

From Duty to Right: The Role of Public Education in the Transition to Aging Societies

By

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Objective

Develop a growth theory to analyze:

- changing role of public education in the process of economic development;
- allocation of government resources between generations (i.e., endogenous policy);
- population aging and economic-growth slowdown in the long-run.

Key Elements

1. The notion of public education

Duty: poor households rely on child labor

Right: education investment is desirable

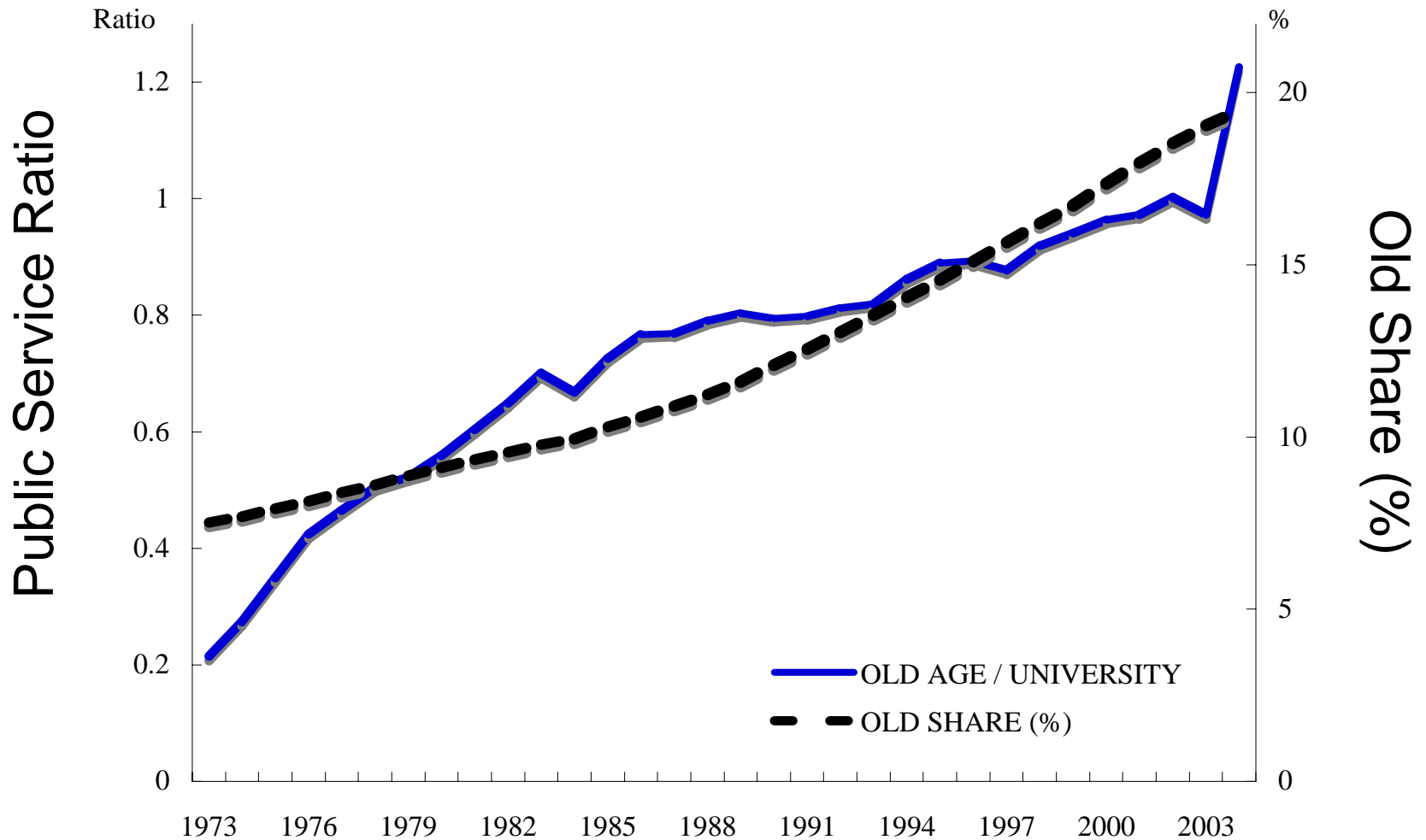
