

Human Evolution and Economic Development

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Economic Growth and Comparative Development

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 - Stimulated the take-off from an epoch of stagnation to sustained growth

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 - Long-Term Orientation (Galor-Özak, 2016; Galor-Özak-Sarid, 2016)

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 - Strong positive selection since the Neolithic transition (Mathieson et al., 2015)

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- 2 factors of production:
 - Labor (measured in efficiency units)
 - Land

Factor Supply

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- Efficiency units of labor evolve endogenously
 - Determined by households' decisions about the number and level of human capital of their children

Main Elements

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- Triggers of the Demographic Transition

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- Fixed factor of production – Land
 - $L \uparrow \implies AP_L \downarrow \implies y \downarrow$
- 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

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
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- Output per efficiency units of labor at time t

$$y_t = x_t^\alpha$$

- $x_t \equiv (A_t X)/H_t \equiv$ effective resources per worker

The Malthusian Structure – Effects of Technological Progress

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- Long-run (population reaches a new steady-state):
 - $L_t \uparrow \implies y \downarrow$ (back to \bar{y})

Sources of Technological Progress

- Average individuals' quality affects technological progress

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

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
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Technological Progress

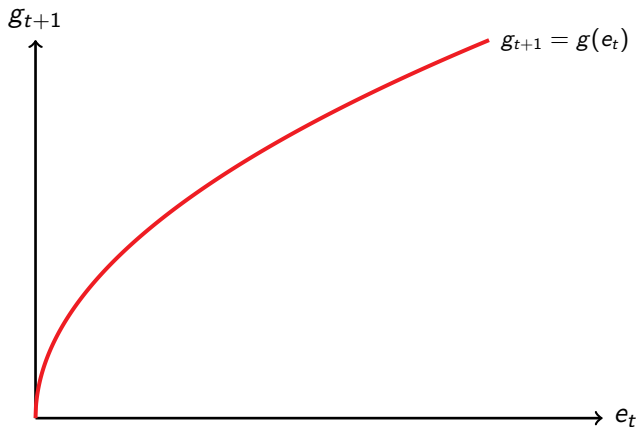
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$$\psi'(e_t) > 0; \quad \psi''(e_t) < 0; \quad \psi(0) = 0$$

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

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

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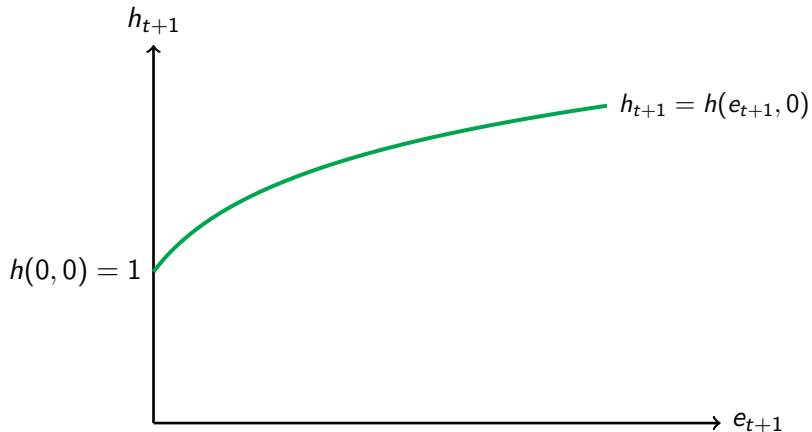
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- $h(0, g) > 0$
 - Basic level of human capital

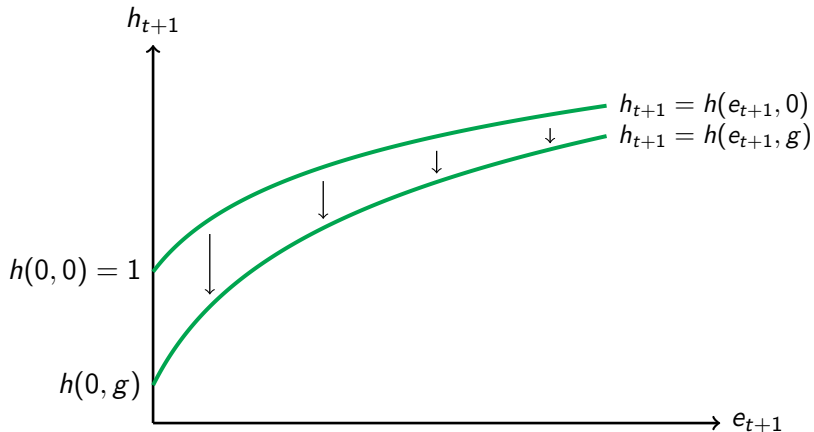
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 - Population growth declines & human capital formation increases further

