Human Evolution and Economic Development

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Economic Growth and Comparative Development

Evolutionary Growth Theory

- Captures the coevolution of human traits and the growth process in the course of human history
  - The effect of the economic environment on the evolutionary processes that affect the composition of human traits
  - The impact of the evolution in the composition of human traits on the growth process
- Intergenerationally transmitted human traits such as
  - Physical and cognitive abilities
  - Preferences and other cultural values
  - Skills, knowledge & technology

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Main Hypothesis

- The coevolution of human traits and the growth process is critical for the understanding of the transition from stagnation to growth
- The composition of human traits that were critical for the growth process evolved during the Malthusian epoch
  - The Malthusian pressure affected the size & the composition of the population
  - Hereditary traits that generated higher income
    - Higher reproductive success
    - Become more prevalent in the population
- The forces of natural selection
  - Increased the representation of traits that were complementary to the growth process
  - Reinforced the growth process
  - Stimulated the take-off from an epoch of stagnation to sustained growth

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Example - Selection of Predisposition Towards Child Quality

- The rise of the reward for human capital has increased the evolutionary optimal investment in offspring's quality due to:
  - The evolution of the human brain and the complementarity between brain capacity and investment in human capital
  - Increased economic complexity in the course of the Neolithic Revolution
- The Malthusian pressure increased the representation of human traits that were complementary to investment in human capital
  - Preference for child quality (Galor-Moav, 2002)
  - Higher life expectancy (Galor-Moav, 2005, 2007; Franck-Galor-Özak, 2017)
  - Entrepreneurial spirit (Galor-Michalopoulos, 2012)
  - Moderate fecundity (Galor-Klemp, 2015)
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Evolutionary Changes in Humans in the Past 10,000 Years - Genetic Evidence

- Lactose Tolerance
  - Variations in the ability to tolerate lactose across regions is inversely related to differences in timing of the transition to agriculture & domestication of dairy animals
- Genetic immunity to malaria - Sickle Cell Trait
  - Variations in natural immunity to malaria is related to the engagement in slash-and-burn agriculture
- 700 regions of the human genome
  - Reshaped by natural selection within the past 5,000 to 15,000 years (Voight et al., 2006)
- Genetic loci associated with immunity, pigmentation and height
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The Benchmark Model – Galor-Moav (QJE 2002)

- Overlapping-generations economy
- $t = 0, 1, 2, 3...$
- One homogeneous good
- 2 factors of production:
  - Labor (measured in efficiency units)
  - Land

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Factor Supply

- Land is fixed over time
  - Surface of planet earth
- Efficiency units of labor evolve endogenously
  - Determined by households' decisions about the number and level of human capital of their children

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- The Malthusian Structure
- The Darwinian Structure
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- Origins of Human Capital Formation
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The Malthusian Structure

- A subsistence consumption constraint
- Positive effect of income on population
  - $y \uparrow \Longrightarrow L \uparrow$
- Fixed factor of production – Land
  - $L \uparrow \Longrightarrow AP_L \downarrow \Longrightarrow y \downarrow$
- Output per capita fluctuates (with a negligible trend) around a constant level in the long-run
  - Reflecting diminishing returns to labor & positive effect of income on population

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Production

- The output produced in period t

$$Y_t = H_t^{1-\alpha}(A_t X)^{\alpha}$$

  - $H_t \equiv$ efficiency units of labor
  - $A_t \equiv$ technological level
  - $X \equiv$ land

- Output per efficiency units of labor at time t

$$y_t = x_t^{\alpha}$$

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The Malthusian Structure – Effects of Technological Progress

- Very short-run (for a given population):
  - $A_t \uparrow \implies y_t \uparrow$ (above $\bar{y}$)
- Short-run (initial adjustment of population):
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- Long-run (population reaches a new steady-state):
  - $L_t \uparrow \implies y \downarrow$ (back to $\bar{y}$)

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Sources of Technological Progress

- Average individuals' quality affects technological progress

$$e_t \uparrow \quad \Longrightarrow \quad A_t \uparrow$$

  - human capital provides an advantage in adopting and advancing new technologies

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Technological Progress

$$g_{t+1} \equiv \frac{A_{t+1} - A_t}{A_t} = \psi(e_t)$$

- $g_{t+1} \equiv$ rate of tech progress
- $e_t \equiv$ average quality

$$\psi'(e_t) > 0; \quad \psi''(e_t) < 0; \quad \psi(0) = 0$$

- The average quality of the population has a positive and diminishing effect on technological progress

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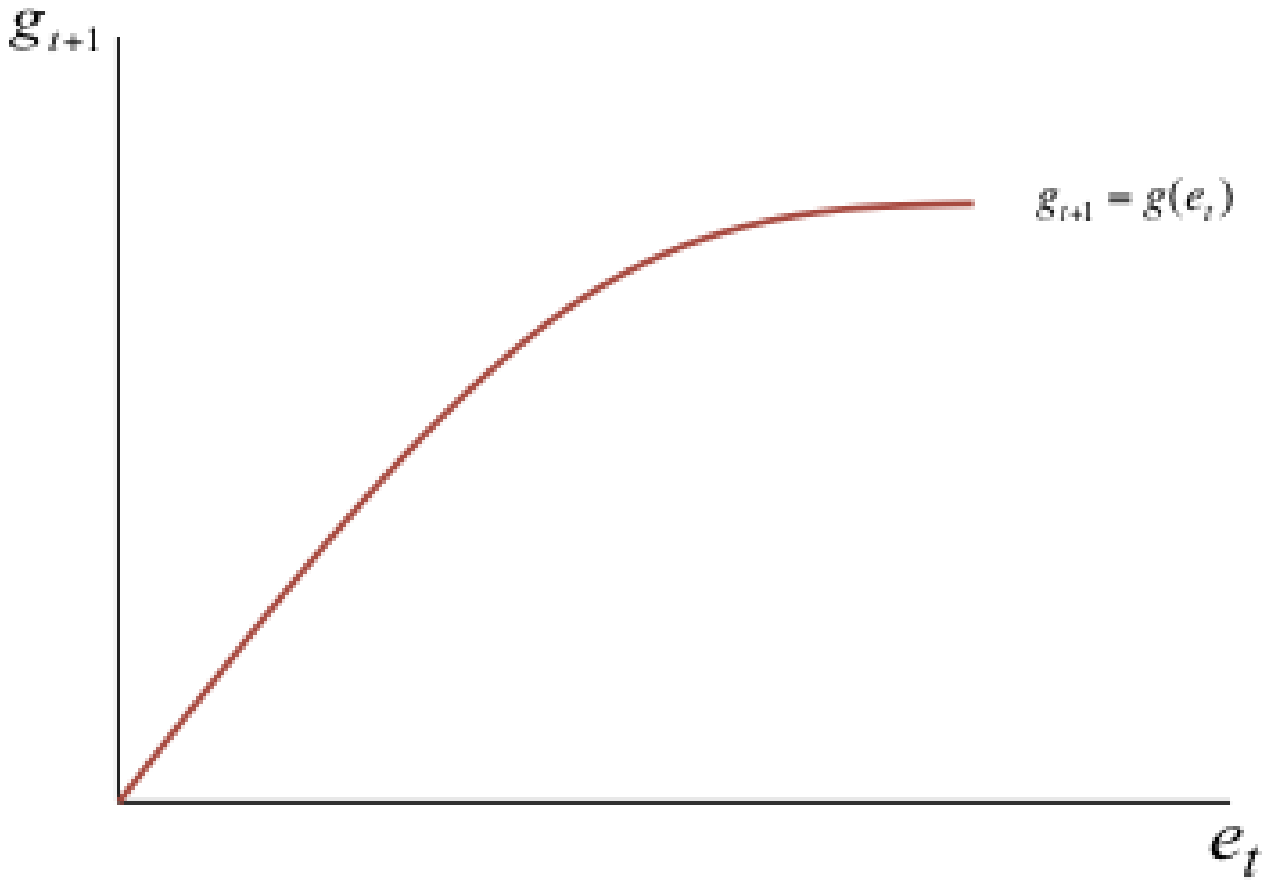

Origins of Human Capital Formation

- The increase in the rate of technological progress increases the demand for human capital
  - Human capital permits individuals to better cope with the changes in the technological environment
  - 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