2. Generational Conflict

Old: Pensions and Social Securities

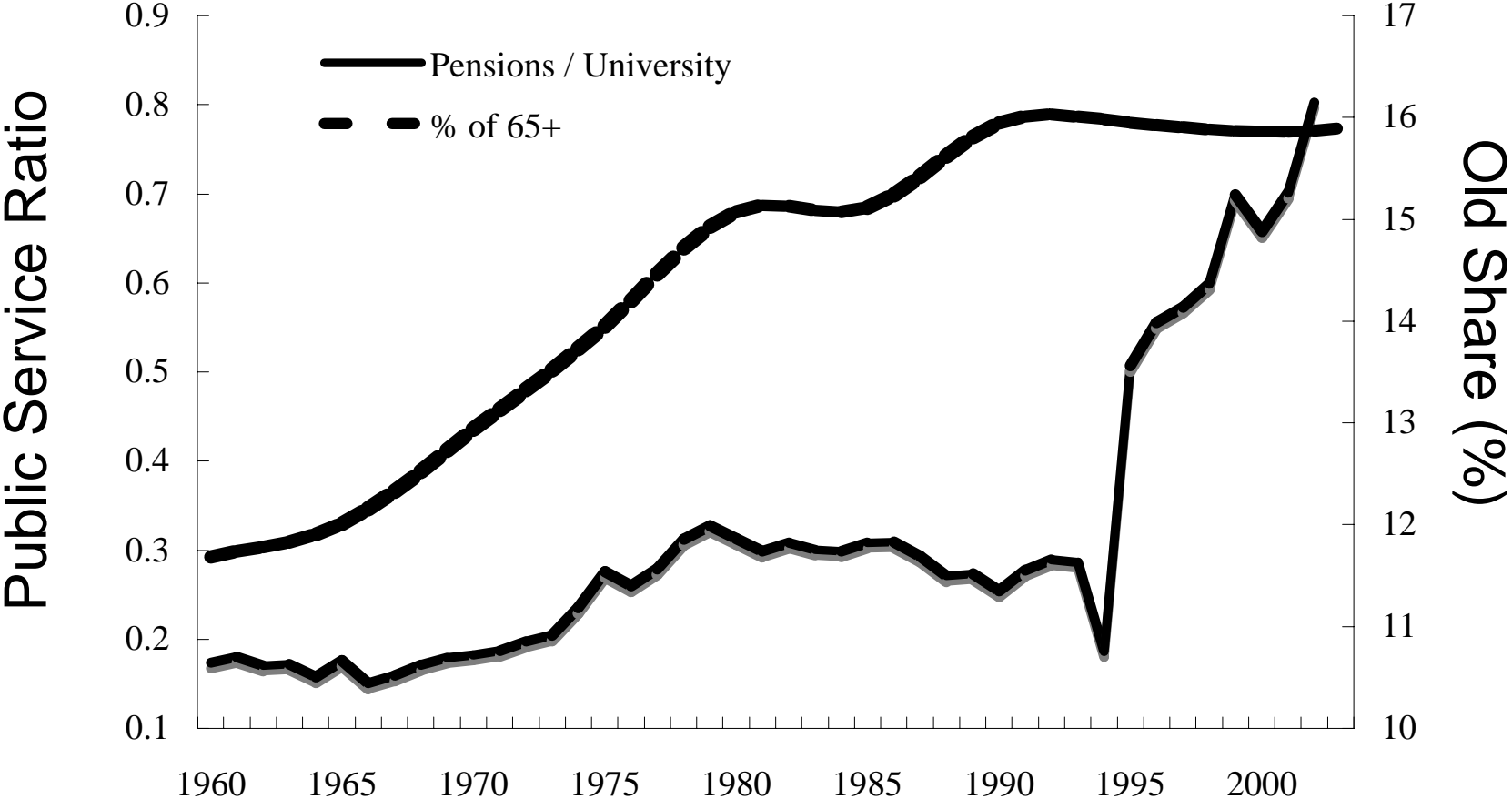
Young: Education and Child Care

Note: Relative political power changes with the age structure

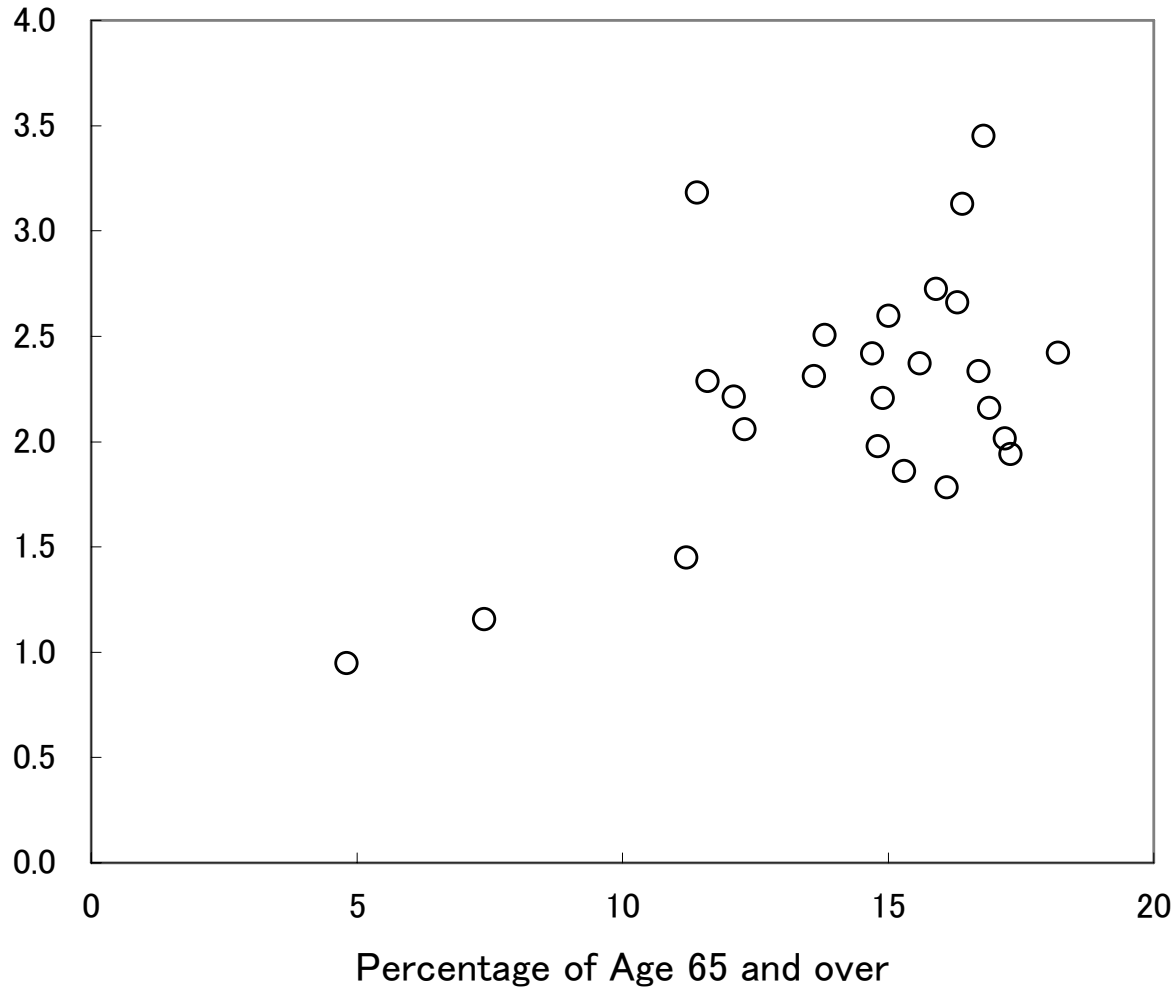
Political Bias in Japan: 1973-2004



Political Bias in the UK: 1960-2002



Political Bias in OECD Countries 2000



Central Argument

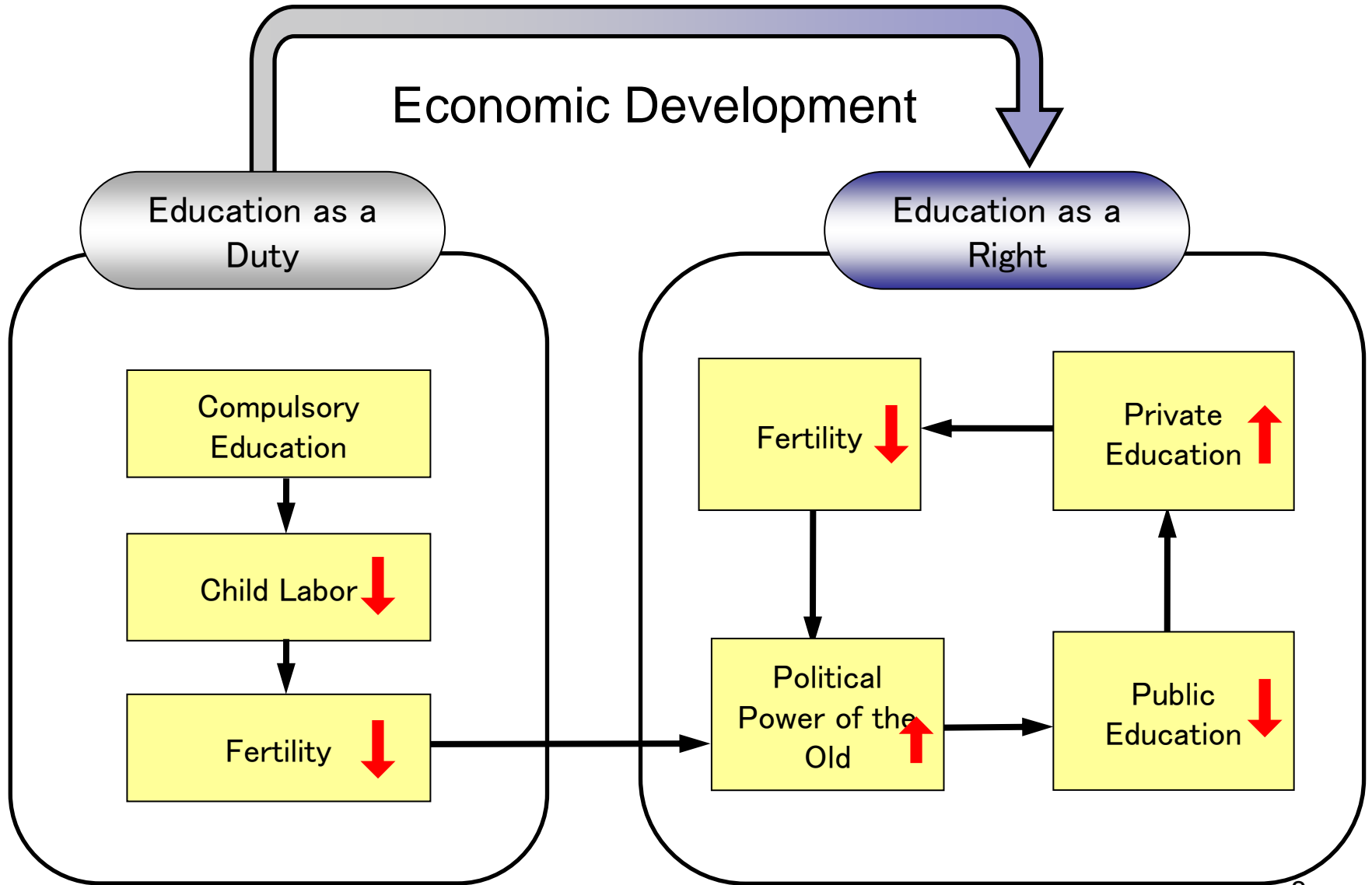
Education and Population in the Growth Process:

Stage of Public Education as a Duty

- Compulsory schooling prohibits child labor and retards population growth

Stage of Public Education as a Right

- Vicious cycle between undersupply of public education and population ageing



Literature Review

1. Galor and Moav (2006)

Birth of public schooling on the course of industrialization

→ No population growth

2. Doepke and Zilibotti (2005)

Legislation of child labor laws and fertility decline

→ Child labor laws \approx Education as a duty

→ No transition of public education from duty to right

3. Holtz-Eakin et al. (2004)

Educational policy determined through generational conflict

→ Exogenous population growth

By contrast, this Paper...