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- Evolution
 - Changes in the composition of types

Preferences

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Preferences

- 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:
 - Resources allocated to the parent vs. offspring
 - Resources allocated to the number vs. quality of offspring
 - Consumption above subsistence assure that survival of the parent & lineage

Budget and Subsistence Consumption Constraints

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

- $z_t^i \equiv$ potential income of individual t
- $\tau \equiv$ time required to raise a child, regardless of quality
- $\tau + e_{t+1}^i \equiv$ time needed to raise a child with education e_{t+1}^i

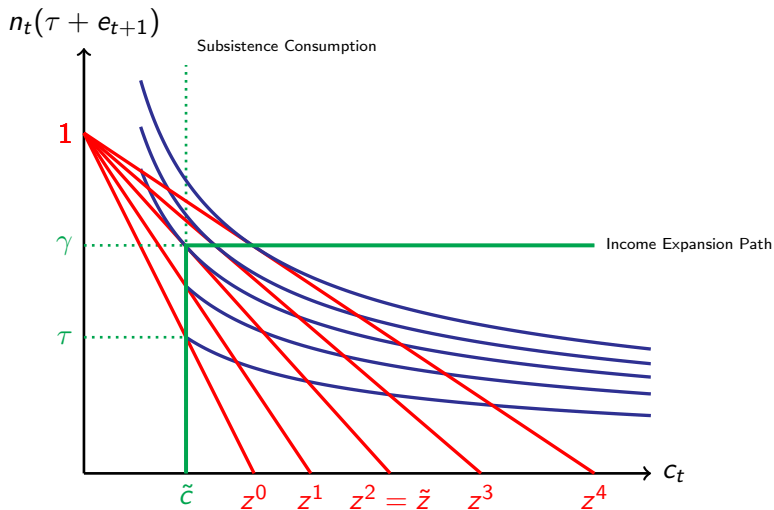
Budget and Subsistence Consumption Constraints

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

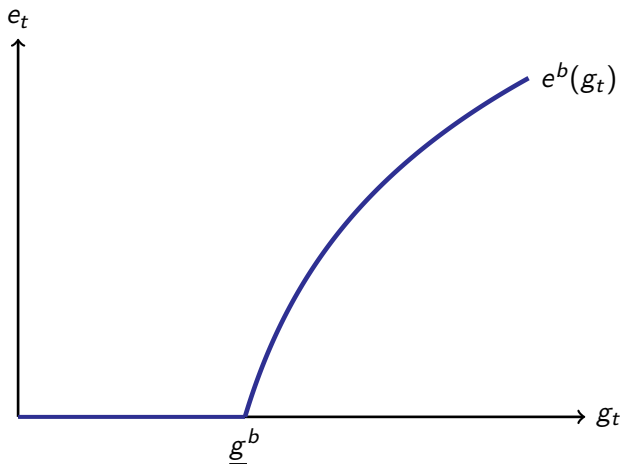
- $z_t^i \equiv$ potential income of individual t
- $\tau \equiv$ time required to raise a child, regardless of quality
- $\tau + e_{t+1}^i \equiv$ time needed to raise a child with education e_{t+1}^i
- Subsistence consumption constraint:

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

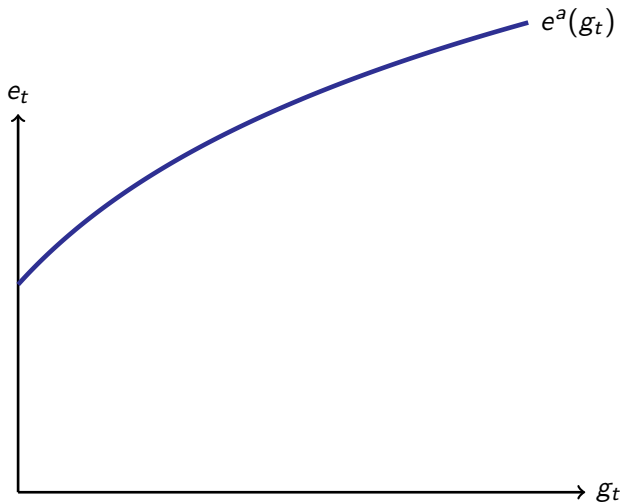
Constraint and Optimization



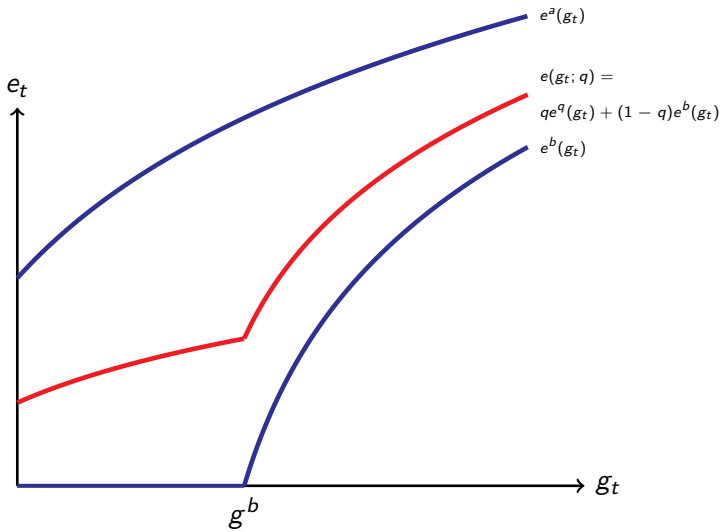
Optimal Investment in Child Quality of the Quantity type



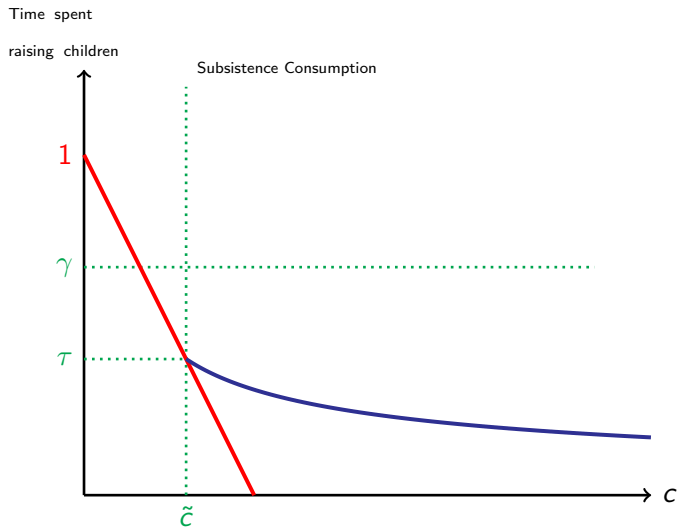
Optimal Investment in Child Quality of the Quality type



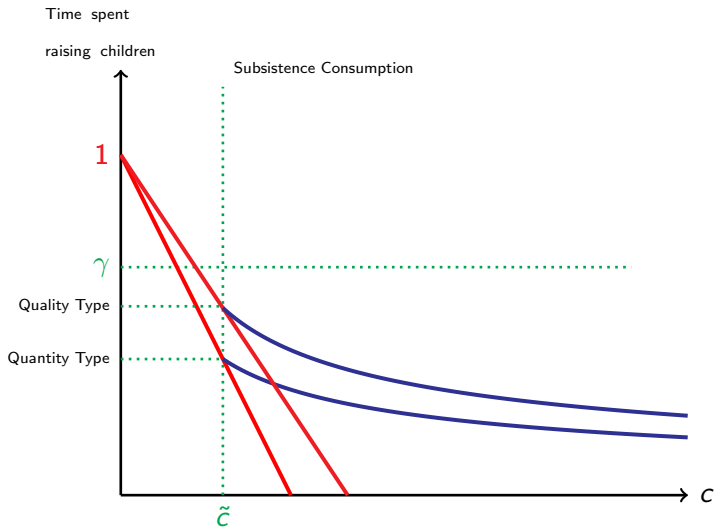
Optimal Investment in Child Quality - Quality type - and Quantity type



