From Physical to Human Capital Accumulation: Inequality in the Process of Development

Oded Galor and Omer Moav

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- Captures the changing role of inequality in the growth process
- Unifies the Classical and the Modern Paradigms
- Provides an intertemporal reconciliation between conflicting viewpoints about the effect of inequality on economic growth
- Generates novel testable predictions that may resolve empirical disputes about the relationship between inequality and growth

The Classical Approach

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$\Longrightarrow$ enhances the development process

The Credit Market Imperfections Approach:

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- CMI increases the cost of investment in human capital for less endowed individuals
- Inequality increases the fraction of society for which investment in human capital is suboptimal

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$\Longrightarrow$ reduces human capital accumulation

$\Longrightarrow$ slows down the development process

A Unified Theory of Inequality and Development

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- Later stages of development: the return to human capital increases due to capital-skill complementarity and human capital became the prime engine of growth $\Longrightarrow$
  - Inequality, due to credit constraints, is harmful for growth

Central Argument

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Fundamental asymmetry between:

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- Physical capital is not embodied in humans $\Longrightarrow$
  - Physical capital accumulation may benefit from the concentration of wealth among individuals whose marginal propensity to save is larger

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- **Inequality** is harmful for economic growth in stages of development in which **human capital** accumulation is the prime engine of economic growth and credit constraints are still binding

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$\Longrightarrow$ Inequality is conducive for growth

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- A negative effect of inequality on growth underlined by the **Modern Approach** reflects later stages of development when human capital accumulation becomes a prime engine of growth, and credit constraints are still binding

The Basic Structure of the Model

- Overlapping-Generations economy

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- Two factors:
  - Physical capital (PC)
  - Human Capital (HC)

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- The level of HC: Outcome of education decisions, subject to borrowing constraint

Production of Final Output

The output produced at time t :

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K_t - PC

H_t - HC (efficiency units)

$k_t \equiv K_t / H_t$

Factor Prices

Inverse demand for factors of production at time t

$$\begin{aligned} r_t &= f'(k_t) \equiv r(k_t) \\ w_t &= f(k_t) - f'(k_t)k_t \equiv w(k_t) \end{aligned}$$

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- Differ in:

  Parental income $\Rightarrow$ Inv't in HC

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  - Saving for offspring's future wealth

Individual i of Generation t: Wealth

Second period wealth:

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w_{t+1} – wage

h^i_{t+1} – efficiency units of labor

x^i_{t+1} – inheritance

Individual i of Generation t: Budget Constraint

Second Period budget constraint:

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Second Period budget constraint:

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b^i_{t+1} – transfers to the offspring

Individual i of Generation t: Intergenerational Transfers

Transfer to offspring, b^i_{t+1}, is allocated between:

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- Inheritance

$$x^i_{t+1} = s^i_t R_{t+1} = (b^i_t - e^i_t) R_{t+1}$$

Individual i of Generation t: Human capital formation

Efficiency units of labor in period $t+1$

$$h^i_{t+1} = h(e^i_t)$$

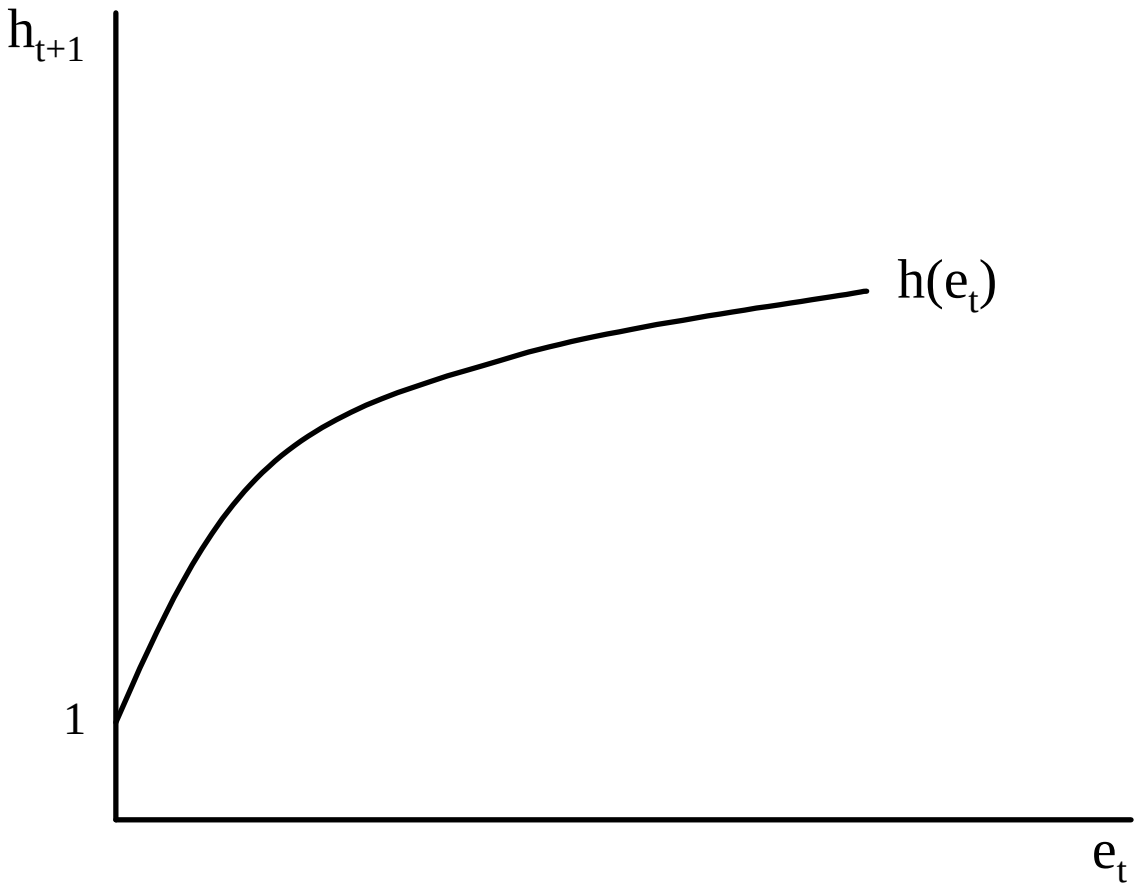
Individual i of Generation t: Human capital formation

Efficiency units of labor in period $t+1$

$$h^i_{t+1} = h(e^i_t)$$

e^i_t – expenditure on education

Individual i of Generation t: Human capital formation



Optimal Inv't in Education of Member i of Generation t

In the absence of borrowing constraints:

$$e_t^i = \arg\max[w_{t+1} h(e_t^i) + (b_t^i - e_t^i) R_{t+1}]$$

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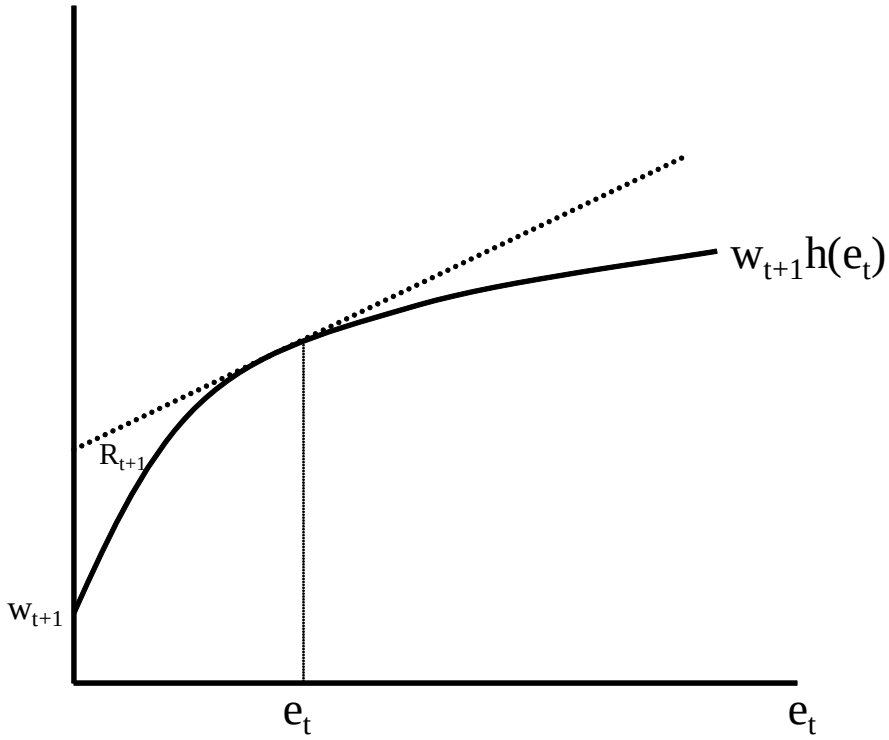
e_t is unique and identical across members of generation t

