The New Growth Theories - Week 6

ECON1910 - Poverty and distribution in developing countries

Readings: Ray chapter 4

8. February 2011

Roadmap of today's lecture

- Endogenous vs Exogenous Growth
- Human capital
- Technical progress

Questions:

- Can we be satisfied with a theory that only assume differences in key parameters without explaining these differences?
- Technical progress does not come exogenously, but through actions. How can we take these actions to be part of the explanation theory?
- If capital, labor and technical knowledge tell the whole story of economic production, we would observe enormous differences in the rate of return to capital between rich and poor countries or an enormous flow of capital to developing countries. This is not the case. Why?

Exogenous vs. Endogenous growth theories

- Exogenous growth:
  Decisions do not affect long-run growth rate – Growth is determined from outside the model by exogenous (non choice) parameters. The choice variables together exhibit diminishing returns.

- Endogenous growth
  Decisions do affect the long-run growth rate – Growth is determined from within the model, and not simply by exogenous parameters. The choice variables together exhibit constant returns.

Endogenous Growth - Human Capital

Constant returns to scale of physical capital and Human Capital combined

H is total human capital
h is human capital per person

$$H = hP$$

$$\frac{H}{P} = h$$

For simplicity we assume that $n = \delta = 0$

Constant returns to scale of physical capital and Human Capital combined

- We modify the production function to include human capital

$$y = f(k, h) = k^{\alpha} h^{1-\alpha}$$

- Can "invest" both in physical capital k, and in human capital h.
- Income is divided into
  - Investment in physical capital sy
  - Investment in human capital qy
  - Consumption $(1 - s - q)y$

Constant returns to scale of physical capital and Human Capital combined

- Growth in capital

$$\Delta k = sy$$

- Growth in physical human capital

$$\Delta h = qy$$

- 2 assets: In equilibrium, returns to investing in each should equalize
- Uniquely determines the ratio between physical capital and human capital, as a function of parameters.

Constant returns to scale of physical capital and Human Capital combined

The ratio of human capital to physical capital, r, must be constant over time.

$$r = \frac{h}{k}$$

$$k = \frac{h}{r}$$

$$h = rk$$

Constant returns to scale of physical capital and Human Capital combined

- We can write the growth rate in the capital stock

$$\frac{\Delta k}{k} = sk^{\alpha-1}h^{1-\alpha} = sr^{1-\alpha}$$

- We can write the growth rate in the human capital stock

$$\frac{\Delta h}{h} = qk^{\alpha}h^{-\alpha} = qr^{-\alpha}$$

$$\frac{\Delta k}{k} = \frac{\Delta h}{h} \Rightarrow sr^{1-\alpha} = qr^{-\alpha} \Rightarrow r = \frac{q}{s}$$

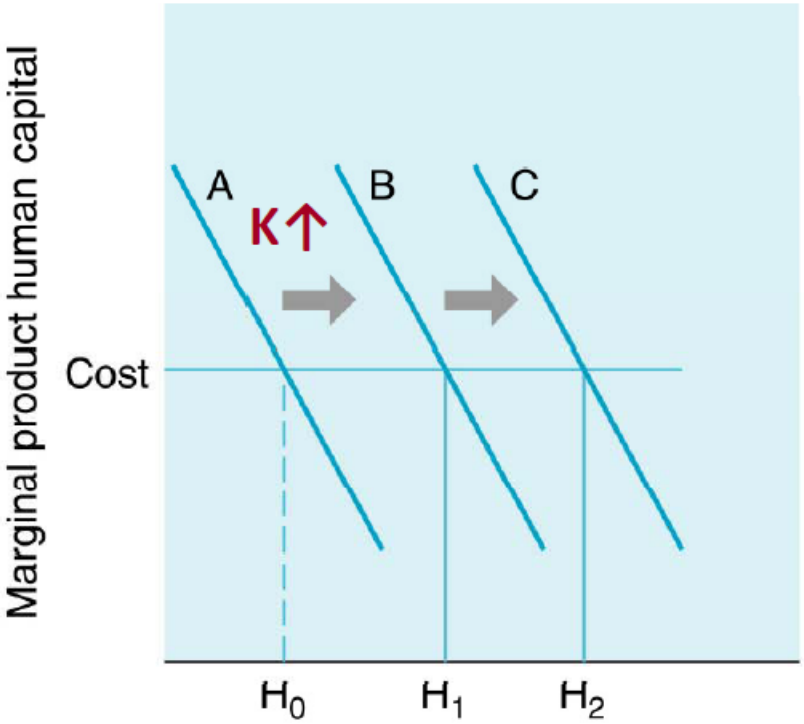
- Therefore:

$$\frac{\Delta k}{k} = \frac{\Delta h}{h} = s\left(\frac{q}{s}\right)^{1-\alpha} = q\left(\frac{q}{s}\right)^{-\alpha} = s^{\alpha}q^{1-\alpha}$$

Constant returns to scale of physical capital and Human Capital combined

$$\frac{\Delta y}{y} = \frac{\Delta k}{k} = \frac{\Delta h}{h} = s^{\alpha} q^{1-\alpha}$$

Endogenous growth - because of constant returns to scale of physical capital and human capital combined.


Marginal product human capital
Cost
A
B
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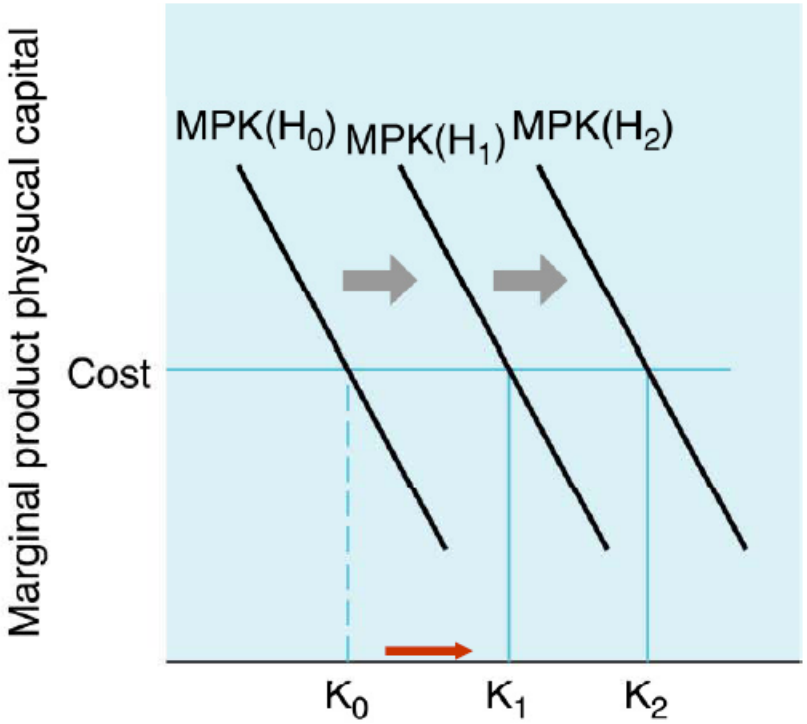
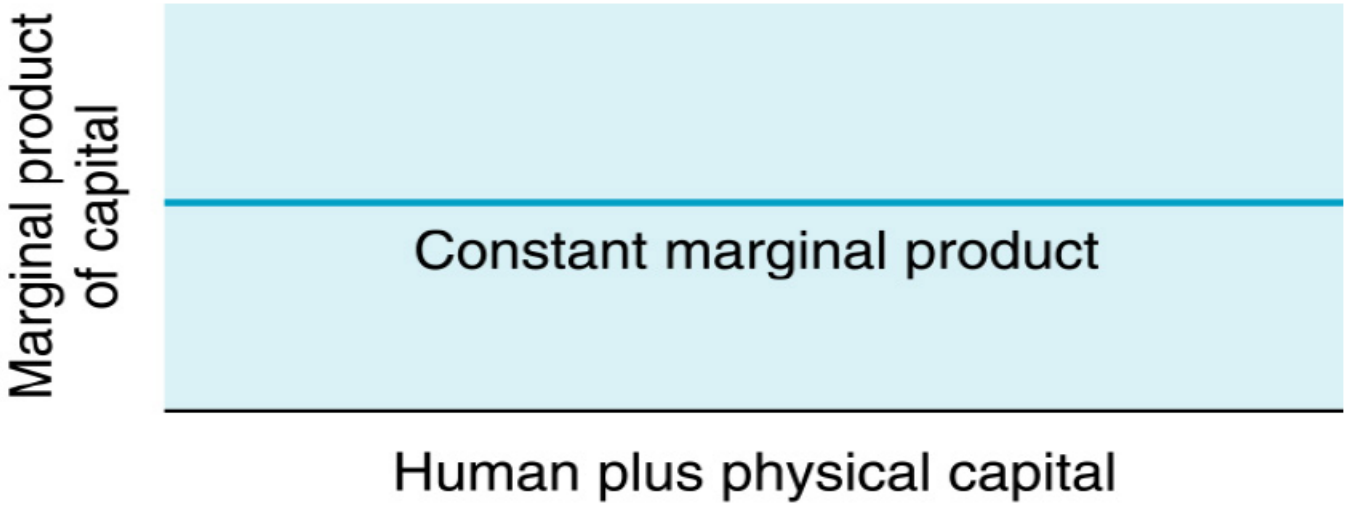
K↑
H_0
H_1
H_2


