ENDOGENOUS GROWTH MODELS – ROMER MODEL

EE 462 Development Macroeconomics

Semester 1/2015

Topics

- Basic Elements of Romer Model
- Growth in Romer Model
- Special Cases
- Comparative Statics: A Permanent Increase in R&D

Endogenous Growth Theory

- The *endogenous growth theory* or *new growth theory* focuses on understanding the economic forces underlying technological progress.
- Technological progress is driven by profit-maximizing firms or investors' own interests.
- The Romer model endogenizes technological progress by introducing the search for new ideas by researchers interested in profiting from their inventions.
- This model is aimed to explain mainly why and how the advance countries exhibit sustained growth.
- Technological progress is driven by *research and development (R&D)*.

Romer Model: Basic Elements (1)

- Romer (1990) and Jones (1995) use a model of firms that invest in R&D.
- The production function is given by:

$$Y = K^{\alpha}(AL_Y)^{1-\alpha}, \qquad (0 < \alpha < 1) \qquad \text{-- (1)}$$

where A = a given level (or stock) of knowledge

L_Y = labor used in the production sector

L = total labor: $L = L_Y + L_A$ (L_A = labor used in R&D)

➢ The production function exhibits CRTS w.r.t. K and L, but exhibits IRTS w.r.t. all three inputs (K, L, and A).

- Capital accumulations as people forego consumption at rate s_K.

$$\Delta K = s_K Y - dK \qquad \text{-- (2)}$$

Romer Model: Basic Elements (2)

- Labor (equivalent to population) grows at a constant rate *n*:

$$\frac{\Delta L}{L} = n \qquad \text{-- (3)}$$

- Romer assumes that the number of new ideas (ΔA) at any given point in time is can be derived from:

$$\Delta A = \bar{\delta} L_A, \qquad \text{-- (4)}$$

where L_A is the number of people attempting to discover new ideas, and $\bar{\delta}$ is the rate at which new ideas are discovered.

- $\bar{\delta}$ could a function of A: $\bar{\delta} = \delta A^{\phi}$ -- (5)
  - $\phi > 0$ → Productivity of research increases with the stock of knowledge
  - $\phi < 0$ → the “fishing out” case
  - $\phi = 0$ → Productivity of research is independent of the stock of knowledge

Romer Model: Basic Elements (3)

- Also, it is possible that the average productivity of research depends on the number people searching for new ideas.
- The general production function for ideas can be written as:

$$\Delta A = \delta A^{\phi} {L_A}^{\lambda} \qquad \text{-- (6)}$$

where $\phi < 1$ and $\lambda \in (0,1)$, according to Jones (1995).

- One can think λ as the "originality of idea", and ϕ as the "knowledge spillover".
  - $\lambda < 1$ ➔ an externality associated with duplication
  - $\phi > 0$ ➔ positive knowledge spillover in research
- Suppose further that $L_A/L = s_R$ ➔ $L_Y/L = 1 - s_R$ -- (7)

Growth in Romer Model

- Along the balance growth path, one can show that

$$g_y = g_k = g_A \qquad \text{-- (8)}$$

- Question: What determine the growth rate of A (i.e. growth rate of ideas)?
- Define the *growth rate of ideas* as $g_A = \Delta A / A$.
- Recall that $\Delta A = \delta A^{\phi} {L_A}^{\lambda}$. Hence,

$$\frac{\Delta A}{A} = \delta A^{\phi - 1} {L_A}^{\lambda}. \qquad \text{-- (9)}$$

- Along a balanced growth path, $\Delta A / A \equiv g_A$ is constant. Taking logs and derivatives of both sides of equation (9) gives:

$$g_A = \frac{\lambda n}{1 - \phi}. \qquad \text{-- (10)}$$

Special Cases in Romer Model

- Case 1: Assume $\lambda = 1$ and $\phi = 0$.
  - No duplication problem in research and the productivity of a researcher today is independent of the stock of ideas previously discovered.

$$\rightarrow \Delta A = \delta L_A$$

$$\rightarrow g_A = \frac{\Delta A}{A} = \text{n}$$

- Case 2: Assume $\lambda = 1$ and $\phi = 1$.