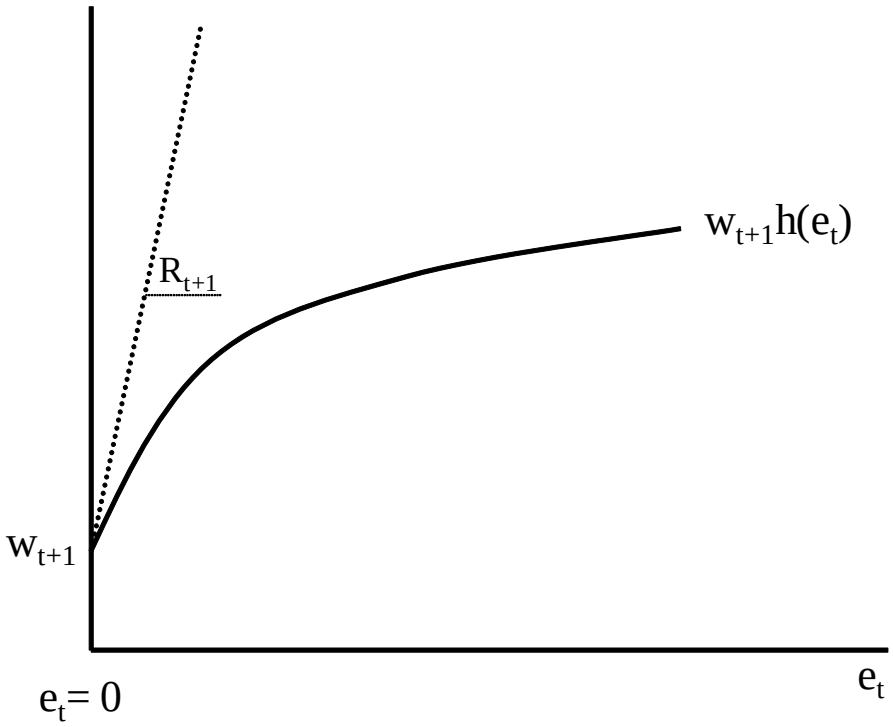
Optimal Inv't in Education of Member i of Generation t

$$e_t > 0 \qquad \text{if} \qquad w_{t+1} h'(e_t) = R_{t+1}$$



Optimal Inv't in Education of Member i of Generation t

$$e_t = 0 \qquad \text{if} \qquad R_{t+1} > w_{t+1} h'(0)$$



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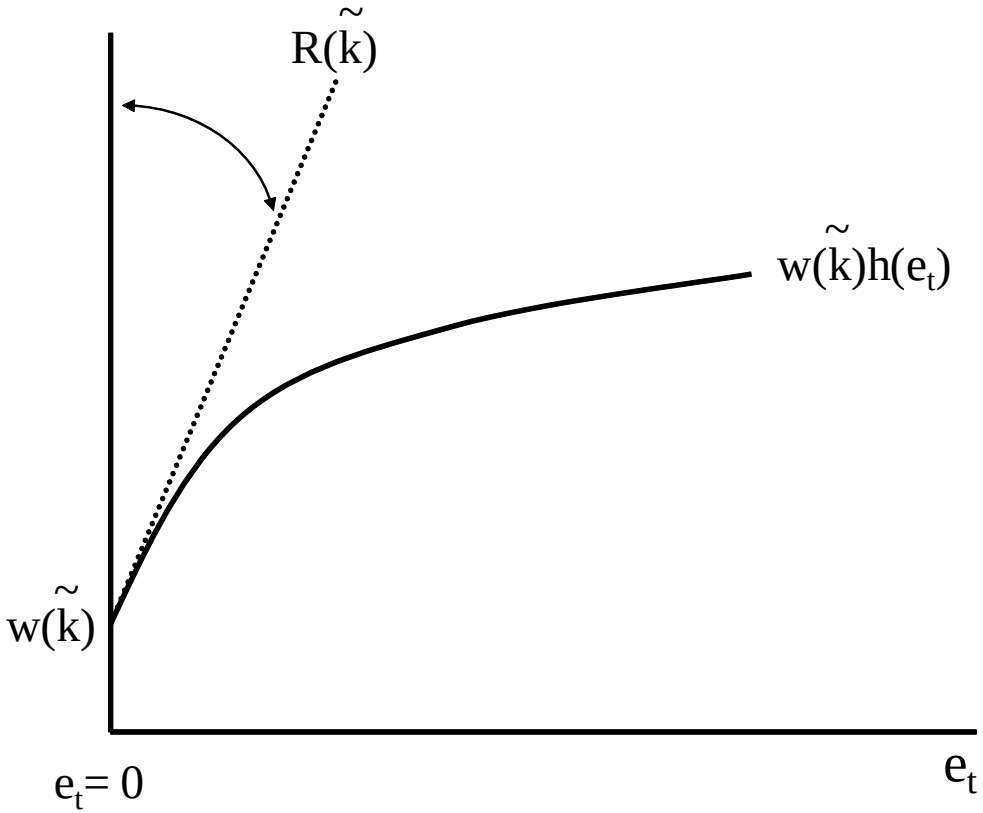

