Unified Growth Theory and Comparative Development

Oded Galor

November 18, 2019

Two Mysteries

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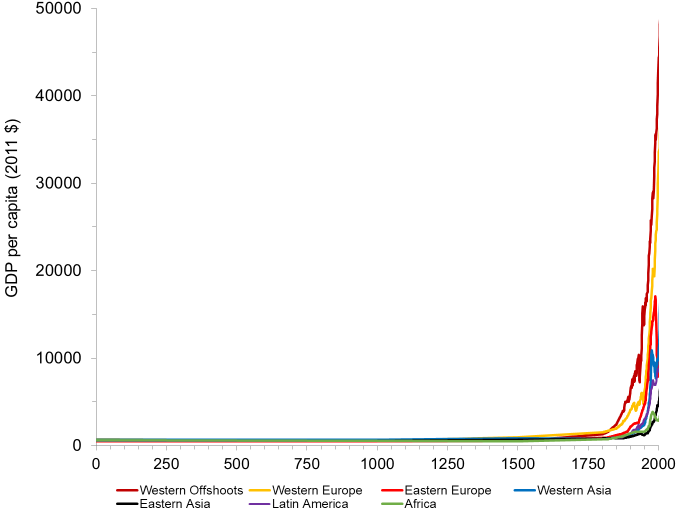

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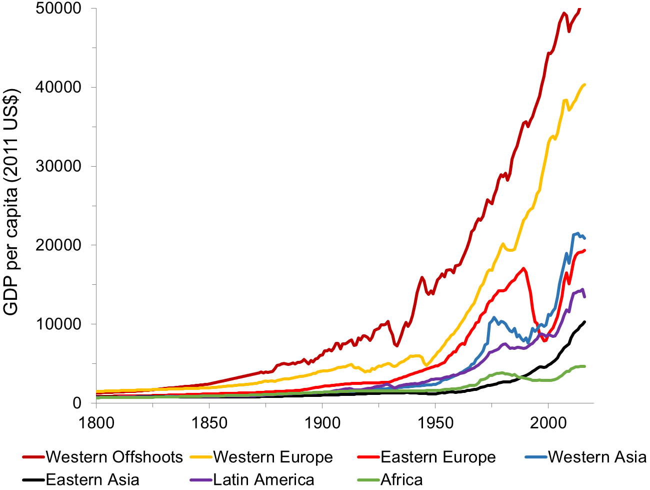

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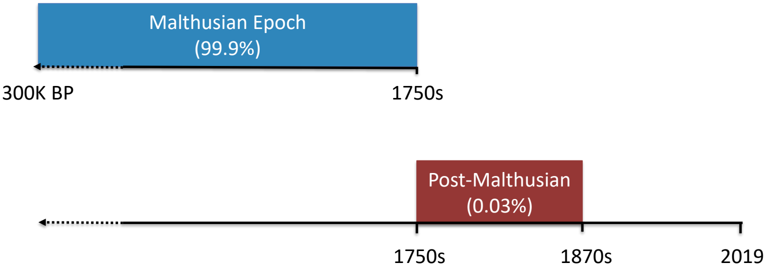

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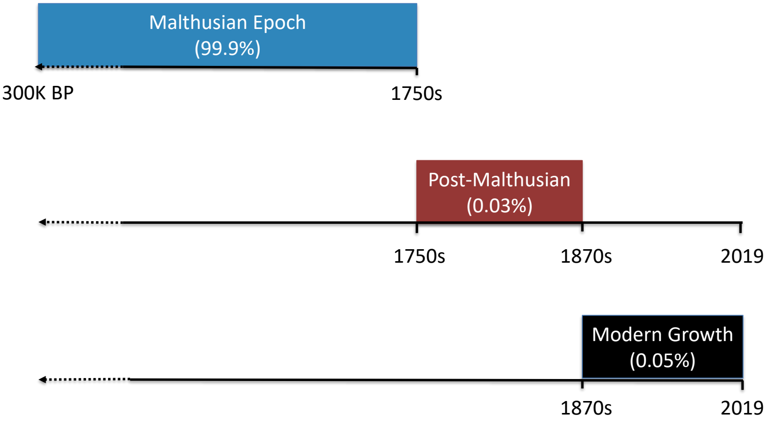

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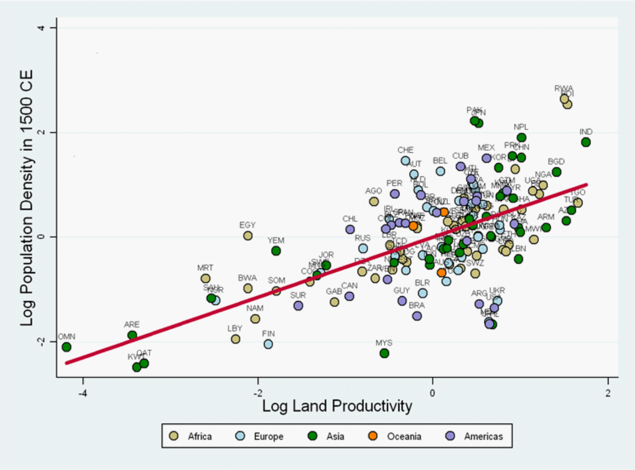
Land Productivity and Population Density in 1500



Source: Ashraf-Galor (AER 2011)

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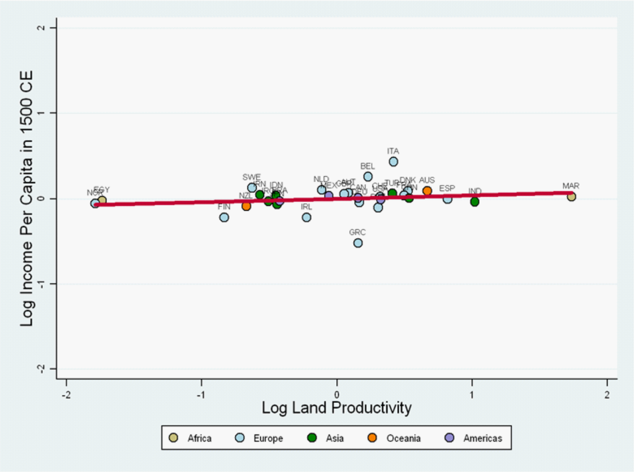

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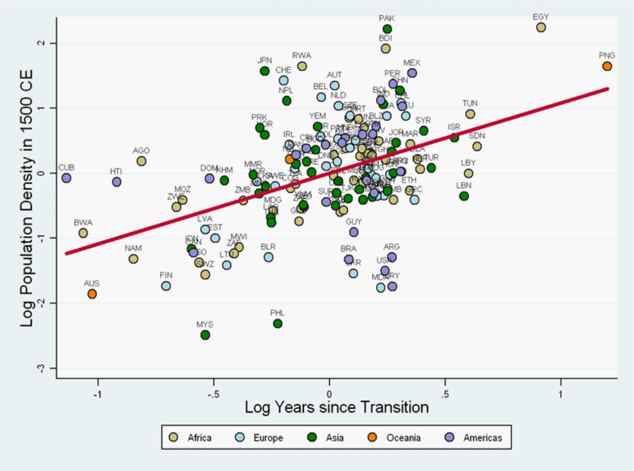