Human capital of an individual who joins the labor force in period $t+1$

$$h_{t+1} = h(e_{t+1}, g_{t+1})$$

- $e_{t+1} \equiv$ the individual education level (determined by parental investment, subject to their subsistence constraint, in period t)
- $g_{t+1} \equiv$ rate of tech progress

Human Capital Formation

Human capital of an individual who joins the labor force in period $t+1$

$$h_{t+1} = h(e_{t+1}, g_{t+1})$$

- $e_{t+1} \equiv$ the individual education level (determined by parental investment, subject to their subsistence constraint, in period t)
- $g_{t+1} \equiv$ rate of tech progress

Human Capital Formation

$$h_{t+1} = h(e_{t+1}, g_{t+1})$$

- $h_e(e,g) > 0$ and $h_{ee}(e,g) < 0$
  - HC is increasing (in decreasing rates) in the parental time investment in the education of the child
- $h_g(e,g) < 0$ and $h_{gg}(e,g) > 0$
  - Obsolescence of HC in a changing technological environment
- $h_{eg}(e,g) > 0$
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- $h(0,g) > 0$
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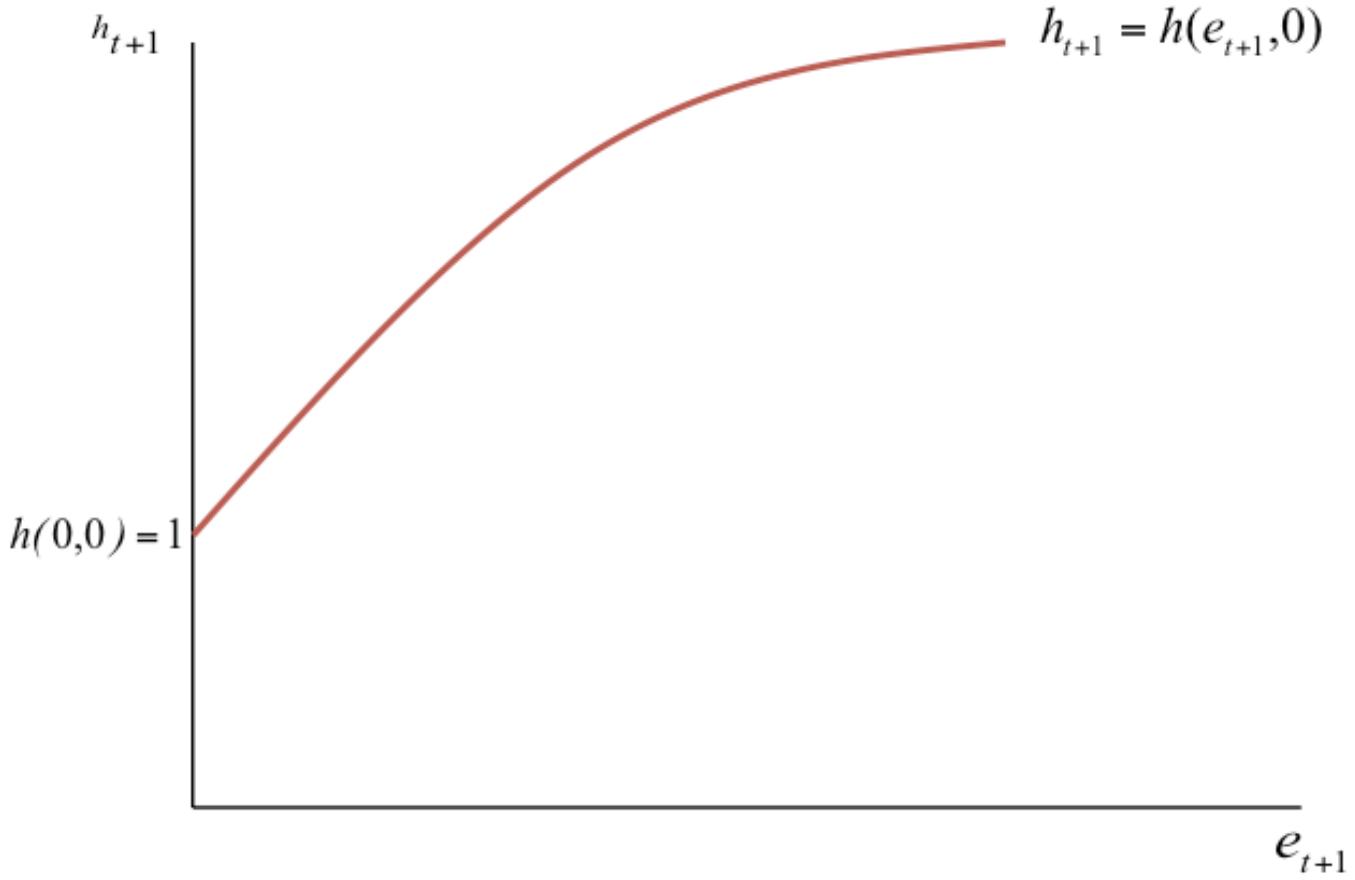

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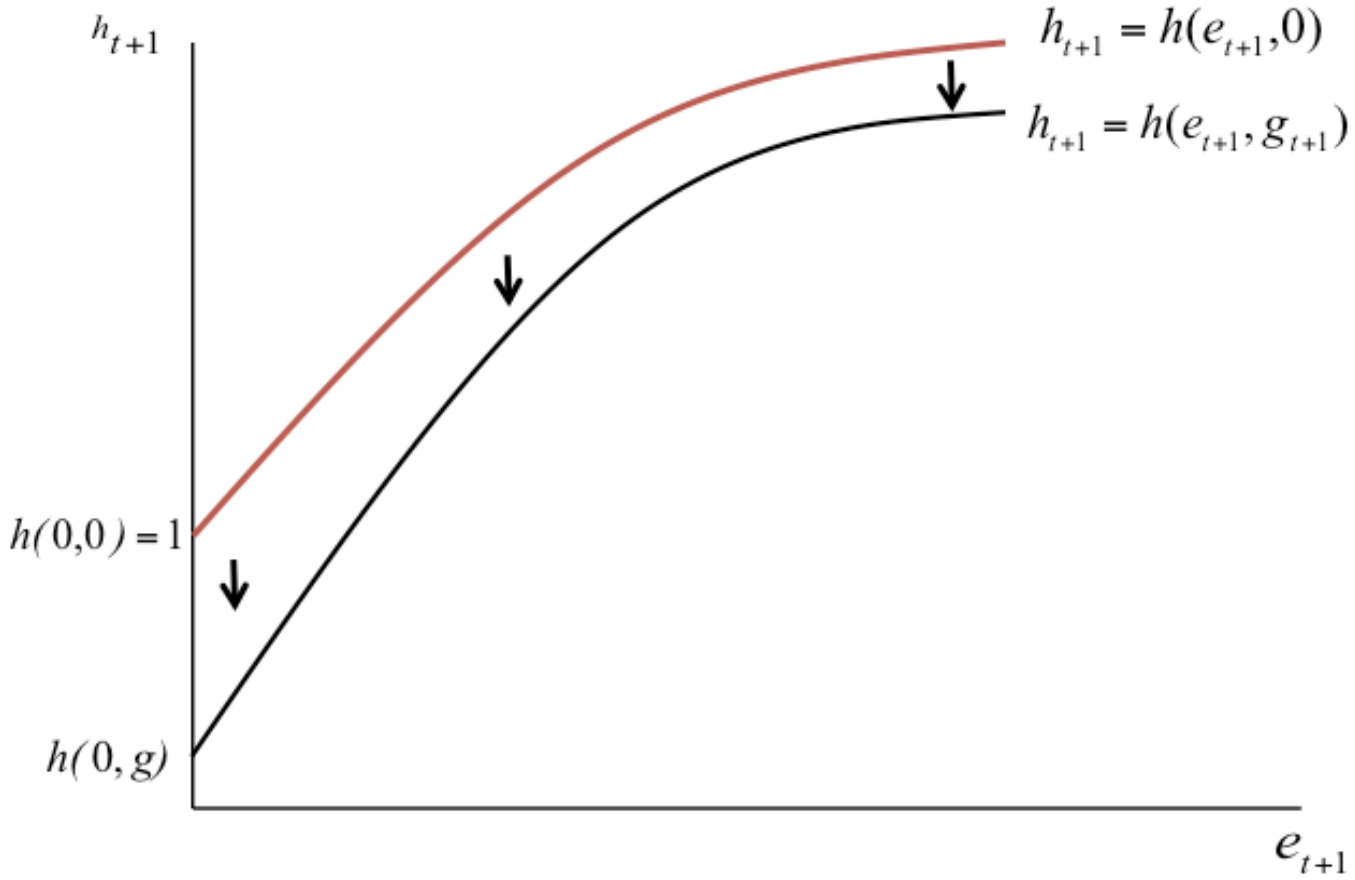