- Analyzes the **interaction** between educational policy and population growth;
- Reveals the changing effects of educational policy on fertility;
- Demonstrates the rise and fall of educational policy.

The Features of the Model

1. Quantity-Quality trade-off
2. Substitutability b/w Public and Private Education
3. Public education as a Child Labor Regulation
4. Skill (Age)-biased Tech Progress
5. Generational Conflict

The Evolution of the Economy

Stage I:

- No HC Investment
- Tech progress driven by population growth

Stage II:

- Legislation of public education, which is a duty for the poor
- Fertility Decline

Stage III:

- Public education as a right for the young
- >Political Conflict with the Elderly

The Evolution of Fertility in Stage III

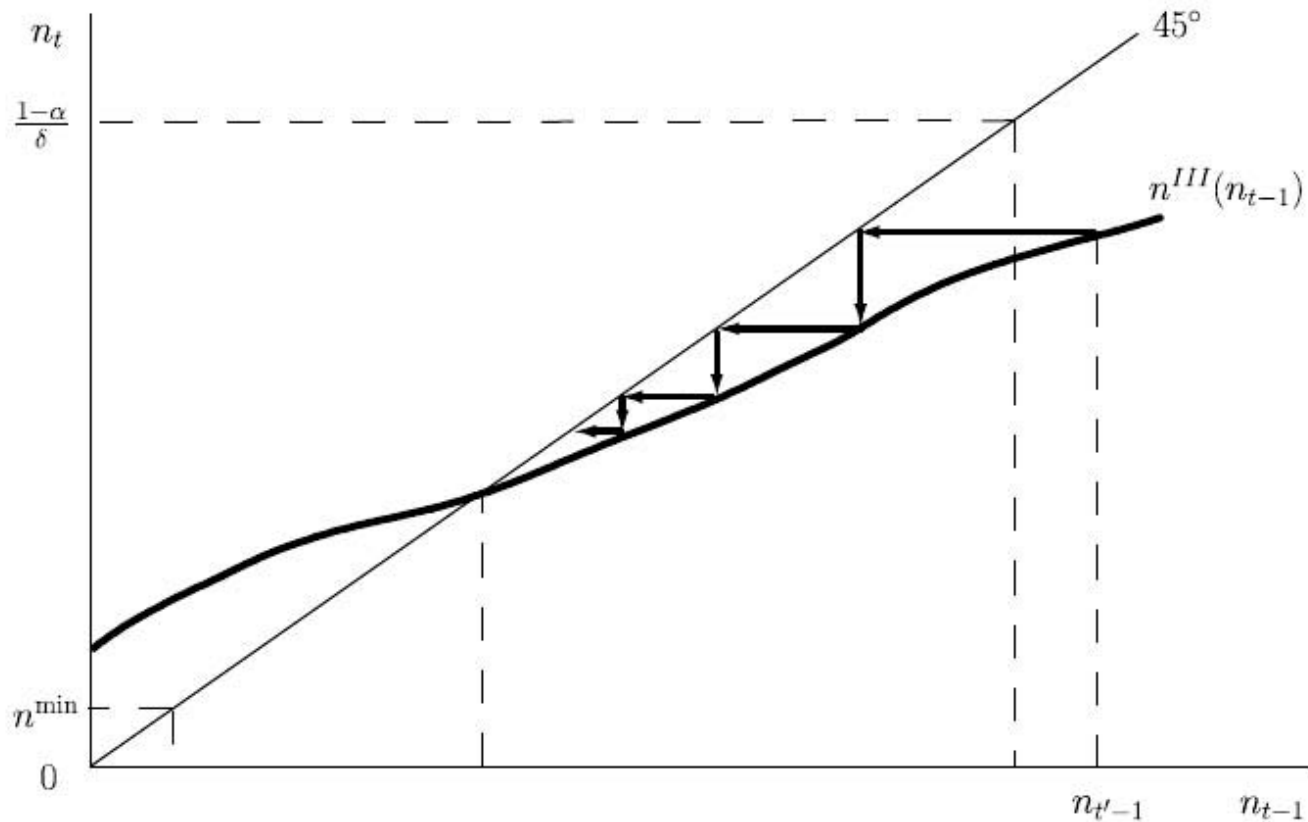


Figure 3. The Evolution of Fertility in Stage III

Economic Growth Slowdown

The size of population may shrink toward **zero** in the long run.



The growth rate of technology converges to **zero** in the long run:

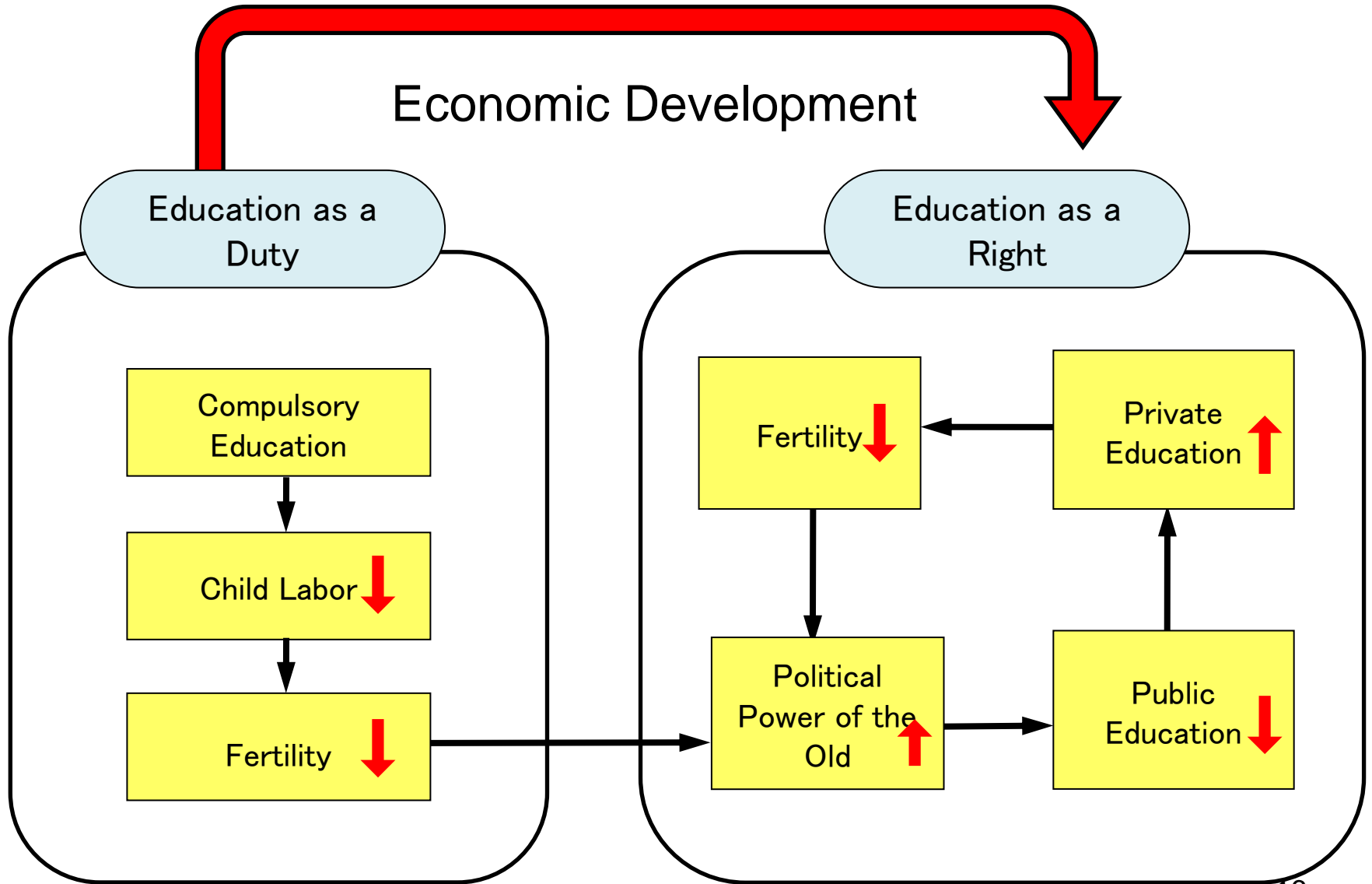
Policy Implication

Education Policy works as a means to:

- support child care;
- prevent population aging and economic-growth slowdown;

only if the productivity of public education is high.

Economic Development



Implication

e_t^G : the quantity of public education

Therefore, $|h_{12}(e_t^i, e_t^G)|$ is sufficiently large
when...