Optimal Inv't in Education of Member i of Generation t

$$e_t = e(k_{t+1}) \begin{cases} = 0 & \text{if} \quad k_{t+1} \leq \widetilde{k} \\ > 0 & \text{if} \quad k_{t+1} > \widetilde{k} \end{cases}$$

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$$e'(k_{t+1}) > 0 \quad \text{if} \quad k_{t+1} > \widetilde{k}$$

Borrowing Constraint of Member i of Generation t

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$$e_t^i = \min\left[e(k_{t+1}), b_t^i\right]$$

Preferences and Transfers of Member i of Generation t

- Preferences:

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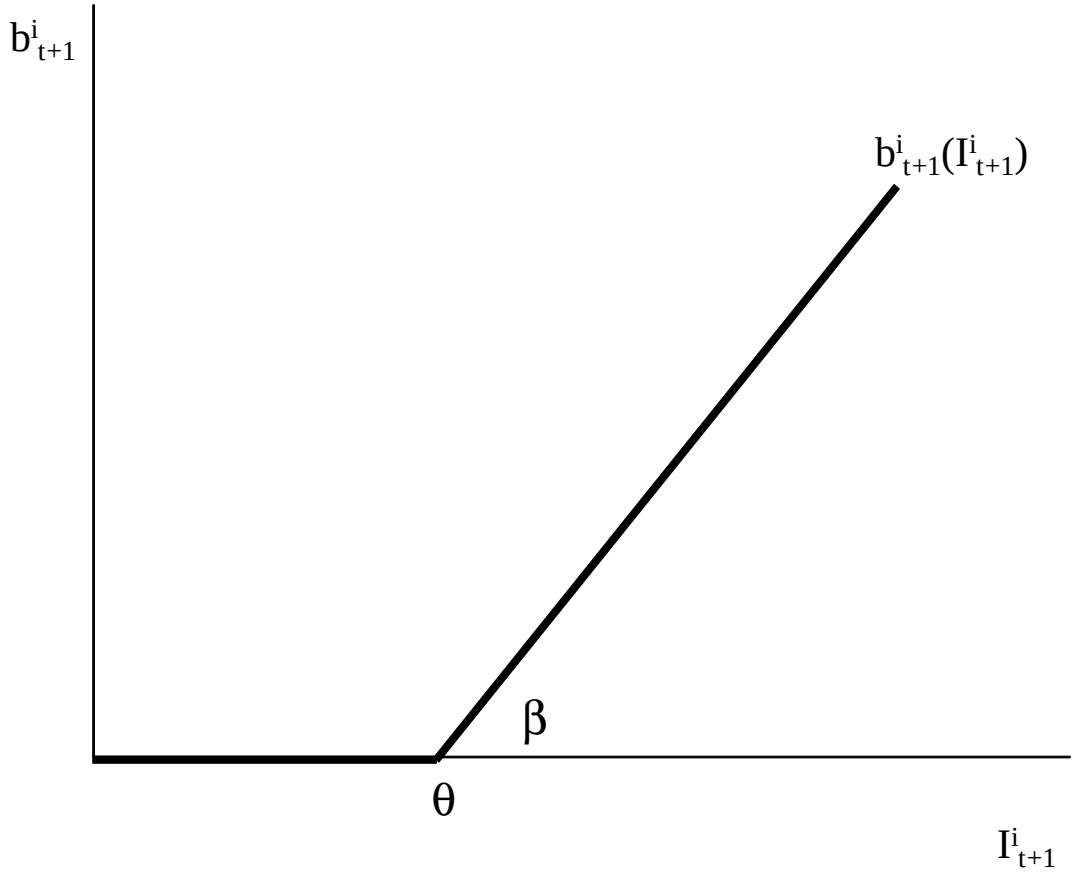
- Optimal transfer to offspring:

$$b_{t+1}^i = b(I_{t+1}^i) \equiv \begin{cases} \beta(I_{t+1}^i - \theta) & \text{if} \quad I_{t+1}^i \geq \theta \\ 0 & \text{if} \quad I_{t+1}^i \leq \theta \end{cases}$$

where $\theta \equiv \overline{\theta}(1-\beta)/\beta$

Optimal transfer of a member i of generation t



Saving of Member i of Generation t

$$s_t^i = \begin{cases} b_t^i & if \quad k_{t+1} \leq \widetilde{k} \\ b_t^i - e_t^i & if \quad k_{t+1} > \widetilde{k} \end{cases}$$

Saving of Member i of Generation t

$$s_t^i = \begin{cases} b_t^i & if \quad k_{t+1} \leq \widetilde{k} \\ b_t^i - e_t^i & if \quad k_{t+1} > \widetilde{k} \end{cases}$$

Saving rate $s_{t+1}^i / \ I_{t+1}^i$ is increasing in I_{t+1}^i

Initial Wealth Distribution

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  - Fraction $1-\lambda$ of all adult individuals
  - No ownership over the *initial* capital stock

Factor Accumulation

$$
\begin{aligned}
K_{t+1} &= \int_0^1 s_t^i di = \lambda(b_t^R - e_t^R) + (1-\lambda)(b_t^P - e_t^P) \\
&= K(b_t^R, b_t^p, k_{t+1}) \\
H_{t+1} &= \int_0^1 h_{t+1}^i di = \lambda h(e_t^R) + (1-\lambda) h(e_t^P) \\
&= H(b_t^R, b_t^P, k_{t+1})
\end{aligned}
$$

The Capital-Labor Ratio

$$k_{t+1} = \frac{K_{t+1}}{H_{t+1}} = \frac{K(b_t^R, b_t^P, k_{t+1})}{H(b_t^R, b_t^P, k_{t+1})}$$

$$\Longrightarrow$$

$$k_{t+1} = \kappa(b_t^R, b_t^P)$$

The Evolution of Transfers within group i = R,P

$$b^i_{t+1} = \max\{\beta[w_{t+1}h(e^i_t) + (b^i_t - e^i_t)R_{t+1} - \theta], 0\}$$

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$$\Longrightarrow$$

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There exists $\widehat{k}$, a critical level of k below which individuals who do not receive parental transfers (i.e., $b^i_t = e^i_t = 0$) do not transfer income to their offspring: $w(\widehat{k}) = \theta$

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$$b^i_{t+1} = \phi(0, k_{t+1}) \begin{cases} = 0 & if \quad k_{t+1} \leq \widehat{k} \\ > 0 & if \quad k_{t+1} > \widehat{k} \end{cases}$$

The Evolution of Transfers within Group i =R,P

$$b^i_{t+1} = \phi(b^i_t, k_{t+1}) = \phi(b^i_t, \kappa(b^R_t, b^P_t))$$

$$\equiv \psi^i(b^R_t, b^P_t)$$

The dynamical system

$\{b_t^P, b_t^R\}_{t=0}^{\infty}$ such that:

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The Process of Development

- Regime I: PC Accumulation $(k \leq \widetilde{k})$

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- Regime I: PC Accumulation $\left(k \leq \widetilde{k}\right)$
- Regime II: HC Accumulation $\left(k > \widetilde{k}\right)$
  - Stage I of Regime II $\left(\tilde{K} < K \leq \hat{K}\right)$

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  - Stage III of Regime II $(K > K^*)$

Regime I: Physical Capital Accumulation

Early stages of development $(k \leq \widetilde{k})$

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Early stages of development $\left(k \leq \widetilde{k}\right)$

- K is the main engine of growth: $\rho^{HC} < \rho^{K}$
- No investment in education

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- No Transfers within Group P

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- K is the main engine of growth: $\rho^{HC} < \rho^{K}$
- No investment in education
- No Transfers within Group P
- Transfers within Group R $\uparrow$