Triggers of the Demographic Transition

- The rise in the demand for human capital induces parents to substitute quality for quantity of children
- The rise in income along with the rise in the potential return to human capital generates:
  - An income effect – more income to spend on children
  - Substitution effects
    - The opportunity cost of raising children increases
    - Return to investment in child quality increases

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Triggers of the Demographic Transition

- Early part of the second phase of industrialization:
  - The income effect dominates (moderate demand for human capital):
    - Population growth & human capital formation increase:
- Later part of the second phase of industrialization:
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Individuals

- Live for 2 periods

- Childhood (1st Period):
  - Consume a fraction of parental time endowment
  - The required time increases with child quality
    - $\tau \equiv$ time required to raise a child, regardless of quality
    - $\tau + e_{t+1} \equiv$ time to raise a child with education e_{t+1}

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The Darwinian Elements

- Variety
  - Preferences for child quality differ across individuals
- Natural selection
  - Evolutionary advantage for the type with the highest reproduction success
- Evolution
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Preferences

- The utility function of a member i of generation t (adults at time t)

$$u_t^i = (1-\gamma)\ln c_t^i + \gamma[\ln n_t^i + \beta^i \ln h_{t+1}^i]$$

  - $c_t^i \equiv$ consumption of individual of type i in generation t
  - $n_t^i \equiv$ number of children of individual of type i in generation t
  - $h_{t+1}^i \equiv$ human capital of each child of member i of generation t
  - $\beta^i \equiv$ predisposition towards quality of individual of type i

- Intergenerational transmission of predisposition towards quality

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- Preferences reflect the implicit Darwinian survival strategy.
  - Individuals do not operate consciously so as to assure the evolutionary advantage of their type (i.e., their variant within the species)
    - The existence of variety of types enables nature to select those who fit the economic environment
  - Capture the most fundamental trade-offs in nature:
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Budget and Subsistence Consumption Constraints

$$w_t h_t^i n_t^i (\tau + e_{t+1}^i) + c_t^i \leq w_t h_t^i \equiv z_t^i$$

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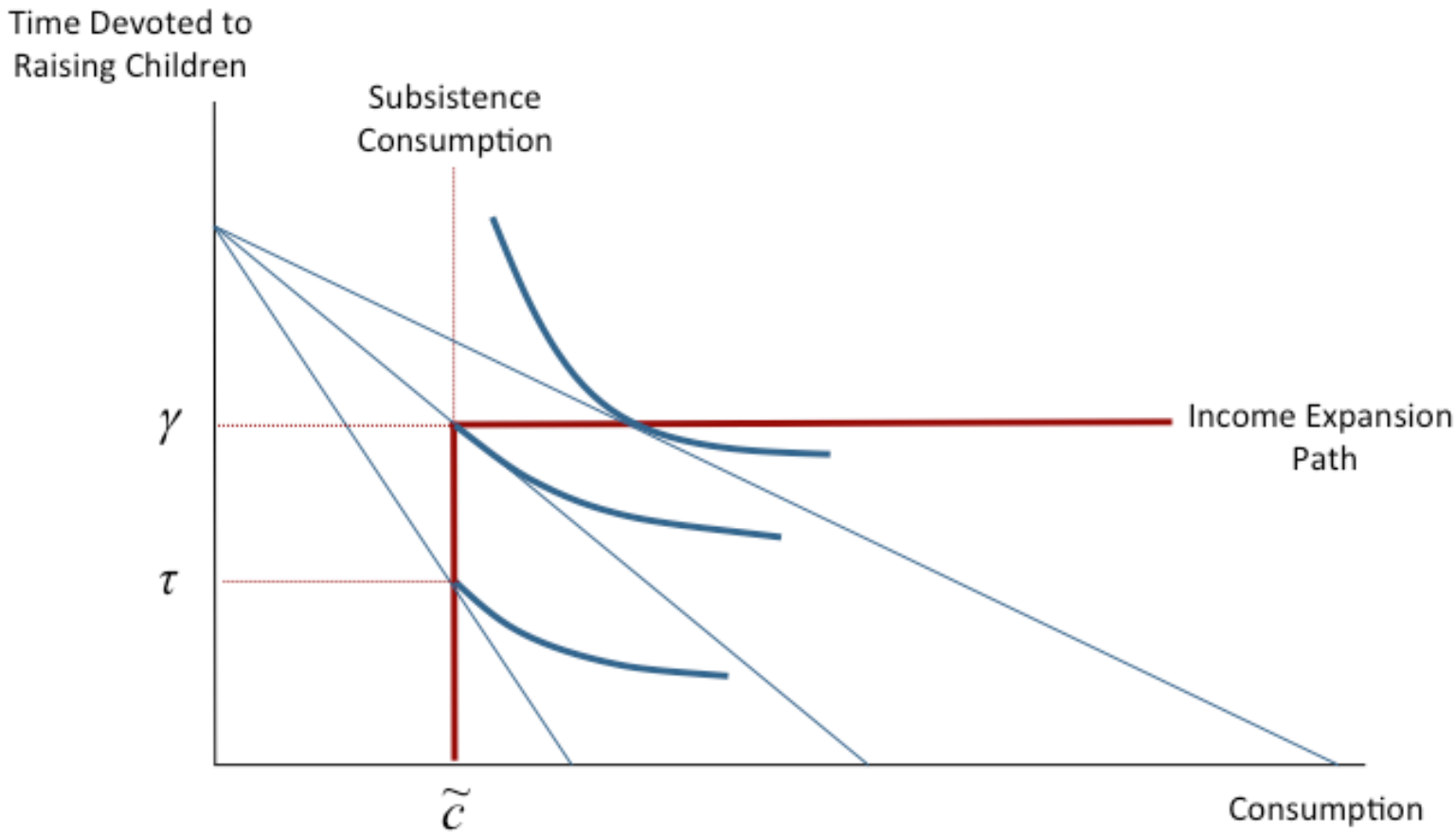
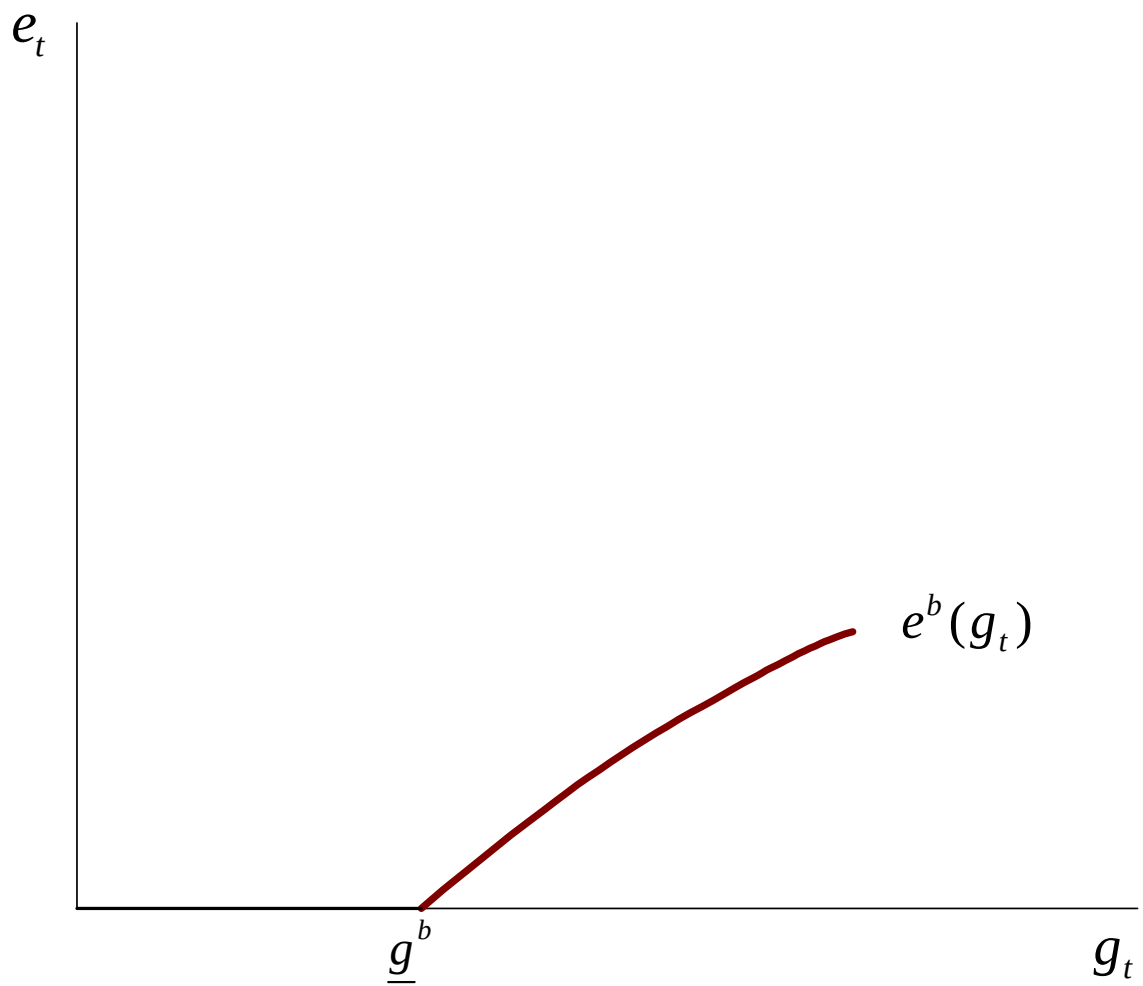
Constraint and Optimization