public education has high quality
competitive with private education

Technological Progress

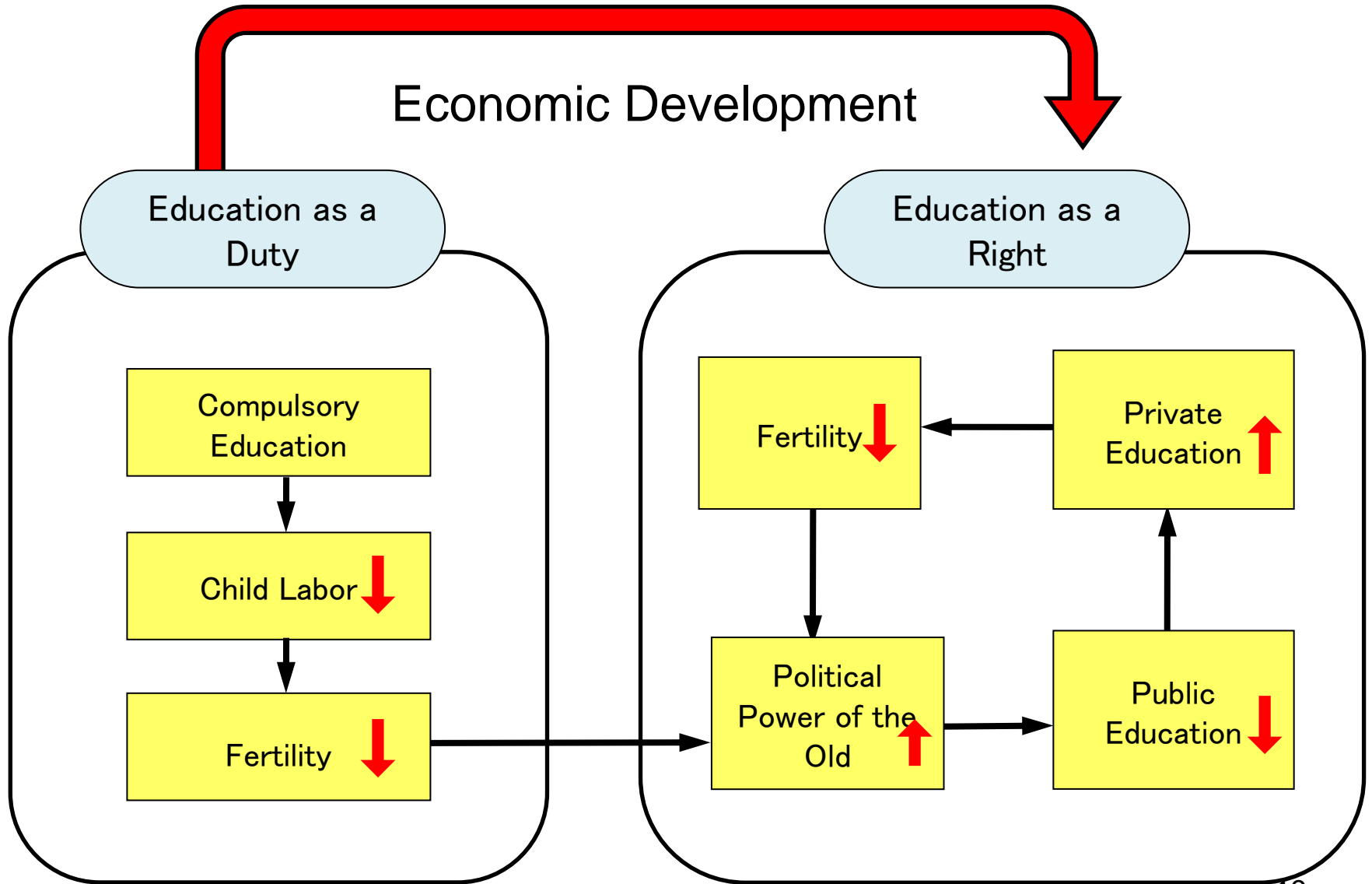
$$\frac{A_{t+1} - A_t}{A_t} = g(H_{t+1})$$

where

$$g(0) = 0$$

$$g'(H) > 0 \quad \forall H \geq 0$$

Economic Development



Skill Acquisition

$$h_{t+1}^i = a^i h(e_t^i, e_t^G)$$

where

e_t^i : Private Education

e_t^G : Public Education

$h_j > 0$, $h_{jj} < 0$ and $h_{12} < 0$

i.e., Private and public edu are substitute.

Aggregate Human Capital

$$H_{t+1} = \sum_{i=R,P} \left(h_{t+1}^i N_{t+1}^i T_{t+1}^i \right)$$

Note: Agg HC depends on fertility rates as well as skill levels

Production

- Closed OLG Economy
- Single final good
- Two independent production sectors
- Employ only labor
(children, adults, and the elderly)

Sector A

Employ only adult workers

$$Y_t^A = A_t H_t$$

where

A_t ... Technology Level

H_t ... Efficiency units of labor

Sector B

- Less advanced technology
- Employ child and old workers

$$Y_t^B = \bar{w} L_t$$

\bar{w} ...stationary level of technology

L_t ... number of workers

Households

- Live and work for 3 periods
- Born in period $t-1$
- Belong to group i

1st period ($t-1$): work and education

2nd period (t): work and child-rearing

3rd period ($t+1$): work and consume public good x

1st period (childhood)

- Work in Sector A to earn ω_t^i
- Receive public and/or private education
- Consume a time fraction δ of her parent

2nd period (adulthood)

- Acquire h_t units of efficiency labor
- Work in Sector A to obtain $w_t h_t$
- Choose the quantity and quality of children
 - > determines the work time of children

Income in the 2nd Period

$$I_t^i = z_t^i \left[1 - (\delta + e_t^i - \omega_t^i) n_t^i \right]$$

where

z_t^i : her potential income

e_t^i : private education for children

ω_t^i : child labor income

n_t^i : number of children

3rd period (elderhood)

- Work in Sector B
- Spend income on consumption
- Enjoy the public service for the elderly, x_{t+1}

Income in the 3rd Period

$$I_t^3 = \bar{w} = c_{t+1}^3$$

where

\bar{w} : stationary wage rate in Sector B

c_{t+1}^3 : consumption in elderhood

Lifetime Utility Function

$$U_t^i = u_t^i + \rho_t^i u_{t+1}^3$$

where

ρ_t^i : income-dependent discount rate

u_t^i : instantaneous utility in 2nd period

u_{t+1}^3 : instantaneous utility in 3rd period

Utility in Adulthood

$$u_t^i = \alpha \ln c_t^i + (1 - \alpha) \ln n_t^i$$

where

c_t^i : consumption

n_t^i : number of children

Utility in Elderhood

$$u_{t+1}^3 = (1 - \beta) \ln \min(\gamma c_{t+1}^3, x_{t+1}) + \beta \ln h_{t+1}^i$$

where

c_{t+1}^3 : consumption

x_{t+1} : public good for the elderly

h_{t+1}^i : human capital of her child (who is adult in period $t+1$)