$$\rightarrow \Delta A = \delta L_A A$$

$$\rightarrow g_A = \frac{\Delta A}{A} = \delta L_A$$

Comparative Statics: A Permanent Increase in R&D Share

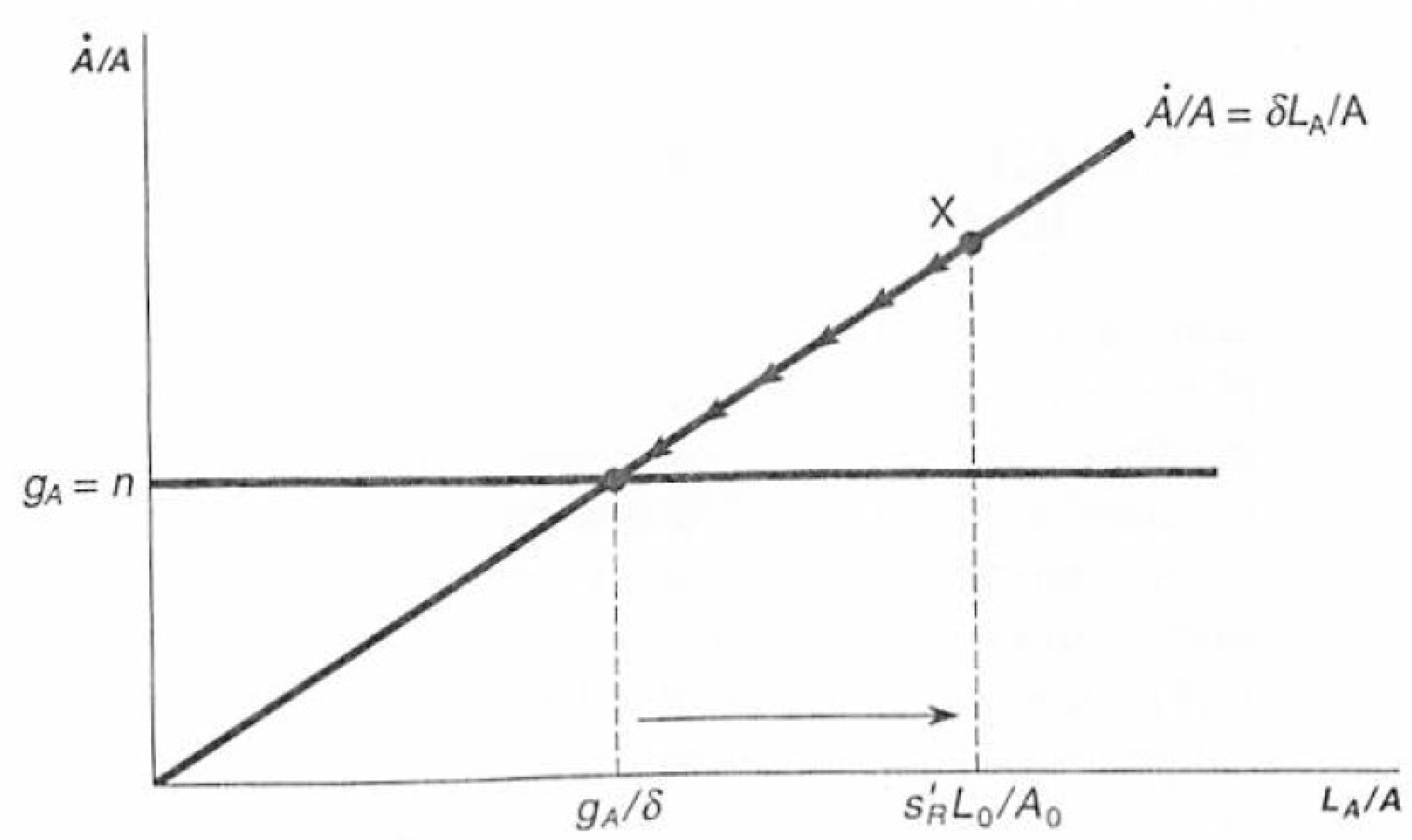
- For simplicity, assume $\lambda = 1$ and $\phi = 0$. Equation (9) can be rewritten as:

$$\frac{\Delta A}{A} = \delta \frac{S_R L}{A}, \qquad \text{-- (11)}$$

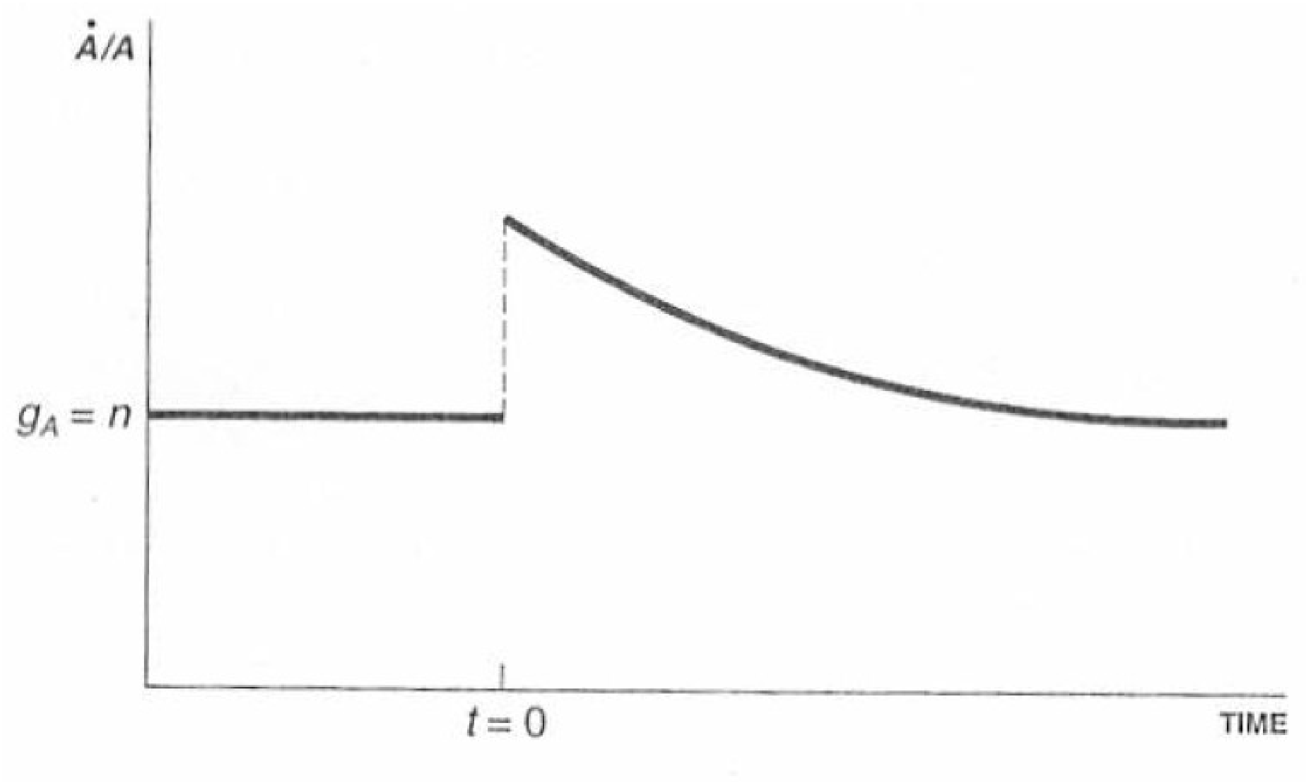
where S_R is the share of labor engaged in R&D.

- Question: What happens to the per capita output (y) if S_R increases?
  - Need to know the impact of an increase in R&D share on technological progress.
  - Use a Solow framework to derive output per effective labor and output per worker along a balanced growth path.