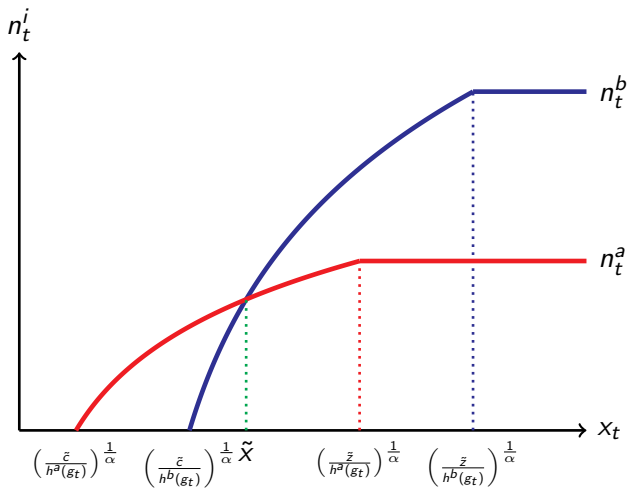
Optimization – Malthusian Epoch



Evolutionary Advantage of the Quality Type



Differential Fertility Across Types



The Dynamical System

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

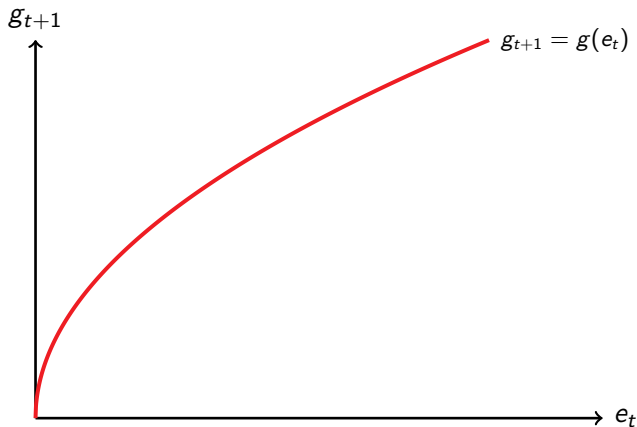
$$\begin{cases} x_{t+1} = x(g_t, x_t, q_t) \\ q_{t+1} = q(g_t, x_t, q_t) \\ g_{t+1} = \psi(e_t) \\ e_t = e(g_t, q_t) \end{cases}$$

The Conditional Evolution of Technology and Education

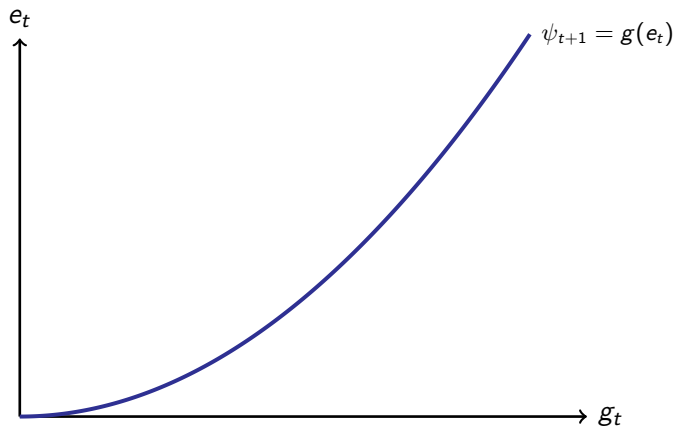
$\{g_t, e_t; q\}_{t=0}^{\infty}$ such that for all t