Marginal product physucal capital
Cost
MPK(H_0)
MPK(H_1)
MPK(H_2)
K_0
K_1
K_2


Marginal product of capital
Constant marginal product
Human plus physical capital

Implications

- We can have diminishing returns to physical capital and yet for there to be no convergence in per capita income.
- If countries have similar savings and technology parameters, they do grow at the same rate in the long run, but there is no tendency for their per capita incomes to come together.
- Both the rate of savings and the rate of investment in human capital now have growth-rate effects, and not just level effects.

Implications

- The growth effects are related to the constant returns to physical and human capital combined.
  - If physical and human capital together exhibit diminishing returns, we are back to exogenous growth – no growth effect of the choice variables.
- Even with diminishing returns the model can explain the overly large coefficients in the MRW analysis.
  - An increase in savings raises income, and the accumulation of both physical and human capital, so the net predicted effect on the future is now much larger than that predicted by the accumulation of physical capital alone.

Implications

- There is now a reason why the regression coefficient on population growth rates is likely to be significantly higher than the coefficient on savings rates.
  - Savings in physical capital does not account for current savings in terms of human capital.
  - An increase in the growth rate of population lowers per capita income and thereby cuts into both forms of savings.
  - An increase in physical savings is only an increase in one of two ways of savings, whereas an increase in the population growth rate diminishes both kinds of savings.
  - The coefficient on population growth is likely to exceed the coefficient on physical savings, and as we have seen, it does

Implications

- The introduction of human capital also helps to explain why rates of returns to physical capital may not be as high in poor countries as the simple Solow model predicts.
- There is shortage of unskilled labor in rich countries $\longrightarrow$ tends to lower the rate of return to physical capital.
- There is also a relative abundance of skilled labor (human capital) $\longrightarrow$ driving up the rate of return.
- The net effect $\longrightarrow$ do not expect large differences in the rate of return to physical capital.

Implications

- The model predicts no tendency towards unconditional convergence even if all parameters are exactly the same across all countries.
- Neutral toward growth - just as the Harrod-Domar model.
- It maintains the hypothesis of diminishing marginal returns to each input separately.

Implications

- Conditional convergence after controlling for human capital. By conditioning on the level of human capital, poor countries have a tendency to grow faster.

- Conditional divergence after controlling for the initial level of per capita income. By conditioning on the level of per capita income, countries with more human capital grow faster.