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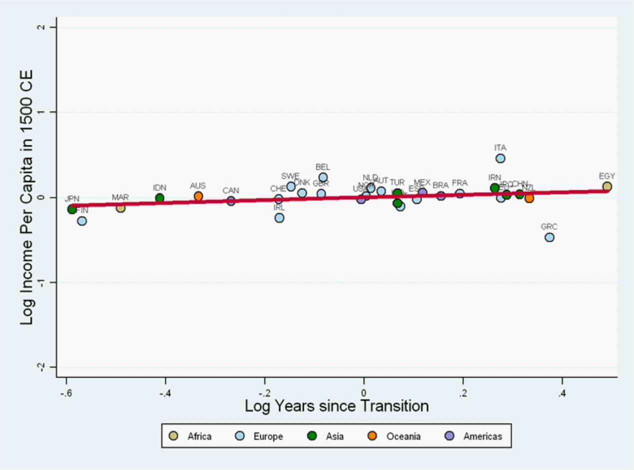

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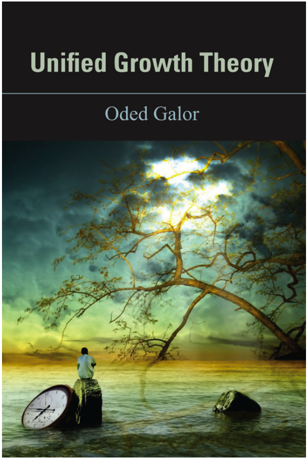

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    - Educated individuals have a comparative advantage in adopting & advancing new technologies

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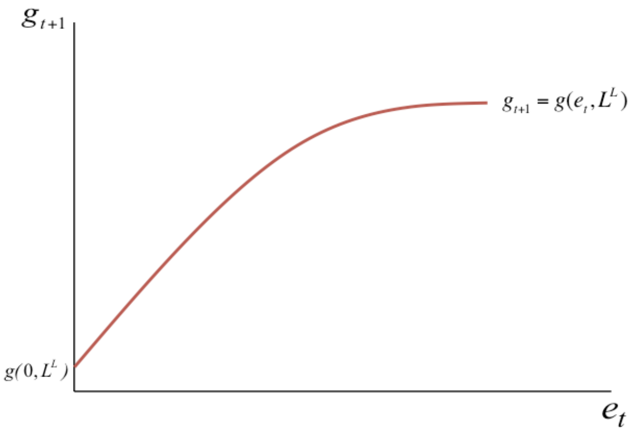
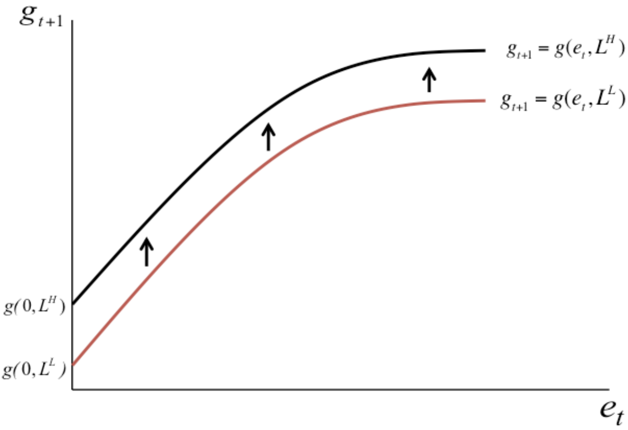
- $g(0, L) > 0$ for $L > 0$
  - Technological progress is positive as long as human are present

Technological Progress



The Effect of Population Size on Technological Progress



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  - The introduction of new technologies is skill-biased in the short-run, although the nature of the technology can be skill-biased or skill-saving in the long run

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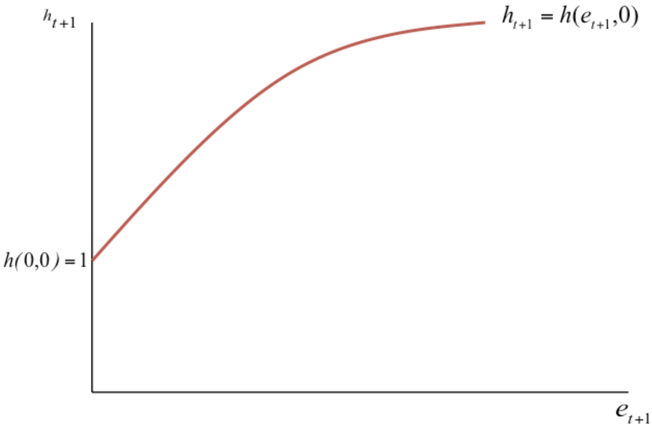
Human Capital Formation



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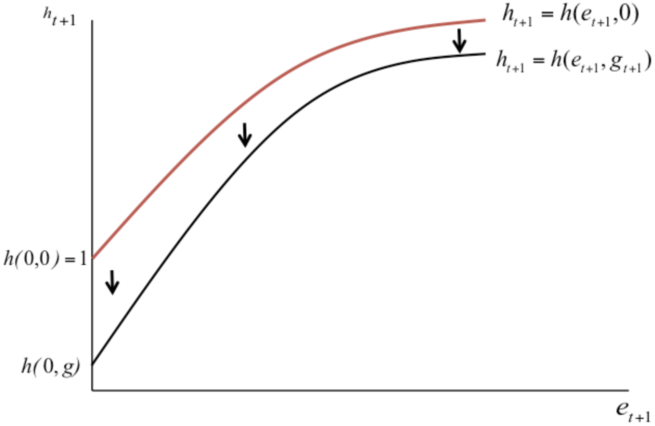

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    - Population growth & human capital formation increase:
- Later part of the second phase of industrialization:
  - The substitution effect dominates (higher demand for human capital):
    - Population growth declines & human capital formation increases

Individuals

- Live for 2 periods

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- Childhood (1st Period):

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- The utility function of individual t (adult at time t)

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Budget and Subsistence Consumption Constraints

$$z_t n_t(\tau + e_{t+1}) + c_t \leq z_t$$

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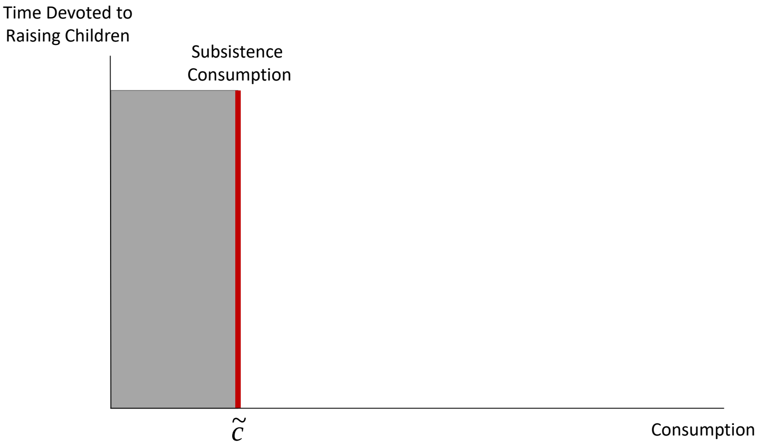
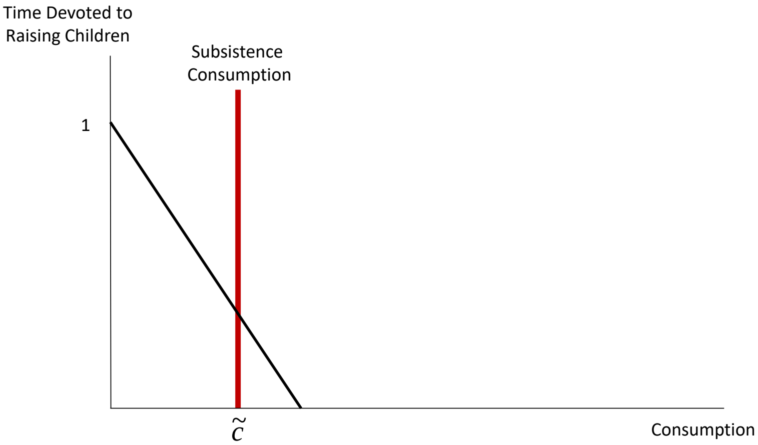
- Subsistence consumption constraint:

$$c_t \geq \tilde{c}$$

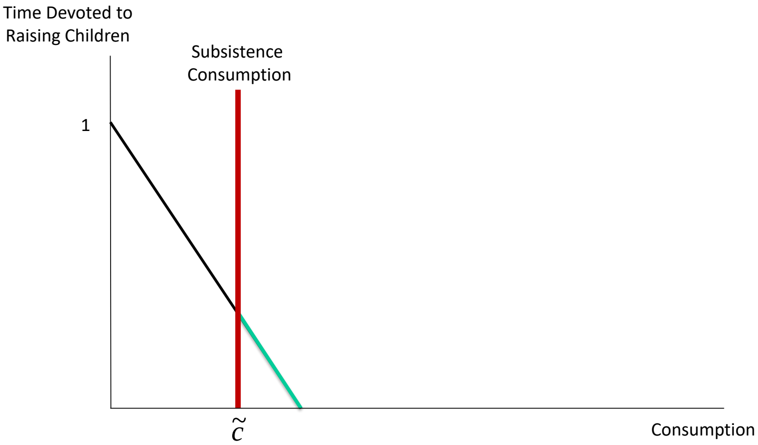
The Subsistence Consumption Constraint



Subsistence Consumption & Budget Constraints



Subsistence Consumption & Budget Constraints



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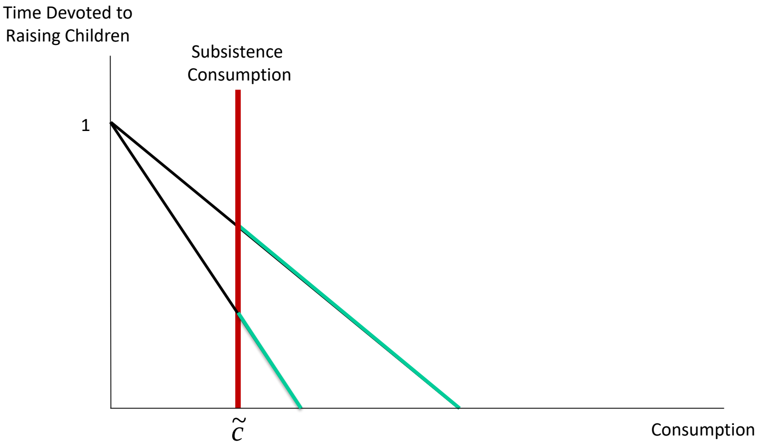

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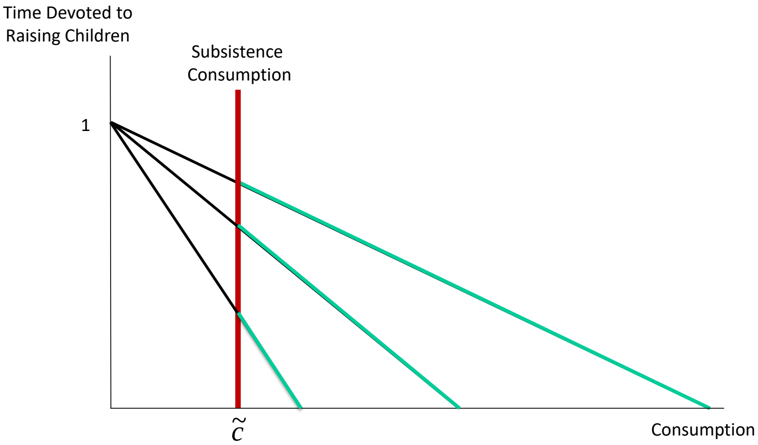
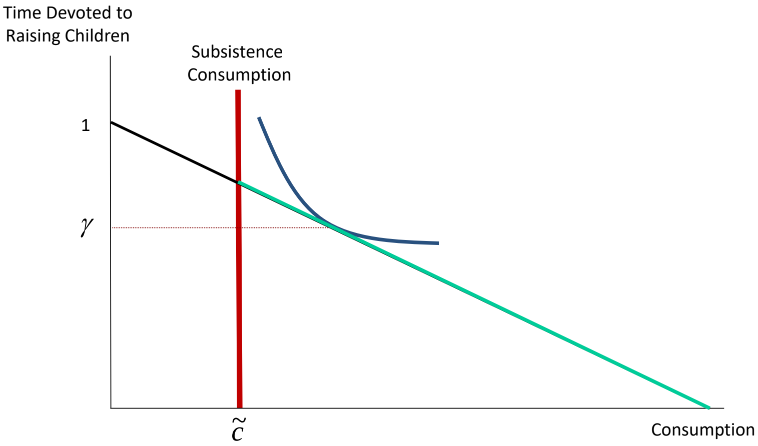


Optimization - Subsistence Constraints is not Binding



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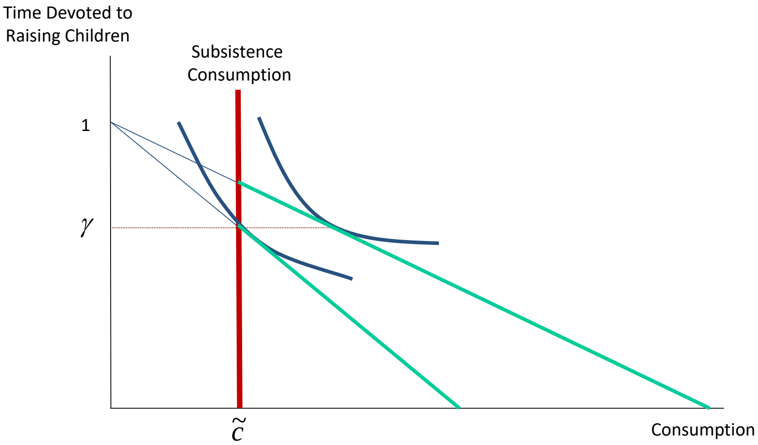

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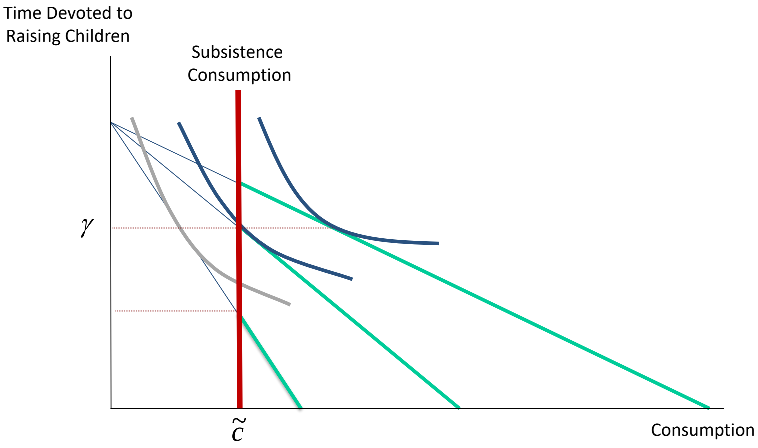