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

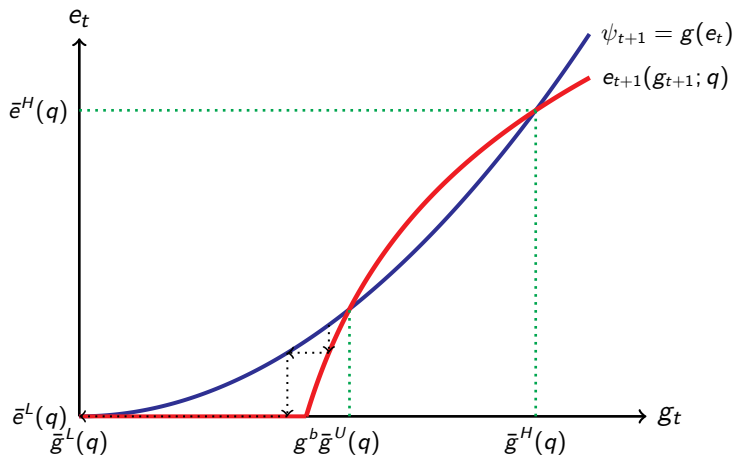
Technological Progress



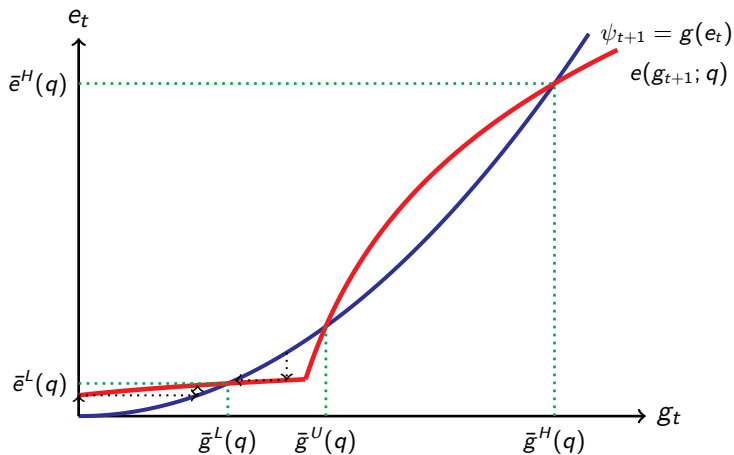
Technological Progress



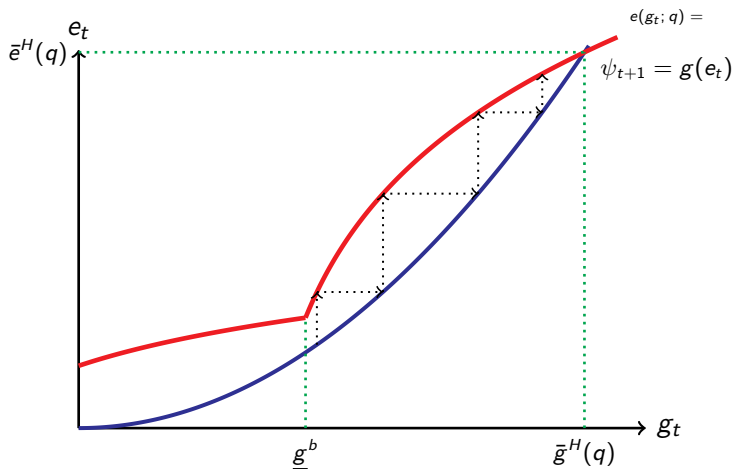
The Evolution of Education and Technology: The Fraction of the Quality Type $q = 0$



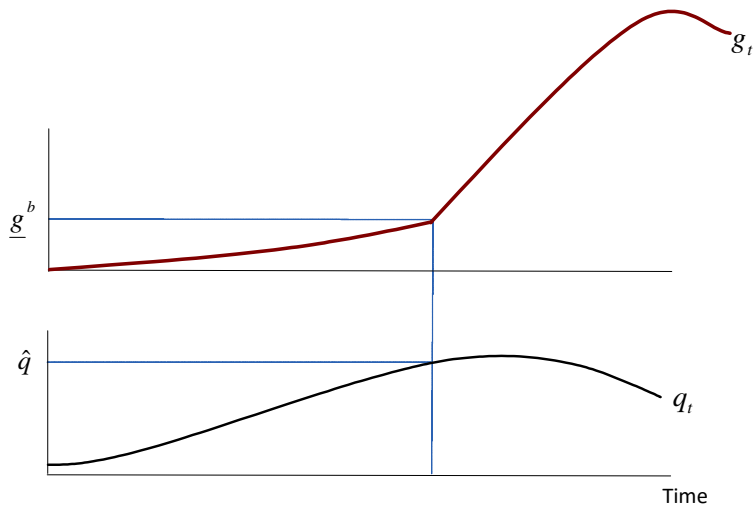
The Evolution of Education and Technology: The Fraction of the Quality Type $q > 0$



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

Conclusions

Evolutionary Growth Theory

- Complementary traits coevolve during process of development

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 - Intergenerationally transmitted traits
 - e.g. genes, culture, human capital, technology

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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
- Origins and persistent effect of culture, language and other intergenerationally transmitted traits