Regime I: Physical Capital Accumulation

Early stages of development $(k \leq \widetilde{k})$

- K is the main engine of growth: $\rho^{HC} < \rho^{K}$
- No investment in education
- No Transfers within Group P
- Transfers within Group R $\uparrow$
- Wages $\uparrow$

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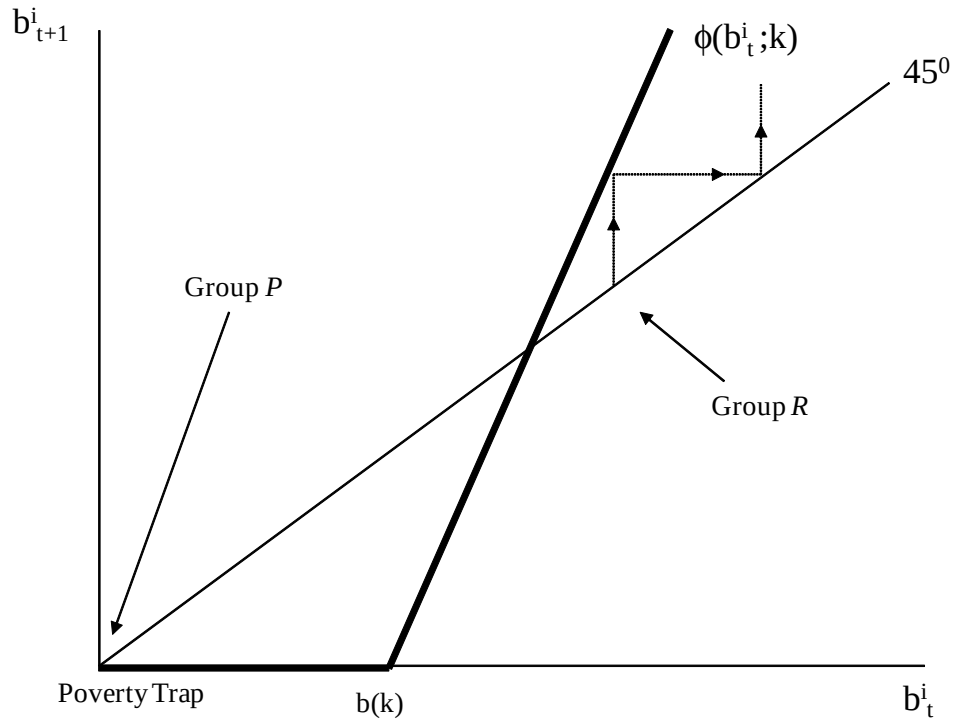
Early stages of development $(k \leq \widetilde{k})$

- K is the main engine of growth: $\rho^{HC} < \rho^{K}$
- No investment in education
- No Transfers within Group P
- Transfers within Group R $\uparrow$
- Wages $\uparrow$
- Income inequality $\uparrow$

The Conditional Dynamical System: Regime I



Regime I: Effect of Inequality

Inequality enhances the process development

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Inequality enhances the process development

- A transfer of wealth from Group R to P $\Longrightarrow$
  - Aggregate consumption $\uparrow$
  - Aggregate intergenerational transfers $\downarrow$
  - Rate of capital accumulation $\downarrow$

Regime II: Human Capital Accumulation

Mature stages of development: $(k > \widetilde{k})$

Regime II: Human Capital Accumulation

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- HC is the engine of growth: $\rho^{HC} \geq \rho^{K}$

Stage I of Regime II: HC Accumulation by group R

Stage I of Regime II $(\tilde{K} < K \leq \hat{K})$

Stage I of Regime II: HC Accumulation by group R

Stage I of Regime II $(\tilde{K} < K \leq \hat{K})$

- Members of group P

Stage I of Regime II: HC Accumulation by group R

Stage I of Regime II $(\tilde{K} < K \leq \hat{K})$

- Members of group P
  - No intergenerational transfers

Stage I of Regime II: HC Accumulation by group R

Stage I of Regime II $(\tilde{K} < K \leq \hat{K})$

- Members of group P
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  - No investment in education

Stage I of Regime II: HC Accumulation by group R

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  - No investment in education
- Members of group R

Stage I of Regime II: HC Accumulation by group R

Stage I of Regime II $(\tilde{K} < K \leq \hat{K})$

- Members of group P
  - No intergenerational transfers
  - No investment in education
- Members of group R
  - Transfers $\uparrow$