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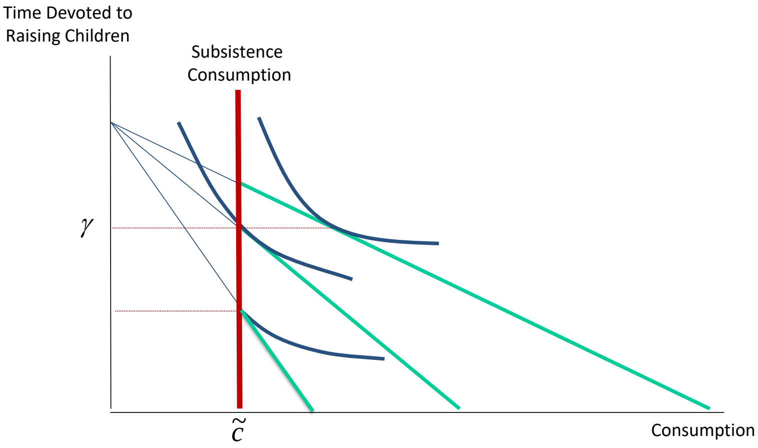
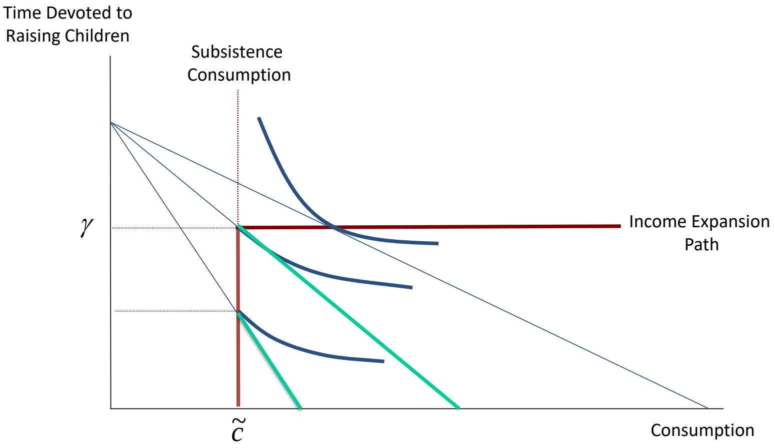
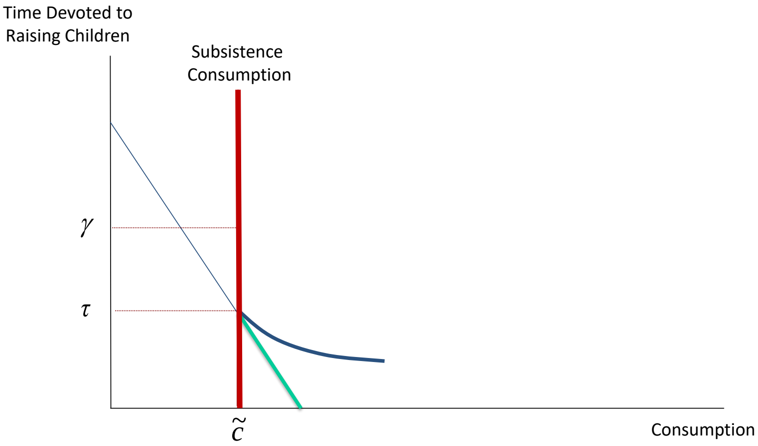


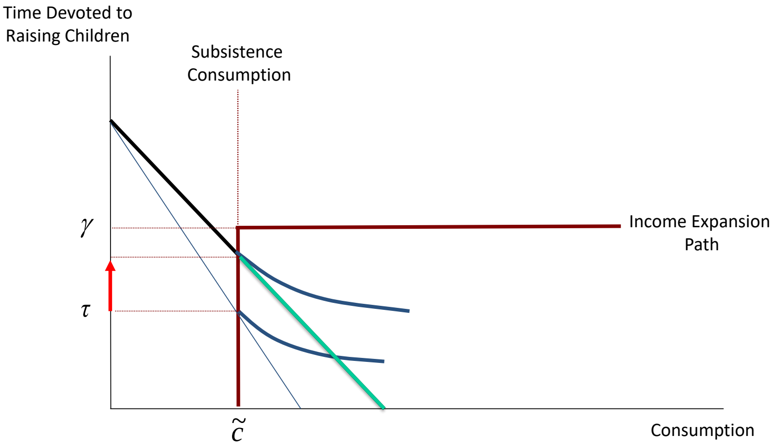
Optimization - Income Expansion Path



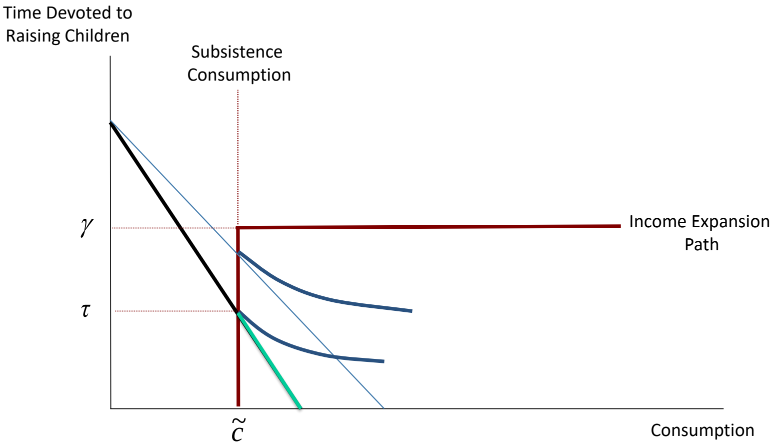
Optimization - Malthusian Steady-State Equilibrium



Optimization - Impact of Tech Progress in the Malthusian Epoch (SR)



Optimization - Impact of Tech Progress in the Malthusian Epoch (LR)



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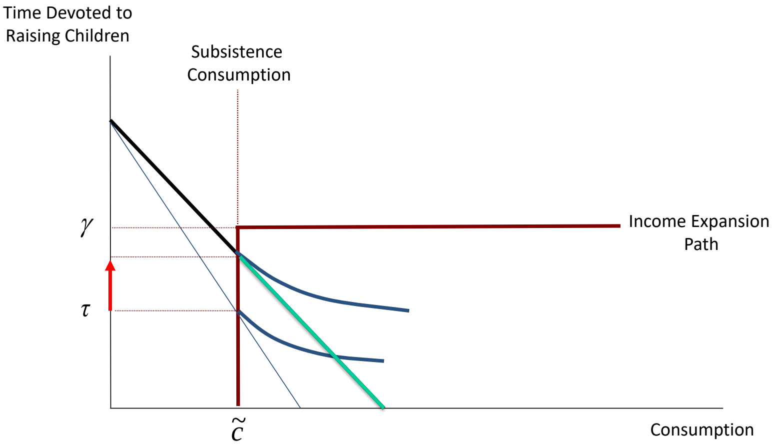