Optimal Investment in Child Quality of the Quantity type



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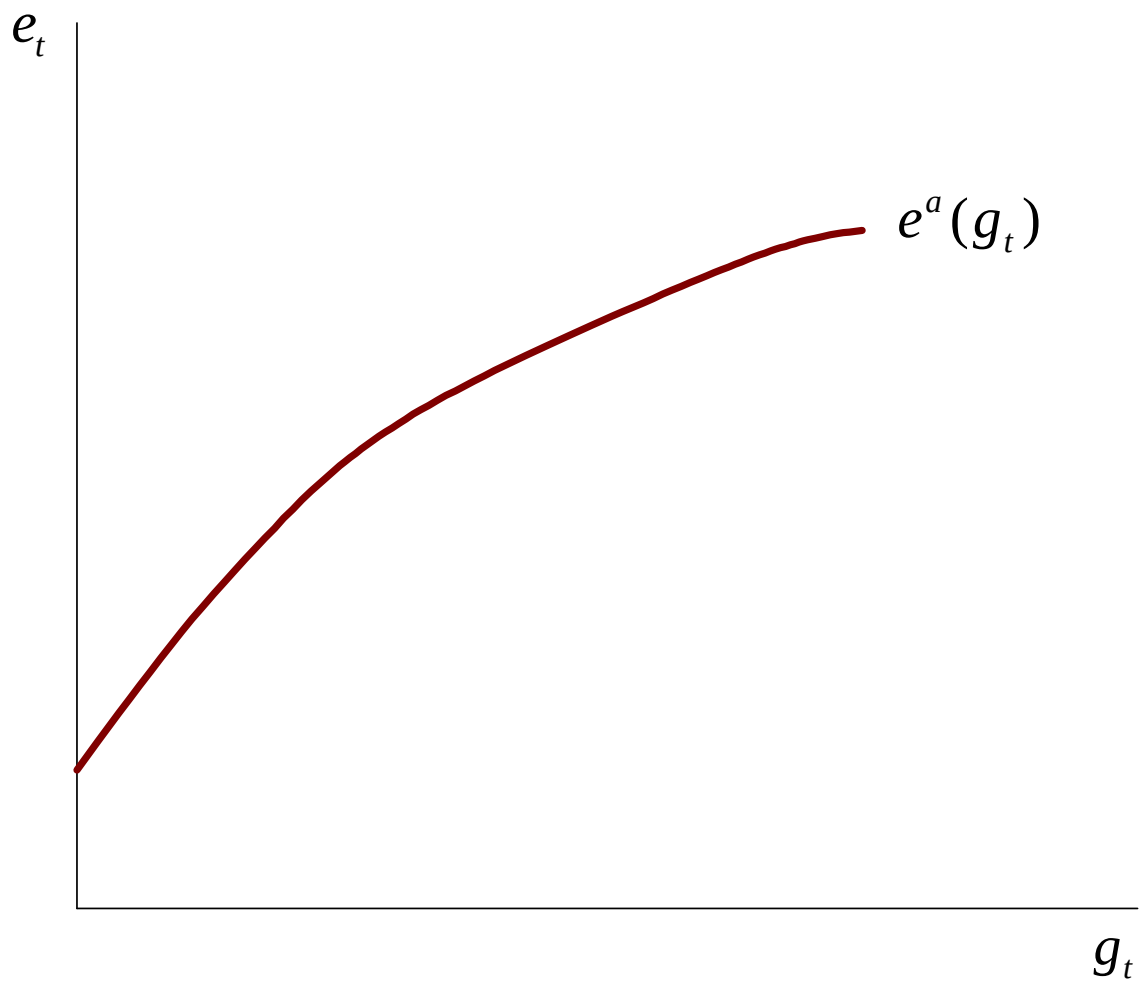
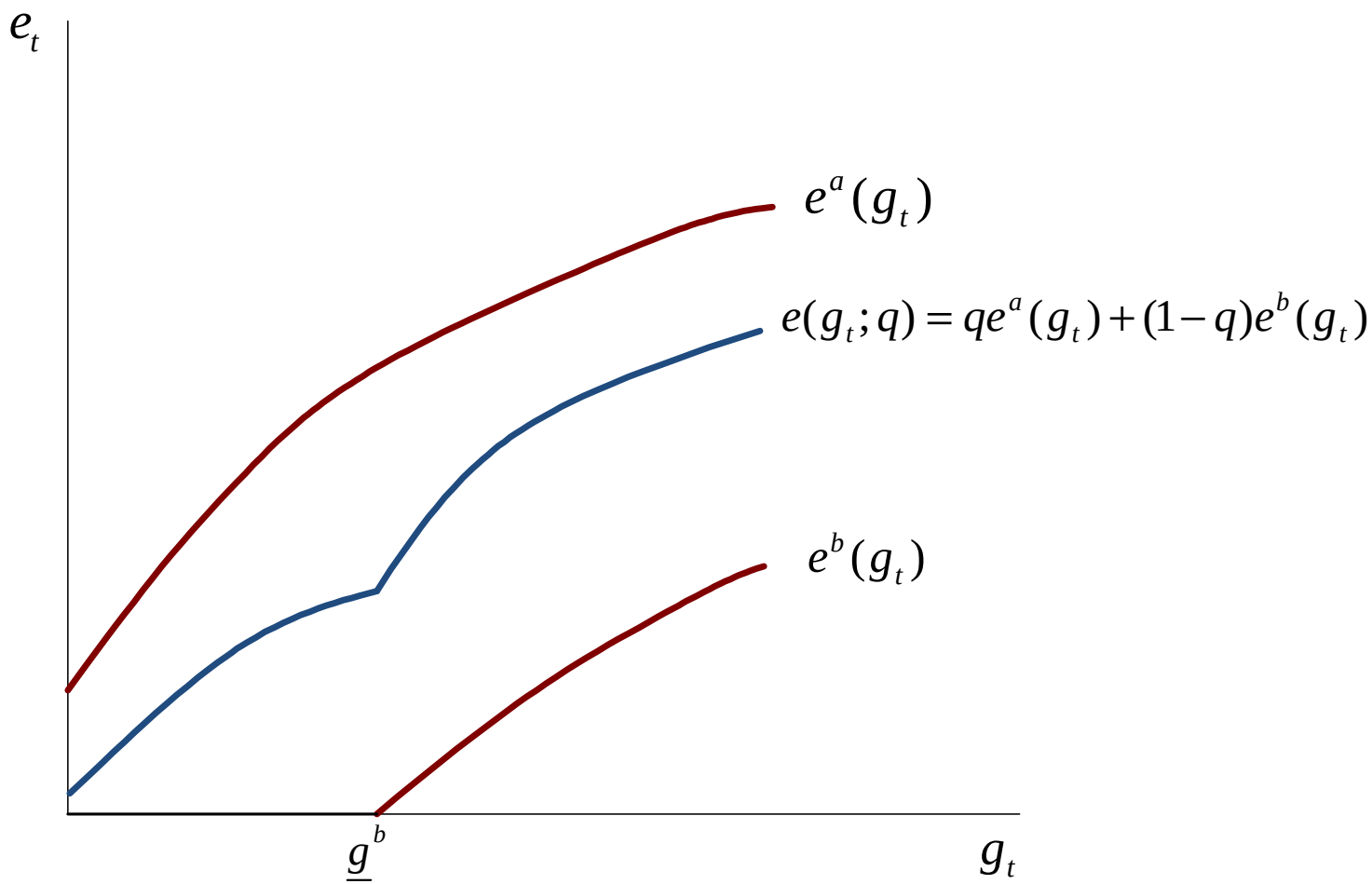
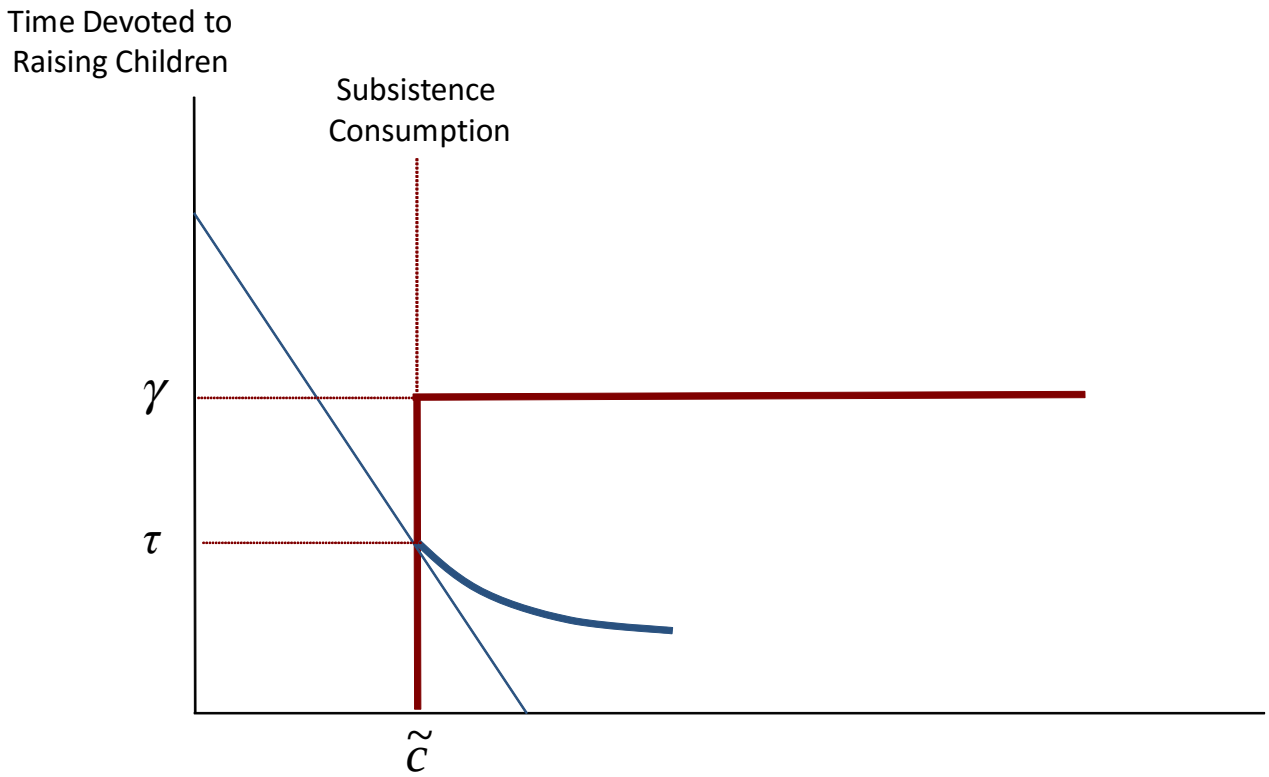