Empirical support? - Barro (1991)

In regression form:

$$growth_{1965-1985} = constant + \alpha X + \beta \log y_{1960} + u$$

X - education variables

y - gdp per capita

Empirical support? - Barro (1991)

- Regressions of this sort tend to show:
  - Negative estimate of β - conditional convergence
  - Positive estimates of α
  - But the magnitude is lower than that suggested by the computations in the Cobb-Douglas Example.

Endogenous Growth - Technical progress

- We can classify technical progress into two categories:
  1. Deliberate diversion of resources from current productive activity in the hope that they will result in profitable production in the future – R&D
  2. Transfer of technical knowledge
     - The new technology can become known to "outsiders" who can profit from it directly
     - The new technology may lay the groundwork for other innovative activity – Learning as a side product.
- These two notions of technological advancement have very different implications for behavior.

A model of deliberate technical progress

H - stock of human capital
E - Stock of technical know-how

- Human capital may be devoted to production or may be employed in a research sector, which produces "knowledge"
- A share u of human capital is used in production of gods, while a share $(1-u)$ is used for research.

A model of deliberate technical progress

- Production function:

$$Y_t = E_t^{\gamma} K_t^{\alpha} (uH)^{1-\alpha}$$

- The rate of growth of knowledge

$$\frac{E_{t+1} - E_t}{E_t} = a(1-u)H$$

- The capital flow

$$K_{t+1} - K_t = sY_t$$

A model of deliberate technical progress

- Technical progress occurs at some rate, but the point is that the rate is not exogenous.
- Both the stock of human capital in the economy, and its degree of utilization in R&D affect the rate of technical progress.

A model of deliberate technical progress

- There is a trade-off between production "today" and better technology "tomorrow"
- How is u actually chosen?
- In most economies, the choice of u is a decision made jointly by private economic actors, who seek economic gain.
- The degree of appropriability of the technology through patent protection and the rate of diffusion of knowledge to outsiders become important factors.
- If you want private initiative for research, you need some kind of intellectual property rights.

Externalities, technical progress, and growth

- An externality is an unintended consequence of an action.
- Imagine that the economy is populated with several firms and each firm is equipped with a production function

$$Y_t = E_t K_t^{\alpha} P_t^{1-\alpha}$$

- E is overall productivity in the economy, common to all firms.
- E is a positive externality generated by the joint capital accumulation of all firms in the economy.
- The external productivity term is related to the average stock by the equation:

$$E = a\bar{K}^{\beta}$$

- $\bar{K}$ is the average capital stock in the economy.

Externalities, technical progress, and growth

- Then the production function of each firm becomes:

$$Y = a\bar{K}^{\beta} K P^{1-\alpha}$$

- In the presence of positive externalities, firms tend to underinvest in capital accumulation relative to what is considered optimal.
- If we assume that all firms are identical, the aggregate production function is:

$$Y = aK^{\alpha+\beta} P^{1-\alpha}$$

- This production function exhibits increasing returns to scale.
- Positive externalities between economic activities may lead to increasing returns to scale on the "macro" level.

Total factor productivity growth

- TFP means Total Factor Productivity.
- TFP growth is "growth that is not due to any change in factors of production". If you have higher GDP because you save more, that is not TFP growth.
- TFP is similar to the "technology parameter"

Variables that have been considered important for growth

* corruption, * democracy, * education, * fertility,* black market premium, * financial sophistication, * inequality,* inflation, * latitude, * civil liberties, * population growth,* price levels of investment, * religion, * rule of law, * trade, * war,* trust, * savings, * openness, * development aid, * structural funds,* fraction of GDP in mining, * R&D expenditures, * landlocked,* taxes, * social security system, * age composition of the population,* public consumption, * public investment, * social capital,* regulatory quality, * government effectiveness . . .

. . . and many many more

Summing up

- Despite its simplicity, the Solow model has enough substance that we can take it to data in various different forms.
- Is safe to say that consensus favors the interpretation that cross-country differences in income per capita cannot be understood solely on the basis of differences in physical and human capital.
- Non of the models have examined fundamental causes of differences in prosperity.
- Why some societies make choices that lead them to low physical capital, low human capital and inefficient technology and thus to relative poverty.