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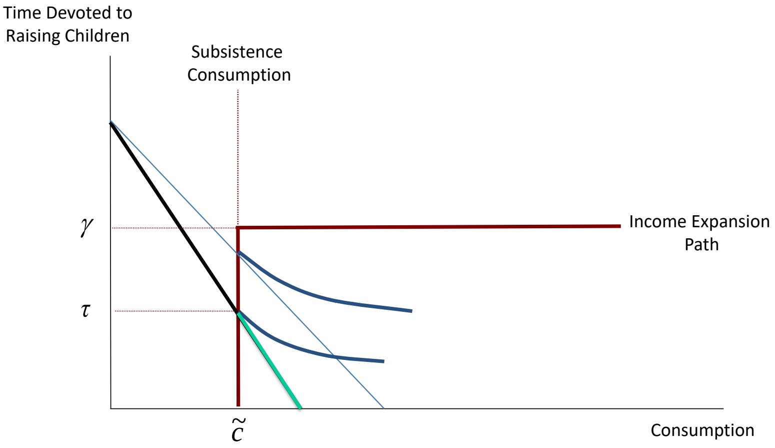
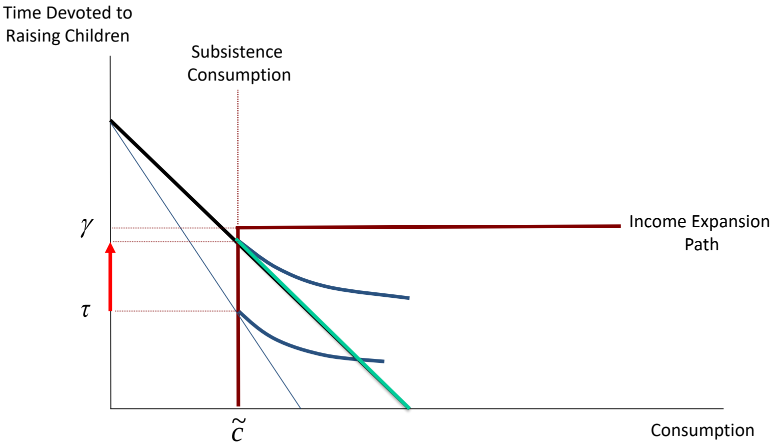
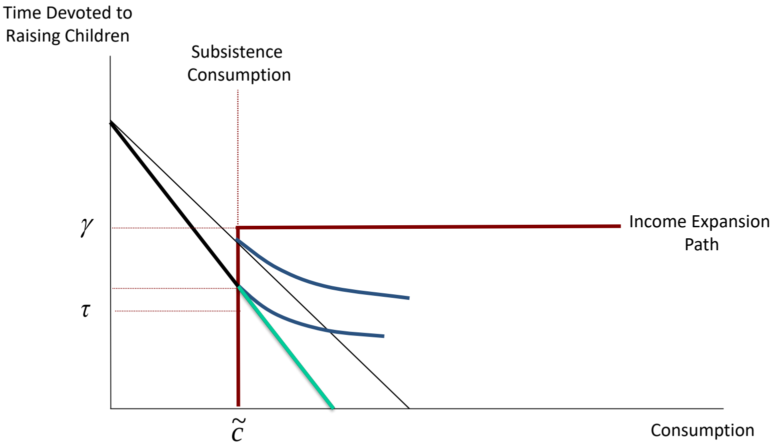


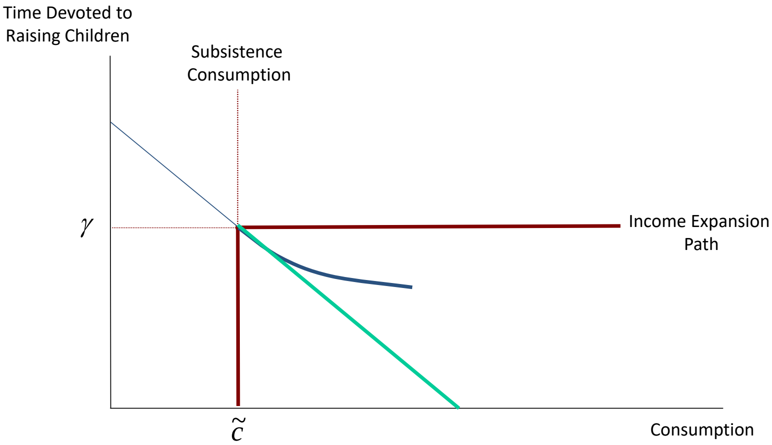
Optimization - Additional Tech Progress in the Malthusian Epoch (SR)



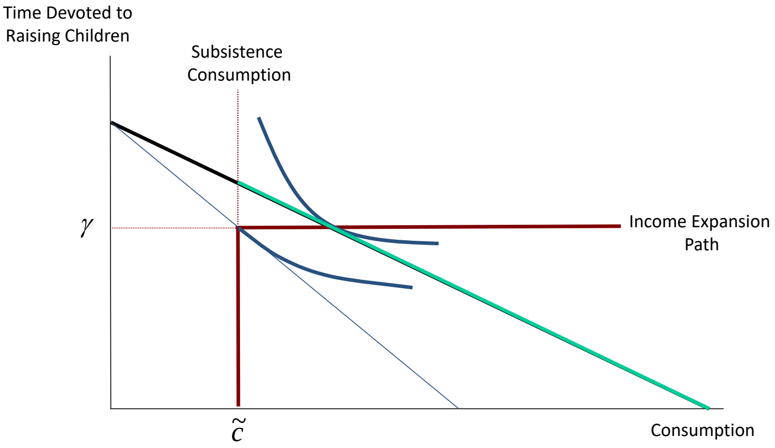
Optimization - Additional Tech Progress in the Malthusian Epoch (LR)



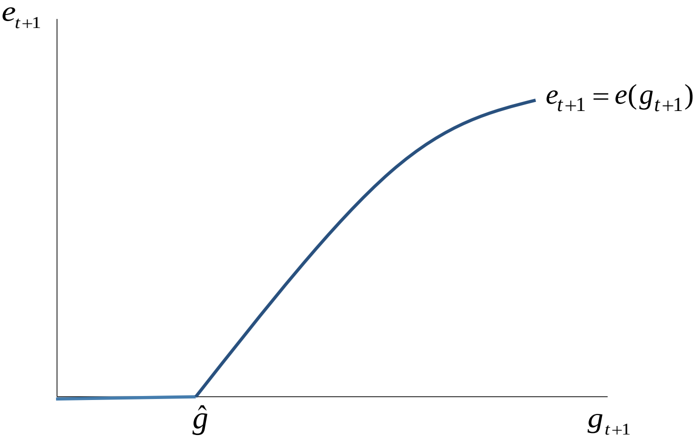
Optimization - Impact of Technological Progress (Eve of the Take-off)



Optimization - Escape from the Malthusian Trap



Optimization - Investment in Child Quality



Optimization: Quantity and Quality of Children

- Time devoted to children
  - Budget constraint:

$$z_t n_t(\tau + e_{t+1}) + c_t \leq z_t$$

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$$n_t = \begin{cases} \frac{\gamma}{\tau + e_{t+1}} & \text{if} \quad z_t \geq \tilde{z} \\ \frac{1 - \frac{\tilde{c}}{z_t}}{\tau + e_{t+1}} & \text{if} \quad z_t \leq \tilde{z} \end{cases}$$

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- Chosen quality

$$e_{t+1} = e(g_{t+1})$$

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Population Dynamics

$$L_{t+1} = n_t L_t$$

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Dynamics of the Level of Resources per Worker

$$x_{t+1} = \frac{A_{t+1}X}{L_{t+1}} = \frac{(1+g_{t+1})A_t X}{n_t L_t} = \frac{1+g_{t+1}}{n_t} x_t$$