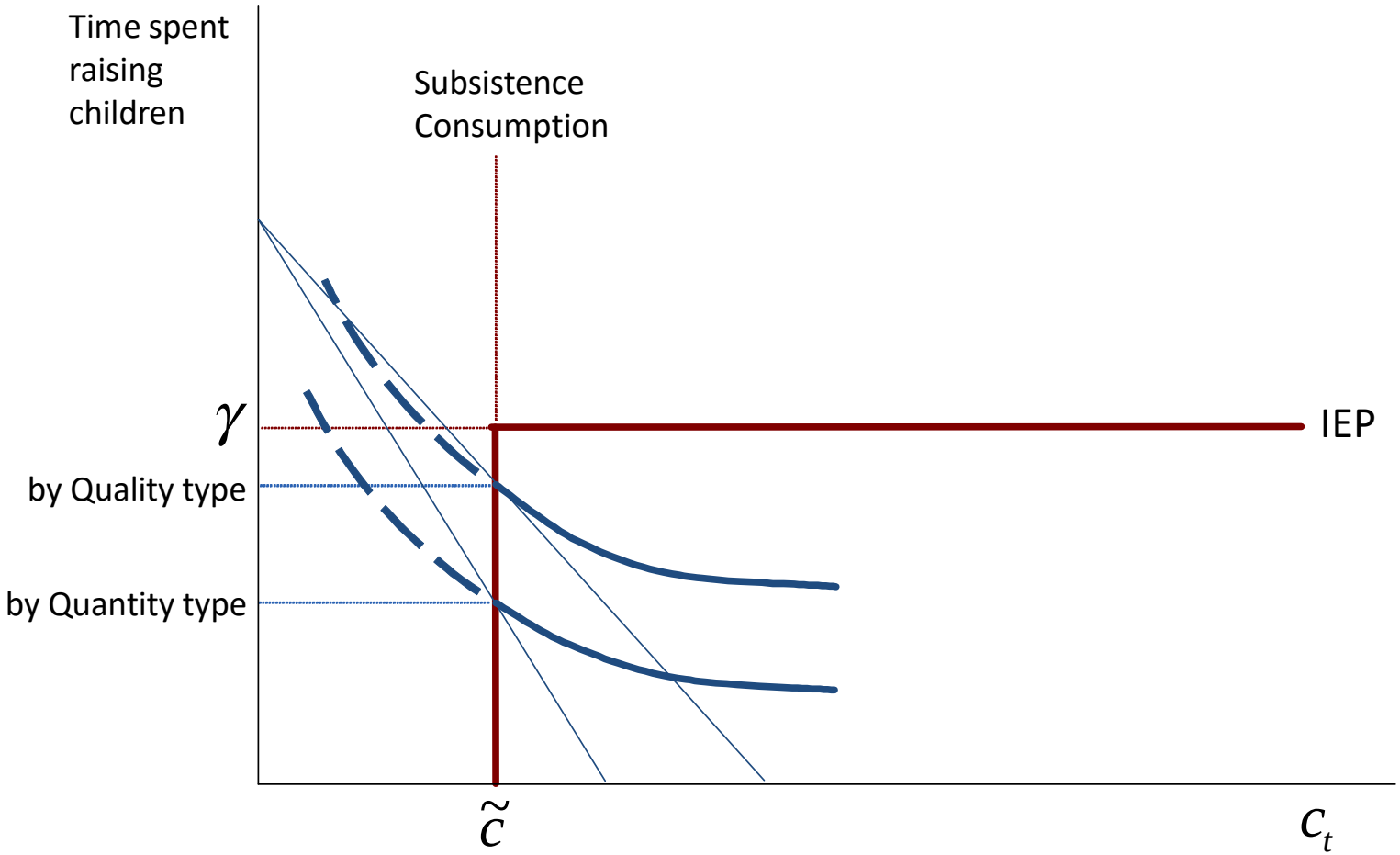
Optimal Investment in Child Quality - Quality type - and Quantity type



