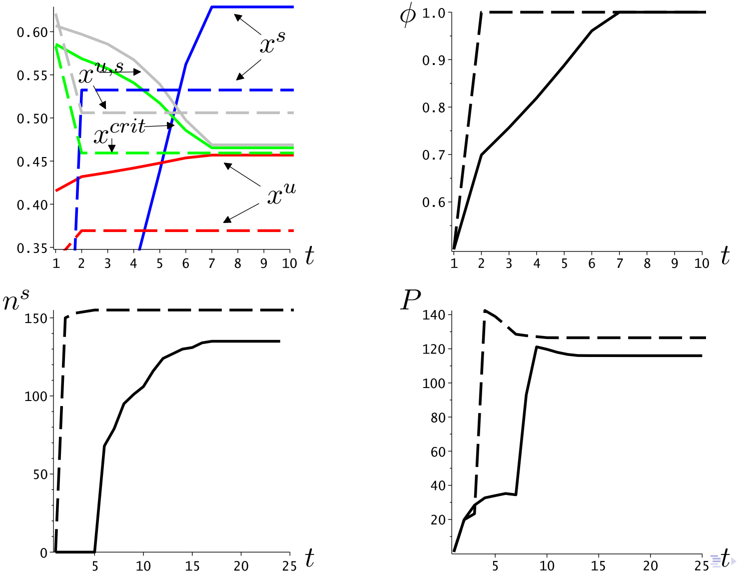
Higher initial inequality

low inequality: solid; high inequality: dashed



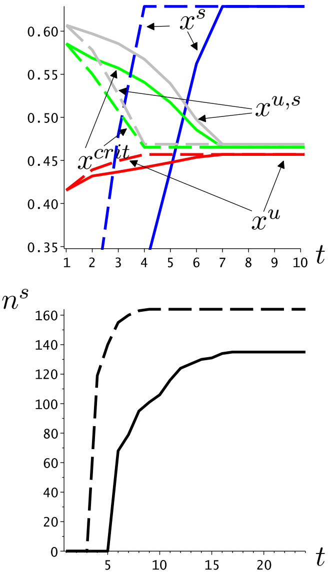
Increase in τ

low τ: solid; high τ: dashed



Increase in ν

low ν: solid; high ν: dashed



Summary and Outlook

- Endogenous take-off in terms of human capital accumulation
- Higher initial inequality delays the take-off, since the tax base is reduced

$\rightarrow$ higher inequality reduces the effectiveness of a given set of policy parameters in terms of health and abatement expenditures shares

- An increase in the share of public health expenditures seems to be advantageous since it leaves disposable incomes unaffected but increases tax revenues
- Next steps: endogenous policies and asymmetric effects of pollution on skilled and unskilled households