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$$x_{t+1} = \begin{cases} \frac{[1+g(e_t,L_t)][\tau^q+\tau^e e(g(e_t,L_t))]}{\gamma} x_t \equiv \phi^b(e_t; L)x_t & z_t \geq \tilde{z} \\ \frac{[1+g(e_t,L_t)][\tau+e(g(e_t,L_t))]}{1-[\tilde{c}/z(e_t,g_t,x_t)]} x_t \equiv \phi^a(e_t, g_t, x_t, L_t)x_t & z_t \leq \tilde{z} \end{cases}$$

The Dynamical System

A sequence $\{x_t, e_t, g_t, L_t\}_{t=0}^{\infty}$ such that:

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$$\begin{cases} g_{t+1} = g(e_t, L_t) \\ e_{t+1} = e(g(e_t, L_t)) \\ x_{t+1} = \phi(e_t, g_t, x_t, L_t)x_t \\ L_{t+1} = n(e_t, g_t, x_t, L_t)L_t \end{cases}$$

The Conditional Evolution of Technology and Education

A sequence $\{g_t, e_t; L\}_{t=0}^{\infty}$ such that:

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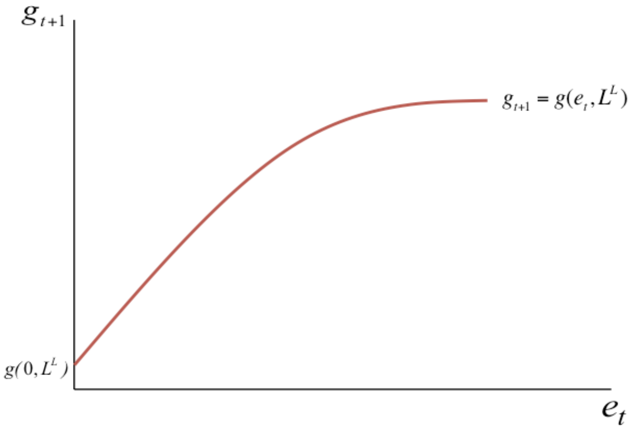
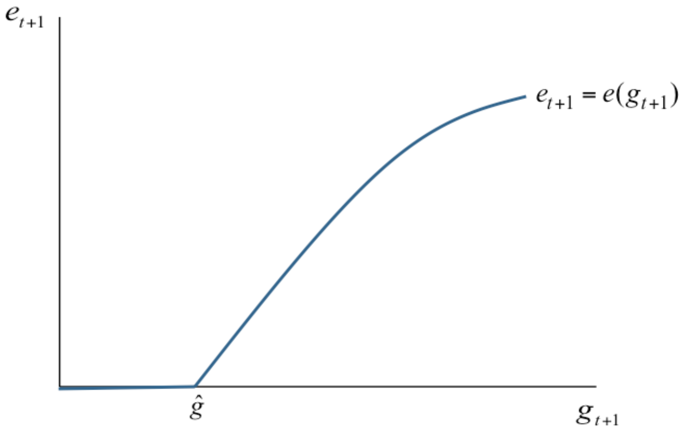
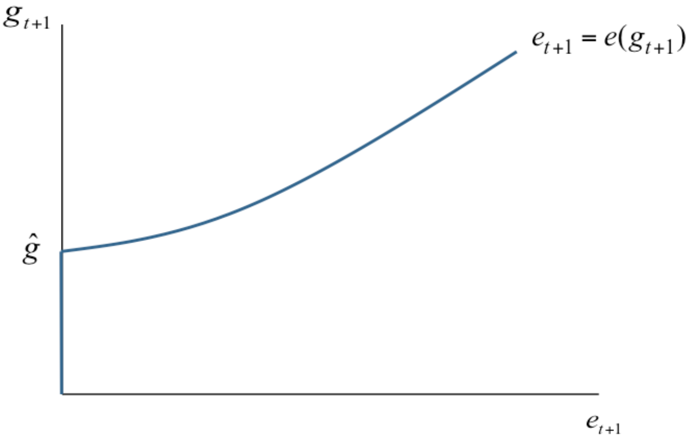
The Effect of Education on Technology



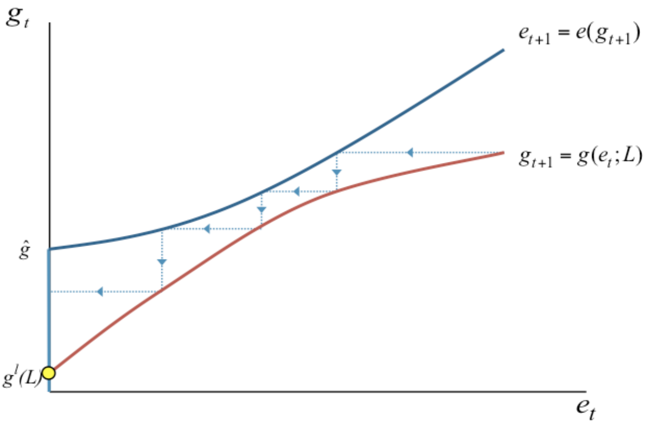
The Effect of Technology on Education



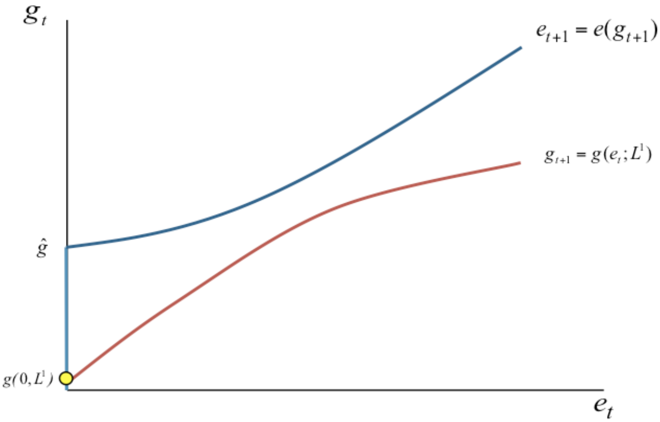
The Effect of Technology on Education: Flipped Axis



The Evolution of Education and Technology: For a Given Population Size



The Evolution of Education and Technology



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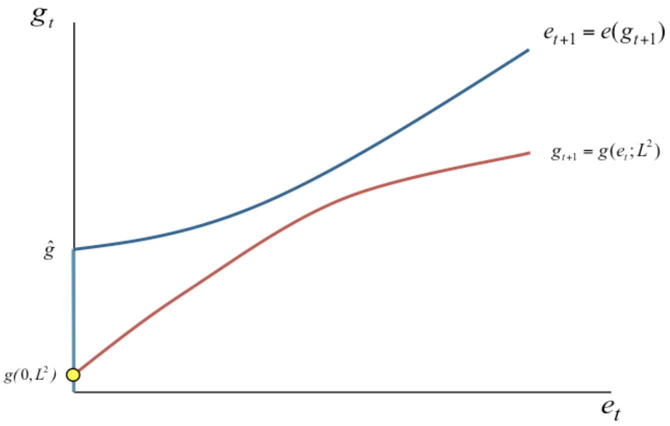