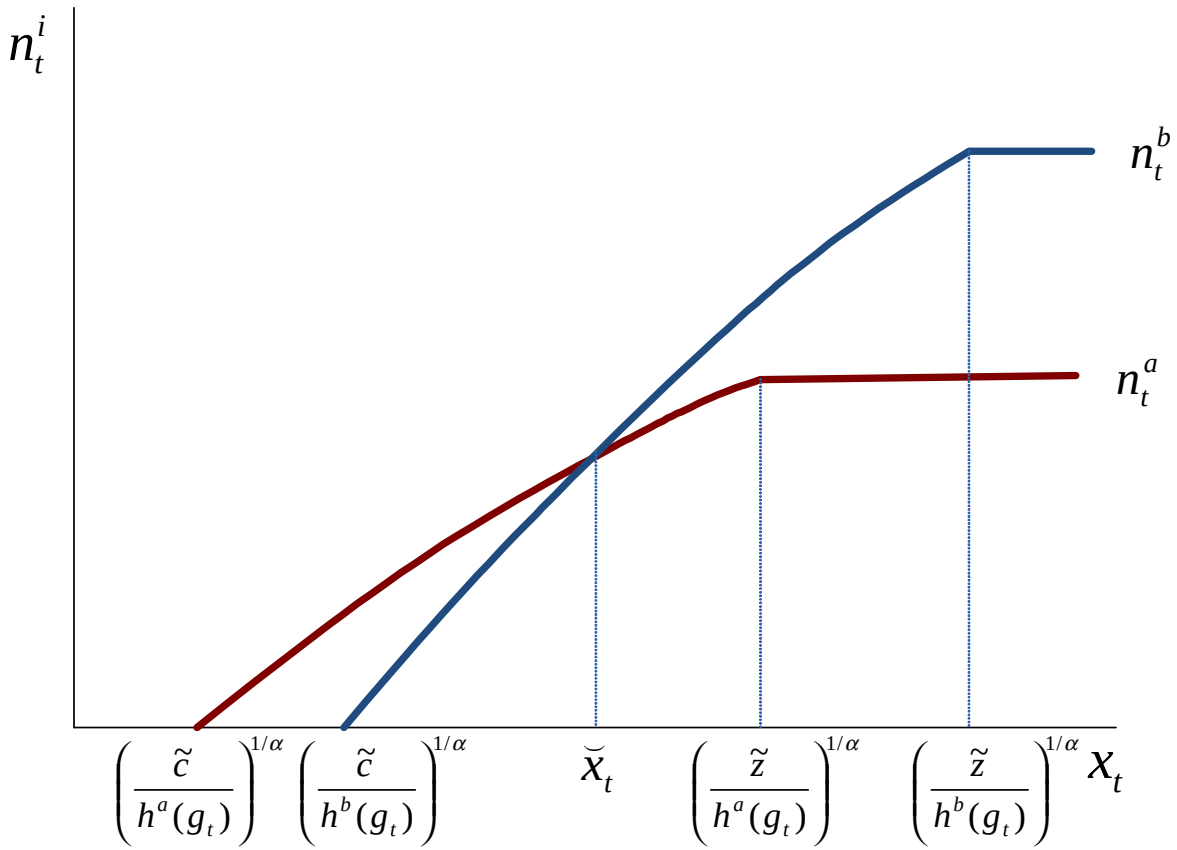
Optimization – Malthusian Epoch



Evolutionary Advantage of the Quality Type



Differential Fertlity Across Types



The Dynamical System

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

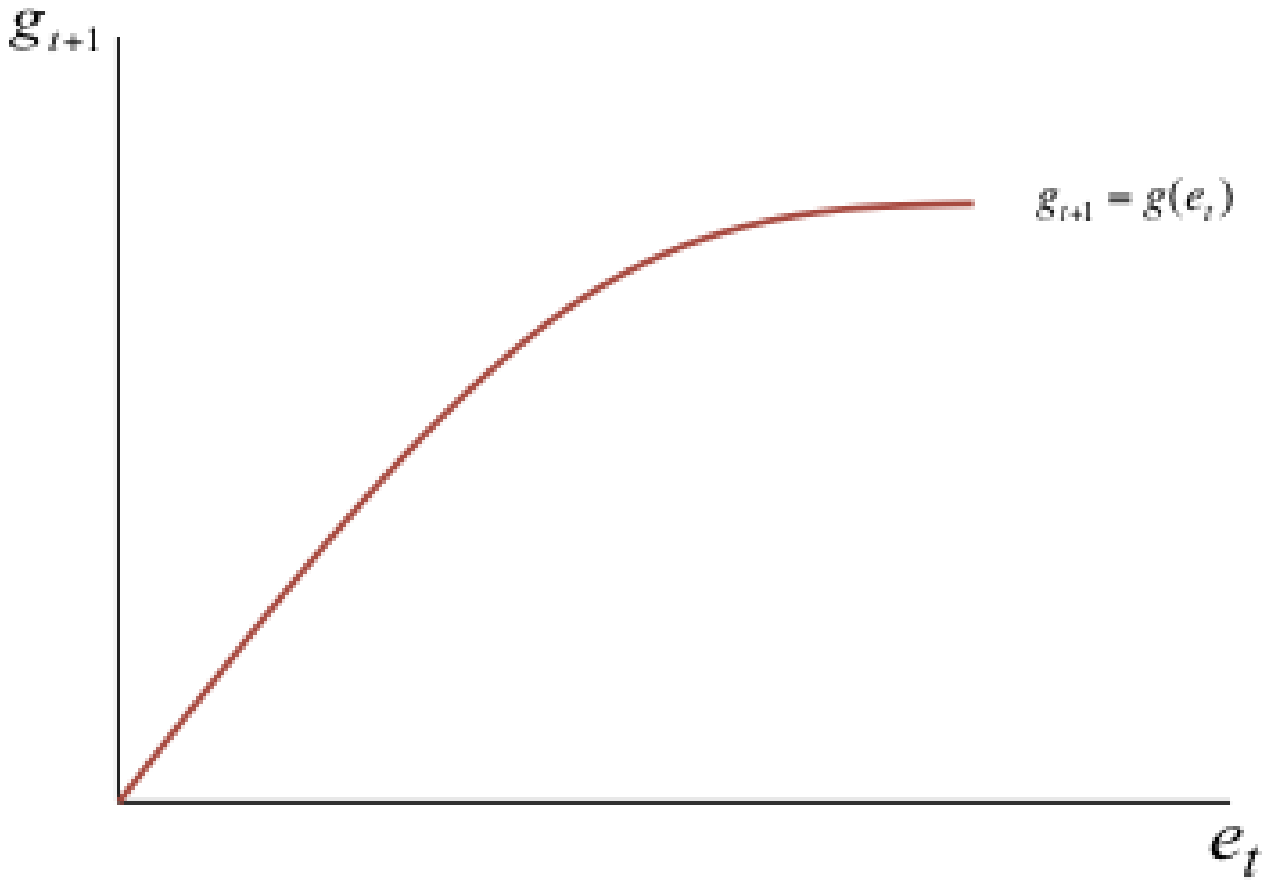
$$\begin{cases} x_{t+1} = x(g_t, x_t, q_t) \\ q_{t+1} = q(g_t, x_t, q_t) \\ g_{t+1} = \psi(e_t) \\ e_t = e(g_t, q_t) \end{cases}$$