Stage I of Regime II: HC Accumulation by group R

Stage I of Regime II $(\tilde{K} < K \leq \hat{K})$

- Members of group P
  - No intergenerational transfers
  - No investment in education
- Members of group R
  - Transfers $\uparrow$
  - Expenditure on education $\uparrow$

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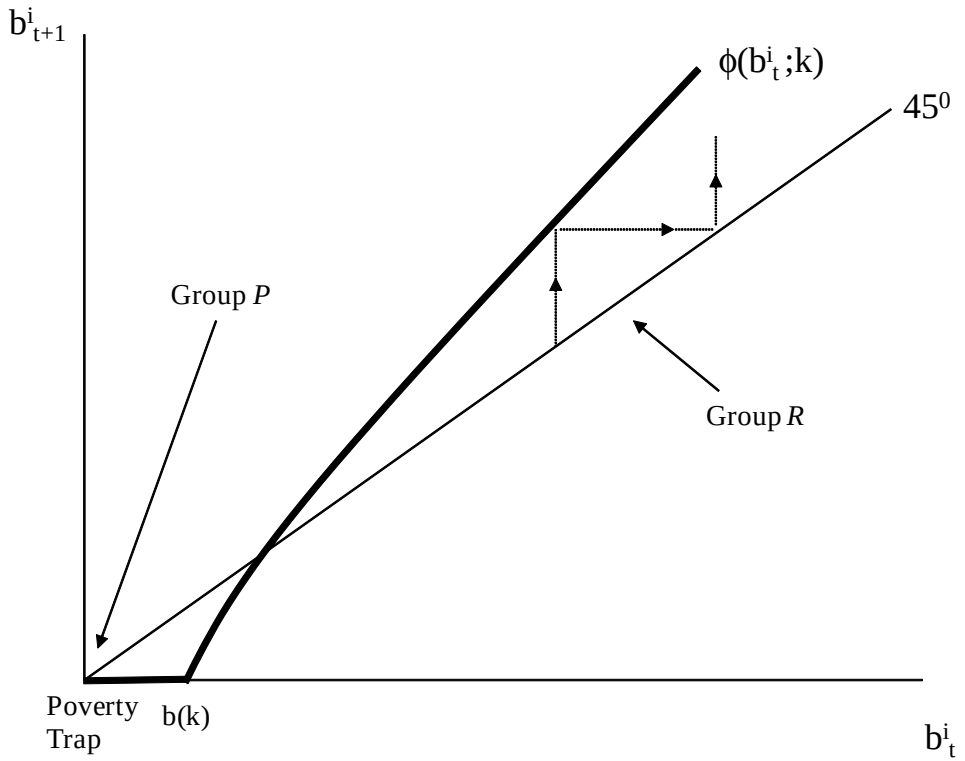
  - No intergenerational transfers
  - No investment in education
- Members of group R
  - Transfers $\uparrow$
  - Expenditure on education $\uparrow$
- Wages $\uparrow$

Stage I of Regime II: HC Accumulation by group R

Stage I of Regime II $(\tilde{K} < K \leq \hat{K})$

- Members of group P
  - No intergenerational transfers
  - No investment in education
- Members of group R
  - Transfers $\uparrow$
  - Expenditure on education $\uparrow$
- Wages $\uparrow$
- Income inequality $\uparrow$

The Conditional Dynamical System: Stage I of Regime II



Stage II of Regime II : HC Accumulation by the Poor

Stage II of Regime II $(\hat{K} < K < K^*)$

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- Members of group R (not credit constrained): $\rho^{HC} = \rho^K$