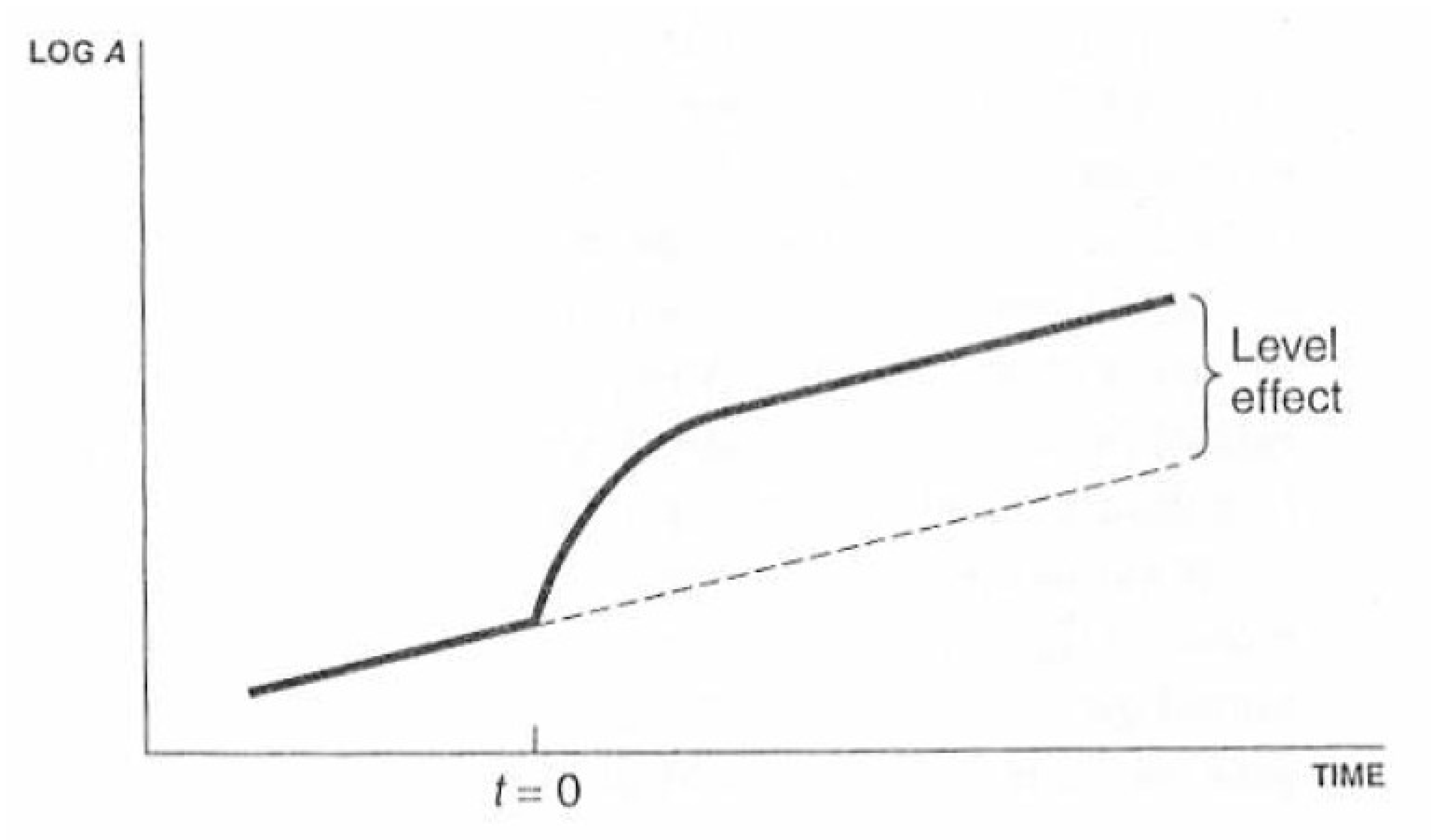
Technological Progress: An Increase in The R&D Share



Technological Progress Over Time



The Level of Technology Over Time



Steady-State Output Per Capita

- Based on the Solow framework, the ratio *y/A* along a balanced growth path is constant and is given by:

$$\left(\frac{y}{A}\right)^{*} = \left(\frac{s_K}{n+g_A+d}\right)^{\alpha/(1-\alpha)} (1 - s_R) \qquad \text{-- (12)}$$

- Also, along a balanced growth path, from equation (11), the level of *A* can be solved in terms of the labor force:

$$A = \delta \frac{S_R L}{g_A} \qquad \text{-- (13)}$$

- Based on the above information, we can derive:

$$y^{*} = \left(\frac{s_K}{n+g_A+d}\right)^{\alpha/(1-\alpha)} (1 - s_R) \frac{\delta S_R}{g_A} L \qquad \text{-- (14)}$$

  - S_R affects y* both negatively (more researchers=fewer workers producing output) and positively (more researchers = more ideas).

Implications

- Population growth is the *only source of* technological progress and any long-run growth in per capita income.
  - ➢A higher population growth in the Romer model means a *higher long-run economic growth rate.*
- Government cannot change the growth rate of per capita income by *any* policy <u>except</u> a policy to increase the fertility rate.
- For instance, a policy of increasing the R&D share of labor s_R cannot change the long-run growth rate of the economy. Why?
  - ➢They only increase the growth rate during the transition period (but not in the long run).