The Conditional Evolution of Technology and Education

$\{g_t, e_t; q\}_{t=0}^{\infty}$ such that for all t

$$\begin{cases} e_t = e(g_t; q) \\ \\ g_{t+1} = \psi(e_t). \end{cases}$$

Technological Progress



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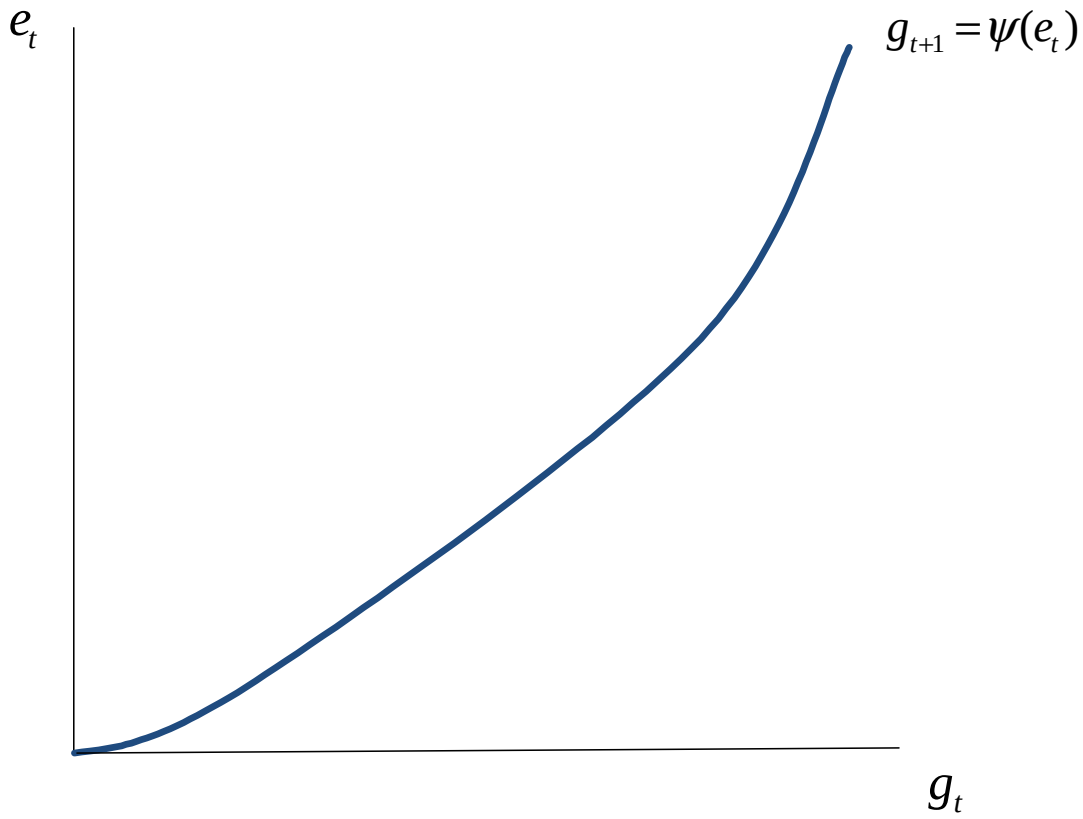
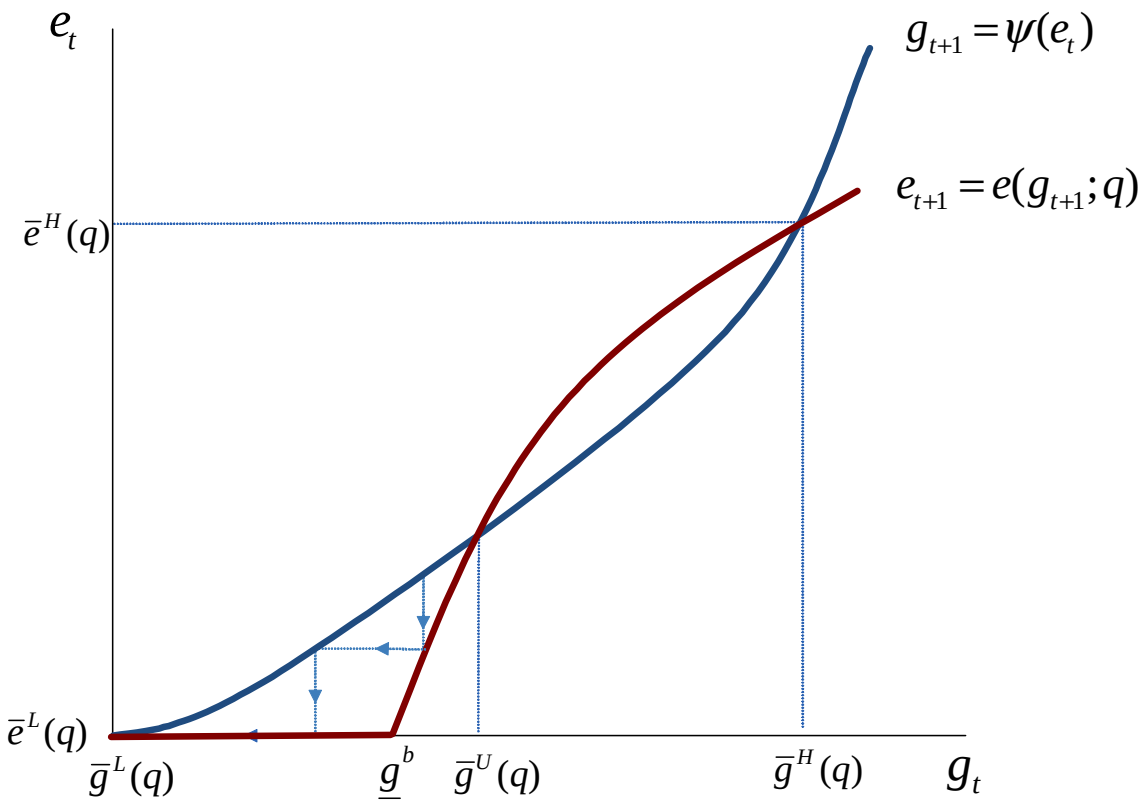
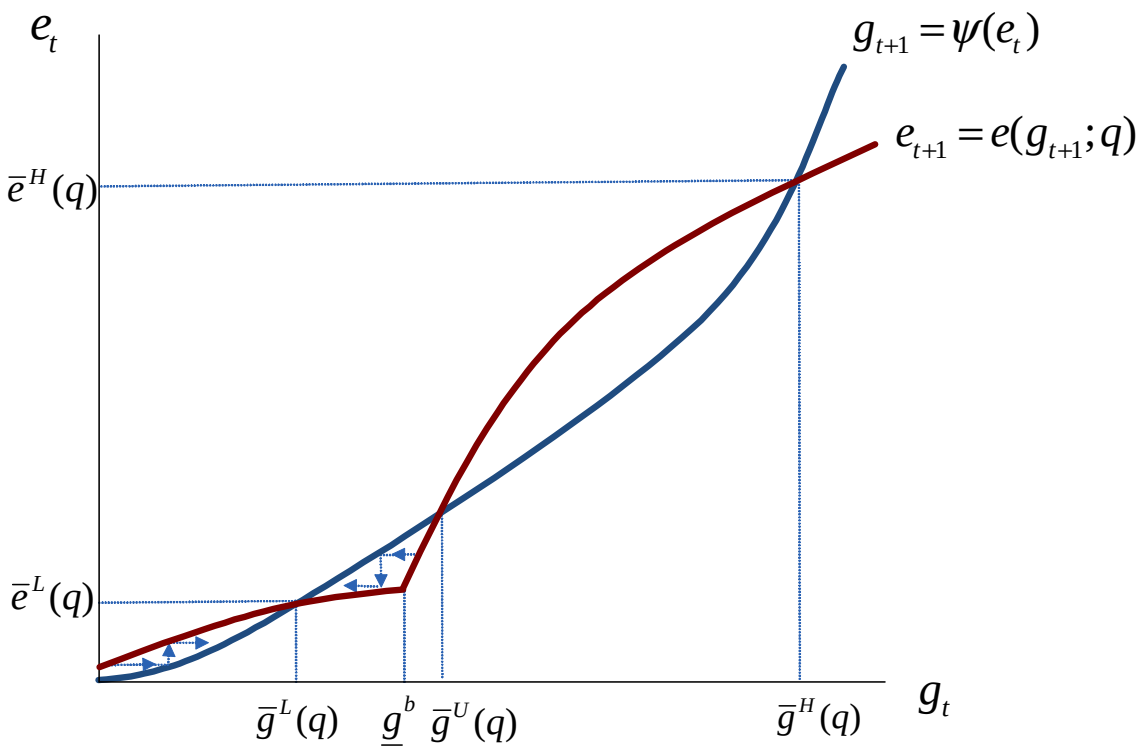