Stage II of Regime II : HC Accumulation by the Poor

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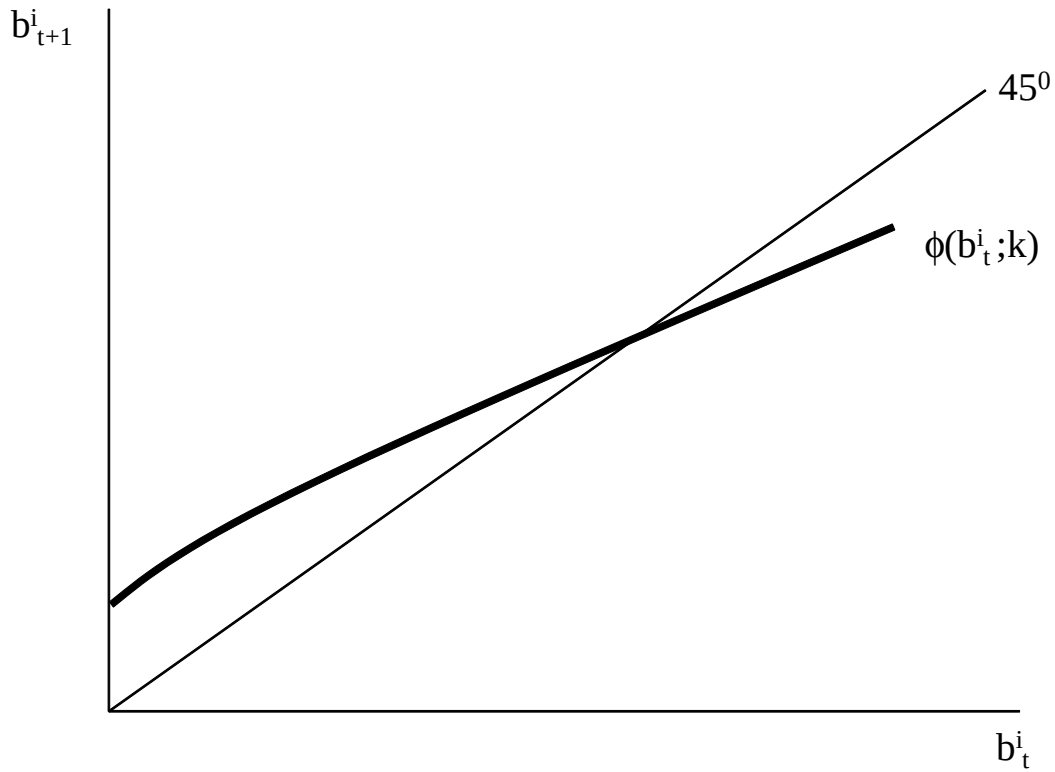
- Members of group P (credit constrained): $\rho^{HC} > \rho^K$
  - Start to transfers
  - Start to acquire education
- Members of group R (not credit constrained): $\rho^{HC} = \rho^K$
  - Invest optimally in human and physical capital

Conditional Dynamical System: Stage II-III of Regime II



Stage II of Regime II: Effect of Inequality

- More equality is beneficial for the process development

Stage II of Regime II: Effect of Inequality

- More equality is beneficial for the process development
  - A transfer of wealth from group R to group P allows (due to credit constraint) a more efficient allocation of aggregate investment between HC and PC

Stage III of Regime II : Credit Constraints are not Binding

- All individuals are not credit constrained: $R^{HC} = R^{K}$

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- All individuals are not credit constrained: $R^{HC} = R^{K}$
- Inequality has no effect on the process of development

The changing Role of Inequality in the Development Process

0_____$\tilde{k}$_____

Regime I	**Regime II**
$\rho^K > \rho^H$	$\rho^K \leq \rho^H$
K only engine	HC main engine
Inequality (+)	Inequality (-)

Effect of Inequality in Regime II

$\tilde{k}$_____$\hat{k}$_____k^*_____

Stage I	**Stage II**	**Stage III**
$\rho^K < \rho^H_p$ $\rho^K = \rho^H_R$	$\rho^K < \rho^H_P$ $\rho^K = \rho^H_R$	$\rho^K = \rho^H$
2 engines	HC main engine	2 engines
	Inequality (-)	

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- The effect on inequality depends on the country's level of income. Inequality is beneficial for poor economies and harmful for rich ones

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The Unified Approach

- The effect of inequality on growth depends on the relative return to human and physical capital. The higher is the relative return to human capital the more harmful is inequality for economic growth

Implications for DC and LDCS

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Implications for DC and LDCS

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  - Inequality is harmful for economic growth in stages of development in which human capital accumulation is the prime engine of economic growth

Implications for DC and LDCS

- The replacement of physical capital accumulation by human capital accumulation as a prime engine of economic growth has changed the impact of inequality on the process of development
  - Inequality stimulates economic growth in stages of development in which physical capital accumulation is the prime engine of growth
  - Inequality is harmful for economic growth in stages of development in which human capital accumulation is the prime engine of economic growth
- Int'l capital inflow to LDCs and the adoption of skilled-biased technologies may place economies directly in the second stage in which inequality is harmful

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