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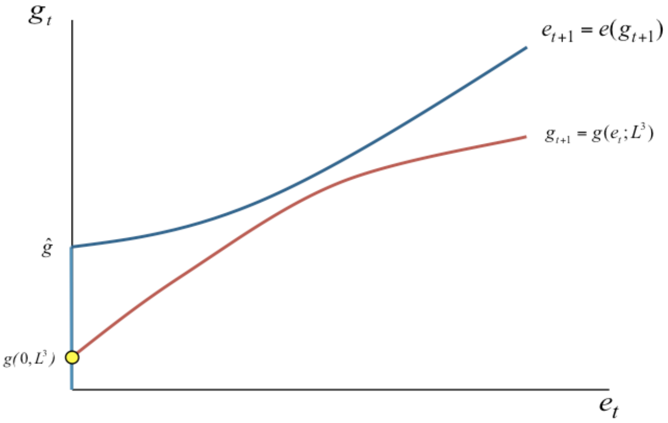

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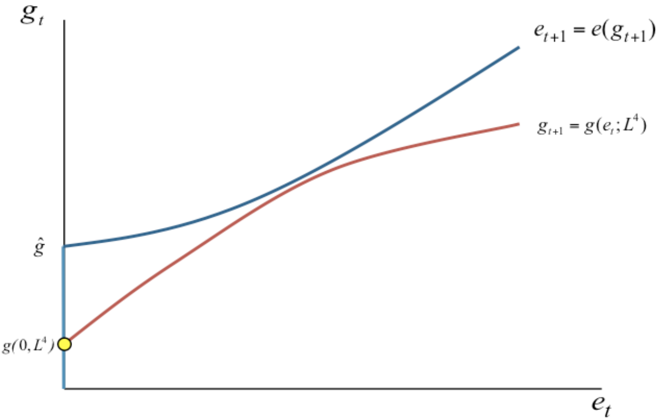

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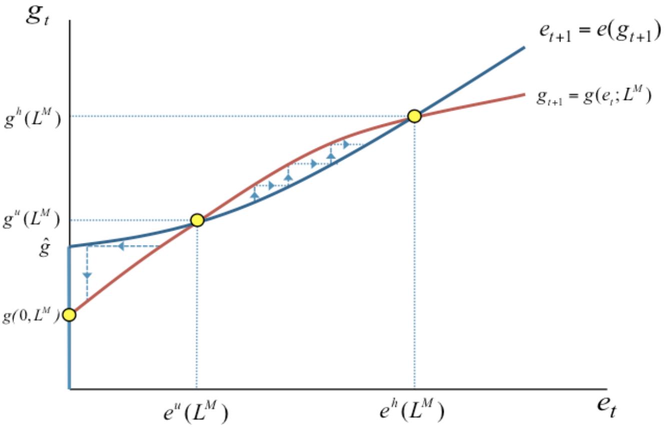

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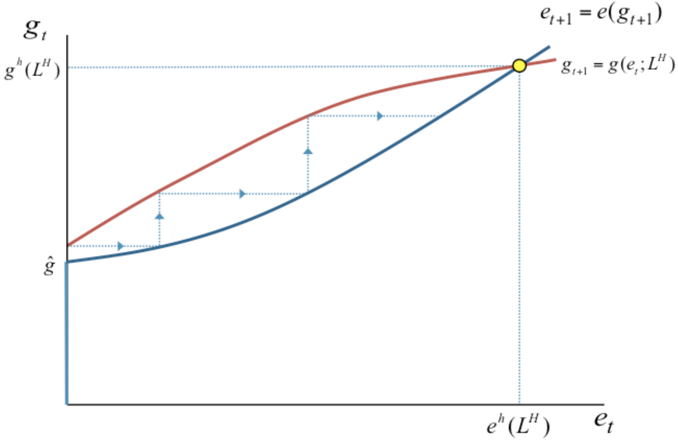
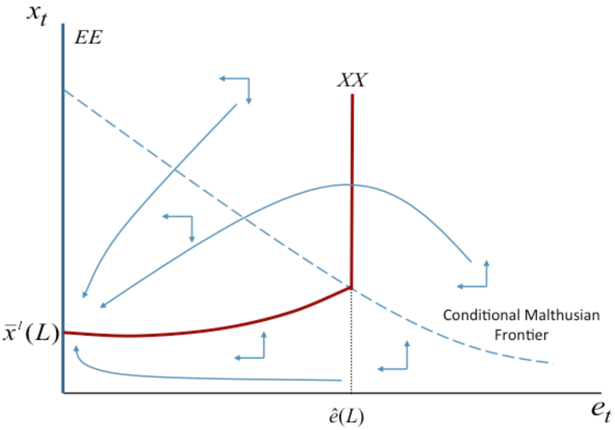
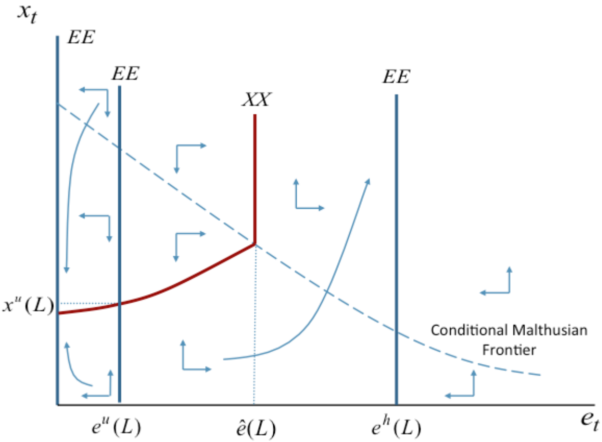


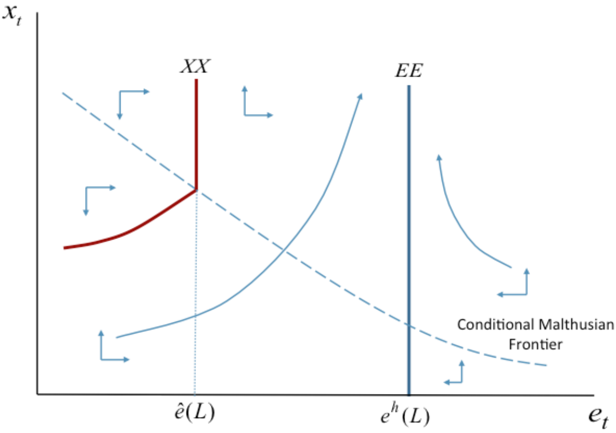
The Evolution of Education and Resources Per Worker: Small Population



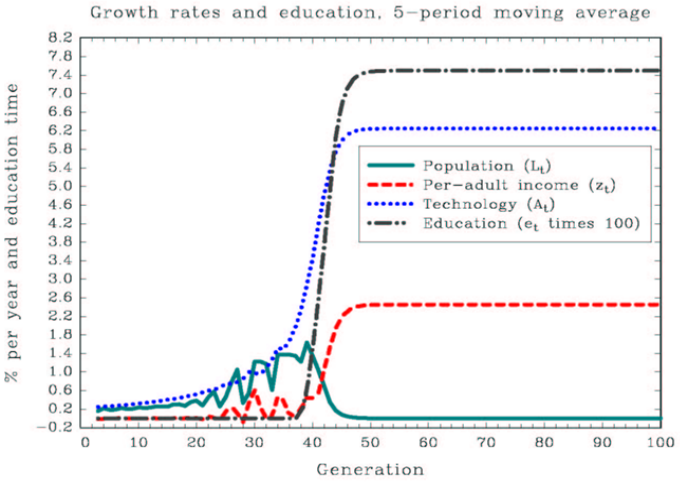
The Evolution of Education and Resources Per Worker: Intermediate Population