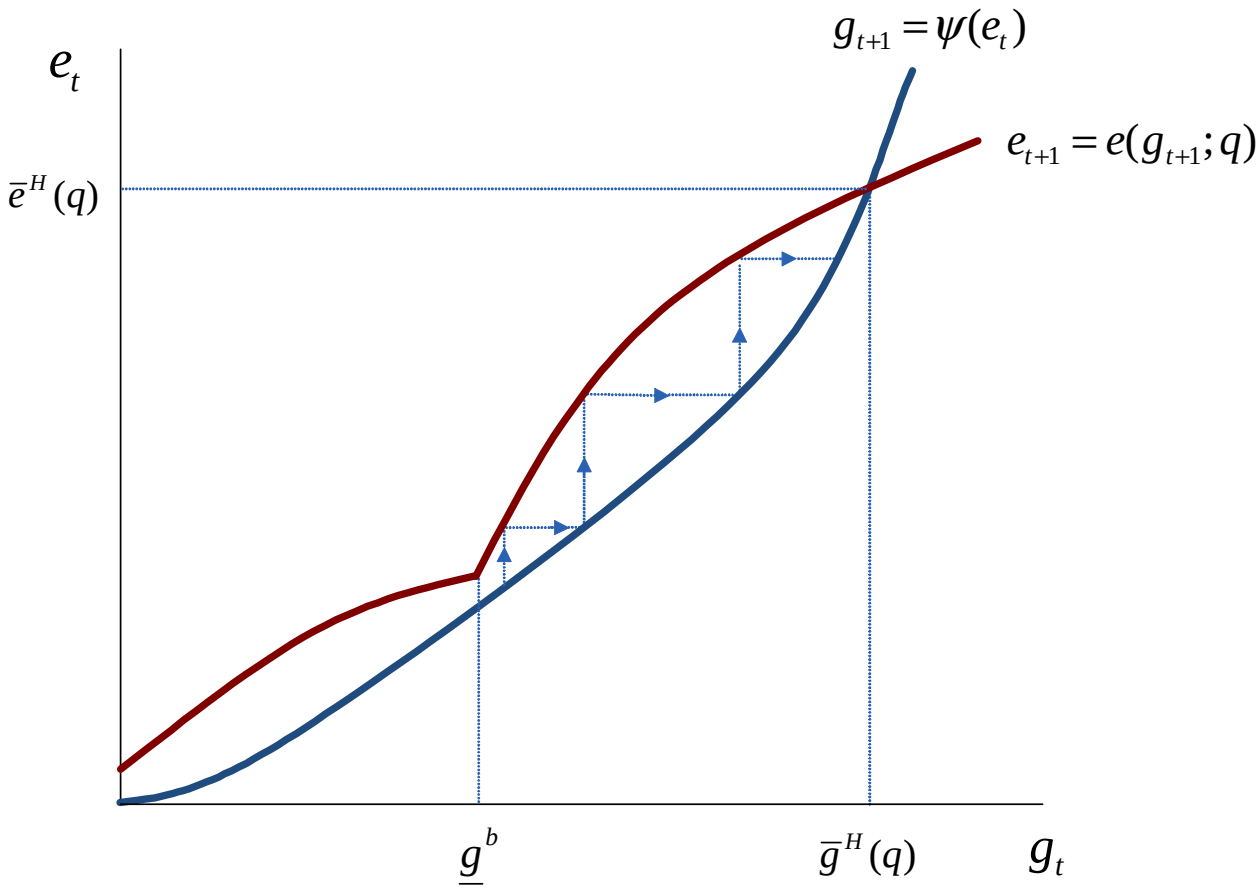
The Evolution of Education and Technology: The Fraction of the Quality Type q=0



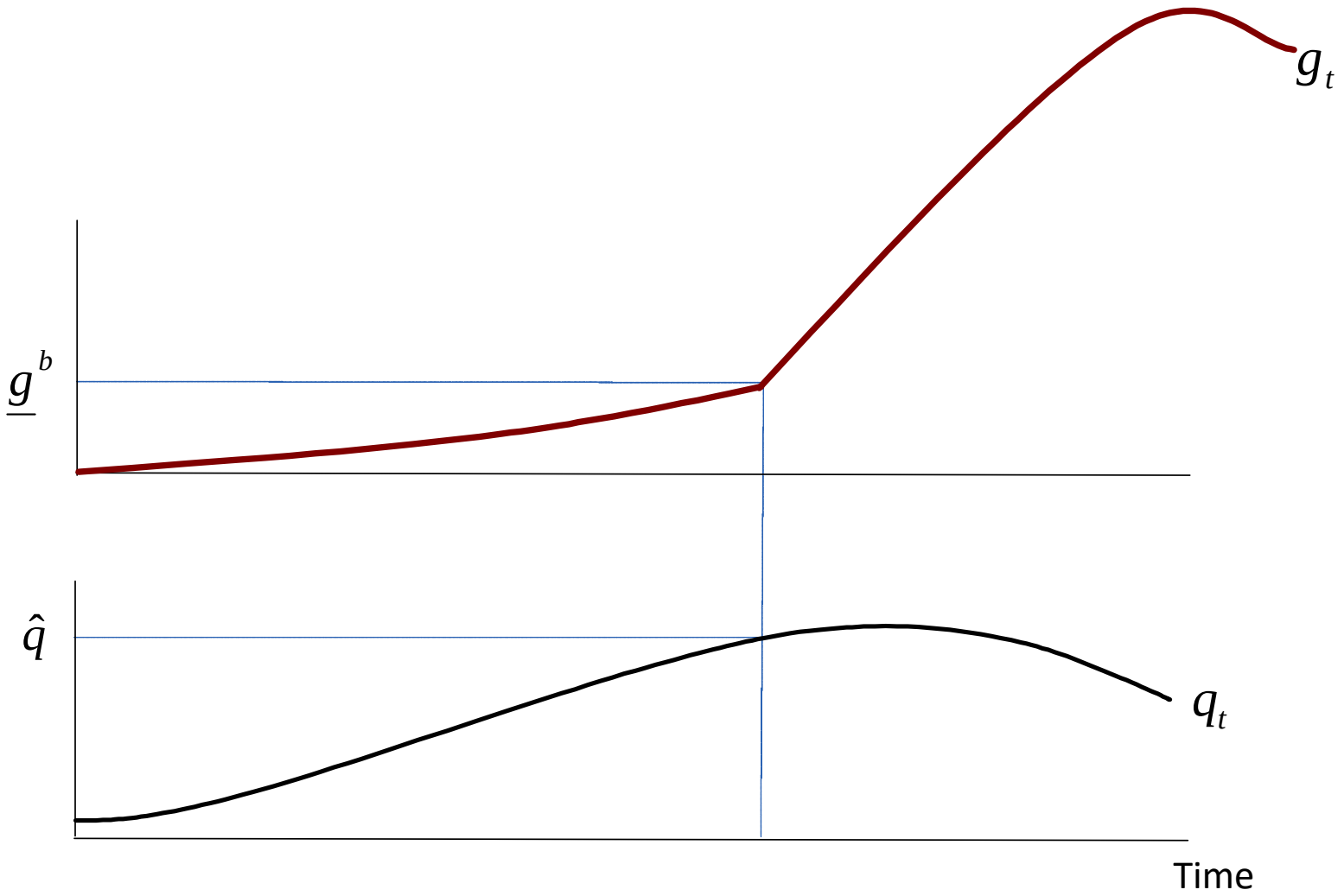
The Evolution of Education and Technology: The Fraction of the Quality Type $q > 0$



The Evolution of Education and Technology: The Fraction of the Quality Type is Above the Threshold



The Evolution of the Quality Type and TFP Growth



Conclusions

Evolutionary Growth Theory

- Complementary traits coevolve during process of development
  - Intergenerationally transmitted traits
    - e.g. genes, culture, human capital, technology
- Allows the analysis of the effect of socio-economic and geographical environment on the development process
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