Supply of Child Labor

$$l_t^i = l(e_t^i + e_t^G)$$

e_t^i : Private Education

e_t^G : Public Education

$$l(0) = 1; \quad l(e) = 0 \quad \forall e \geq \hat{e}$$

-> Public Education restricts child labor

Child Labor Wage

$$\omega_t^i = \frac{\bar{w} \cdot l(e_t^i + e_t^G)}{z_t^i} \equiv \omega(e_t^i, e_t^G, z_t^i)$$

where

\bar{w} : Wage rate in sector B

ω_t^i : Child labor wage

z_t^i : Potential income of her parent

Human Capital

$$h_{t+1}^i = a^i h(e_t^i, e_t^G)$$

where

a^i : ability of group i

$$h_j > 0, \quad h_{jj} < 0 \quad \text{and} \quad h_{12} < 0$$

i.e. private and public edu are substitute

Optimization (Adulthood)

Price takers with perfect foresight

Maximize the objective function:

$$\begin{aligned} v_t^i &= \left\{ (1 - \alpha) \ln \left[1 - \left(\delta + e_t^i - \omega(e_t^i, e_t^G, z_t^i) \right) n_t^i \right] \right. \\ &\quad \left. + \alpha \ln n_t^i + \rho(z_t^i) \beta \ln h(e_t^i, e_t^G) \right\} \\ &\equiv v(n_t^i, e_t^i, e_t^G, z_t^i) \end{aligned}$$

Private Education

$$e_t^i = e(e_t^G, z_t^i) \equiv \begin{cases} 0 & \text{if } \bar{w} / \delta < z_t^i < z^* \\ \phi(e_t^G) \geq 0 & \text{if } z_t^i \geq z^* \end{cases}$$

where

$$\phi(e_t^G) + e_t^G > \hat{e} \quad \text{and} \quad \phi'(e_t^G) < 0 \quad \forall e_t^G < \hat{e}$$

Fertility

$$n_t^i = n(e_t^G, z_t^i) \equiv \begin{cases} \frac{1-\alpha}{\delta - \omega(0, e_t^G, z_t^i)} > 1 & \text{if } \bar{w}/\delta < z_t^i < z^* \\ \frac{1-\alpha}{\delta + \phi(e_t^G)} > 0 & \text{if } z_t^i \geq z^* \end{cases}$$

Note: The effect of public education changes qualitatively

The Government

Tax on adult individuals every period

-> obtains $\alpha\tau N_t$ units of time

Allocate the tax revenues between

- Public education for children
- Public service for the elderly

Supply of Public Education

$$e_t^G = \frac{\alpha \tau \varepsilon_t}{n_t}$$

ε_t : budget share of public education

$n_t \equiv N_{t+1} / N_t$: growth rate of population

Public Service for the Elderly

$$x_t = \frac{(1 - \varepsilon_t) \alpha \tau N_t}{N_{t-1}} = (\alpha \tau - e_t^G n_t) n_{t-1}$$
$$\equiv x(e_t^G, n_t, n_{t-1})$$

n_{t-1} : adult/old ratio

n_t : child/adult ratio

Technological Progress

$$g_t \equiv \frac{A_{t+1} - A_t}{A_t} = g(H_{t+1})$$

$$g(0) = 0$$

$$g'(H) > 0 \quad \forall H \geq 0$$

Aggregate Human Capital

$$\begin{aligned} H_{t+1} &= \sum_{i=R,P} \left(h_{t+1}^i N_{t+1}^i T_{t+1}^i \right) \\ &= \alpha N_t \left[q_t n_t^R h_{t+1}^R + (1 - q_t) n_t^P h_{t+1}^P \right] \geq \alpha N_{t+1} \end{aligned}$$

q_t : share of group R among adults

Note: Agg HC depends on fertility rates as well as skill levels

Class Structures

Group R ... high ability when adult

Group P ... low ability when adult

$$a^R > a^P$$

Recall that: $h_{t+1}^i = a^i h(e_t^i, e_t^G)$

Note: Individuals are identical in 1st and 3rd period.

Initial Conditions

$$h_0^R = \alpha^R > h_0^P = 1$$

$$N_0^R = q_0 N_0 > 0$$

$$\bar{w} / \delta < (1 - \tau) A_0 < z^* / a^R$$

q_0 : fraction of group R among adults

The Political System

$$e_t^G = \lambda_t \left[\theta e_t^{GR} + (1 - \theta) e_t^{GP} \right] + (1 - \lambda_t) e_t^{G3}$$

Where $\lambda_t \in (0,1)$

λ_t : political power of the adult generation

θ : political power of group R among the adult generation

$$\lambda_t = \lambda(n_{t-1}) \quad \forall n_{t-1} \geq 0$$

Policy Preferences

Adult Individuals' desirable edu policies:

$$e_t^{Gi} = \arg \max v(n_t^i, e_t^i, e_t^{Gi}, z_t^i)$$
$$= \begin{cases} 0 & \text{for } z_t^i < z^* \\ \tau & \text{for } z_t^i \geq z^* \end{cases}$$

Policy Preferences

The Elderly's Objective Function

$$v_t^3 = \min[\gamma \bar{w}, x(e_t^G, n_t, n_{t-1})]$$

Policy Preferences

The Elderly's Desirable Policy

$$e_t^{G3} = \begin{cases} e_t^{G2} & \text{if } e_t^{G2} \leq \bar{e}_t \\ \max(\bar{e}_t, 0) & \text{if } e_t^{G2} > \bar{e}_t \end{cases}$$

\bar{e} is such that $\gamma \bar{w} = x(\bar{e}_t, n_t, n_{t-1})$

Stage I: Economic Growth Driven by Pop Expansion

$$z_t^P < z_t^R < z^* \quad \forall t < t^*$$

It follows that

$$\rho_t^R = \rho_t^P = 0$$

Education and CL in Stage I

$$\left. \begin{aligned} e_t^i &= e_t^{Gi} = e_t^G = 0 \\ z_t^i &= (1 - \tau) a^i A_t \\ l_t^R &= l_t^P = l(0) = 1 \end{aligned} \right\} \forall t \in [0, t^*]$$