The Evolution of Education and Resources Per Worker: Large Population



Simulation



Source: Lagerlof (RED 2006)

- The Malthusian interaction between technology & population

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- The propensity of a country to trade (geography & policy)
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  - Specialization and technological progress via learning by doing

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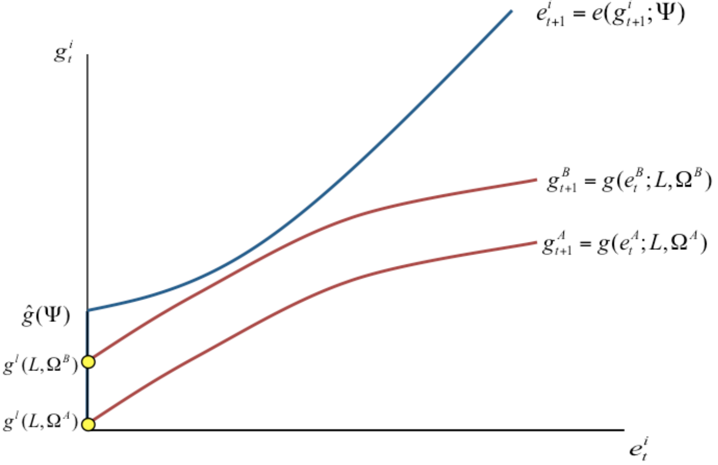
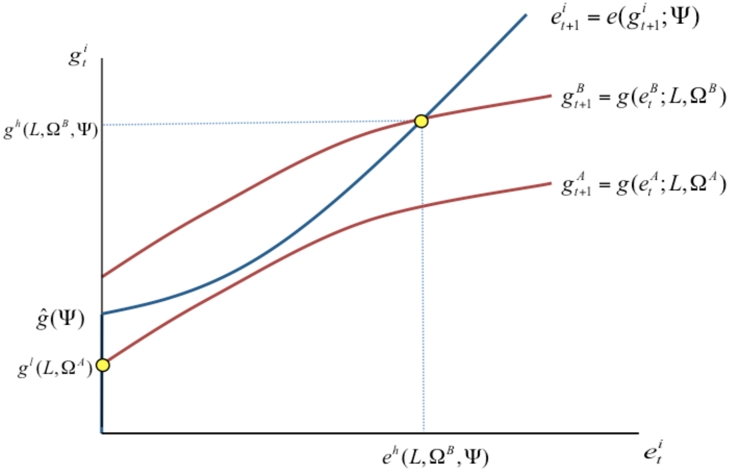
- Abundance of natural resources
  - complementary for industrialization (e.g., Coal & Steam engine)

Variations in Country-Specific Characteristics Conducive for Technological Progress



Earlier Take-off in Country B



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$$e_{t+1}^i = e(g_{t+1}^i; \Psi_t^i) \begin{cases} = 0 & \textit{if} \quad g_{t+1}^i \leq \hat{g}(\Psi_t^i), \\ > 0 & \textit{if} \quad g_{t+1}^i > \hat{g}(\Psi_t^i) \end{cases}$$

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- Social status associated with education

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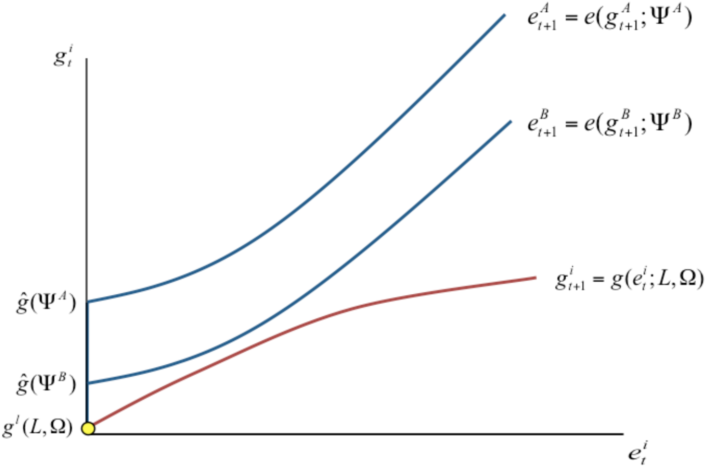
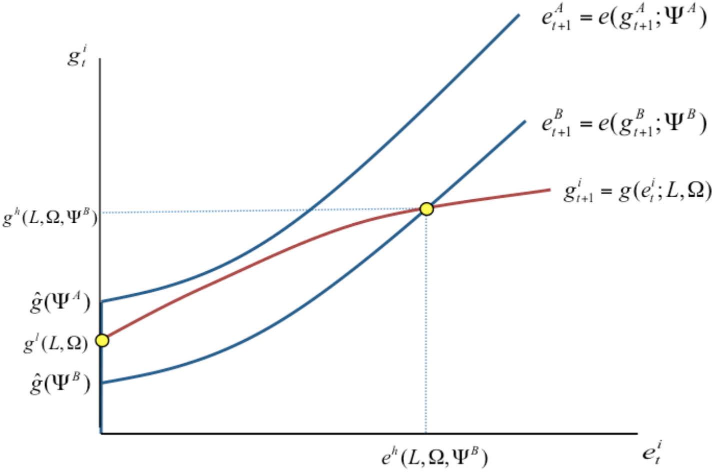


Concluding Remarks



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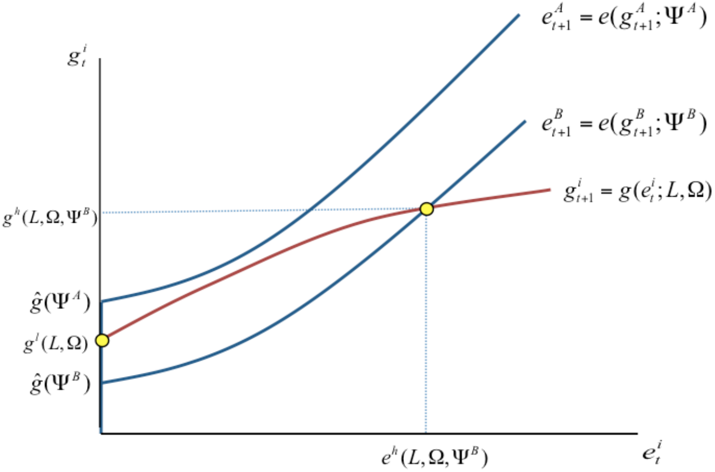

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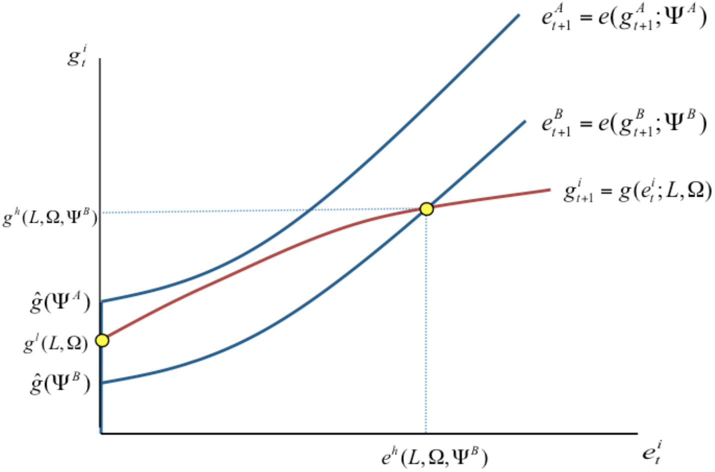

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