All children work and receive no education

Fertility in Stage I

$$1 < n_t^R = \frac{1-\alpha}{\delta - \bar{w} / z_t^R} < n_t^P = \frac{1-\alpha}{\delta - \bar{w} / z_t^P}$$

$$n_t \equiv \frac{N_{t+1}}{N_t} = \frac{N_{t+1}^R + N_{t+1}^P}{N_t} = q_t n_t^R + (1 - q_t) n_t^P$$

Note: $q_{t+1} \leq q_t$

--> the group R is decreasing its share over time

Note: the trend of n_t is ambiguous

Stage II: Education Reform with Class Conflict

$$z_t^P < z^* < z_t^R \quad \forall t \in [t^*, t')$$

It follows that

$$\rho_t^R = \rho > \rho_t^P = 0$$

i.e., only group R cares about HC of their children

Educational Policy in Stage II

$$e_t^{GR} = \tau > e_t^{GP} = 0 \quad \forall t \in [t^*, t')$$

i.e., Education is undesirable for the poor

$$e_t^G = \theta\tau < \hat{e} \quad \forall t \in [t^*, t')$$

Private Edu and CL in Stage II

$$e_t^R = \phi(\theta\tau) > e_t^P = 0 \quad \forall t \in [t^*, t')$$

$$l_t^R = l(\phi(\theta\tau) + \theta\tau) = 0; \quad l_t^P = l(\theta\tau) > 0$$

$$\forall t \in [t^*, t')$$

Potential Income in Stage II

$$\left. \begin{aligned} z_t^R &= (1 - \tau)A_t a^i h(\phi(\theta\tau), \theta\tau) \\ z_t^P &= (1 - \tau)A_t h(0, \theta\tau) \end{aligned} \right\} \forall t \in (t^*, t']$$

reflecting between-group inequality in private education.

Public Education as a Duty

Given n_t^i , education level e_t^{GR} would reduce consumption of group P, which is

$$c_t^P = z_t^P \left[1 - \left(\delta - w(0, e_t^G, z_t^P) \right) n_t^P \right]$$

$$\forall t \in [t^*, t')$$

Fertility in Stage II

$$n_t^R = \frac{1-\alpha}{\delta + \phi(\theta\tau)}; \quad n_t^P = \frac{1-\alpha}{\delta - \omega(0, \theta\tau, z_t^P)} > 1$$

Population Growth in Stage II

$$n_t = q_t n_t^R + (1 - q_t) n_t^P$$

Proposition: If the initial share of group R, q_0 , is sufficiently small under (A1)-(A4),

education policy in period $t \in [t^*, t')$
decreases the average fertility n_t

Stage III: Social Ageing & Generational Conflict

$$z^* < z_t^P < z_t^R \quad \forall t \geq t'$$

It follows that

$$\rho_t^R = \rho_t^P = \rho > 0$$

i.e., All individuals care about HC of their children

Private Edu and CL in Stage III

$$e_t^R = e_t^P = \phi(e_t^G) > 0 \quad \forall t \geq t'$$

$$l_t^R = l_t^P = l(\phi(e_t^G) + e_t^G) = 0 \quad \forall t \geq t'$$

i.e., No CL regardless of educational policy

Educational Policy in Stage III

$$e_t^G = \lambda(n_{t-1})\tau + [1 - \lambda(n_{t-1})]\bar{e}(n_t, n_{t-1})$$

$$\equiv e^G(n_t, n_{t-1})$$

$$\forall t \geq t'$$

Fertility in Stage III

$$n_t^R = n_t^P = n_t = \frac{1 - \alpha}{\delta + \phi(e_t^G)} \quad \forall t \geq t'$$

The fertility rate of group P above is lower than that in the previous stages, as they no longer use child labor

Proposition 5

The growth rate of technology, g_t , converges to zero in the long run under (A1)-(A5) with the following conditions

(a) Public education is sufficiently productive;

i.e., $h_2(e_t^i, e_t^G)$ is sufficiently large for all $(e_t^i, e_t^G) \geq 0$

Assumptions

- (A1) $D^h(\hat{e}, \hat{e}) = \rho\beta h(\hat{e}, \hat{e})(\delta + \hat{e}) - \alpha h(\hat{e}, \hat{e}) > 0$

- (A2) $\tilde{z} < z^*$

- (A3)
$$\begin{cases} h_0^R = \alpha^R > h_0^P = 1 \\ N_0^R = q_0 N_0 \\ \bar{w} / \delta < (1 - \tau) A_0 < z^* / a^R \end{cases}$$

Assumptions

- (A4) $\theta\tau < \bar{e}^{\min} < \hat{e}$
- (A5) $\bar{e}^{\max} < \tau < \hat{e}$

Proposition 5

The growth rate of technology, g_t , converges to zero in the long run under (A1)-(A5) with the following conditions:

(b) The substitutability between public and private education is sufficiently strong;

i.e., $h_{12}(e_t^i, e_t^G)$ is sufficiently small for all $(e_t^i, e_t^G) \geq 0$

Implication

e_t^G ; the quantity of education

Therefore, those conditions on the h function are satisfied when...

public education has high quality
competitive with private education

Implication

Educational Policy works as a means to:

- support child care;
- prevent population ageing and economic-growth slowdown;

only if the quality of public education is high.