The Romer Model: Policy Implications

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Policies have level effects

What are the effects of government policies?

We may expect policies to affect saving (s_K), R&D (s_A), or population growth (n).

Consider the case of $\phi < 1$, where growth is

$$g(A) = \frac{\lambda \ n}{1 - \phi} \tag{1}$$

Main result: Policies that affect only saving or investment in R&D (s_A) do not affect long-run growth.

Note: For policies that do not affect R&D the model behaves exactly like the Solow model.

R&D Subsidies

Consider a permanent increase in s_A.

We must consider two equations:

$$g(A) = B \ (s_A L)^{\lambda} \ A^{\phi - 1} \tag{2}$$

$$\dot{K} = s_K \ Y - d \ K \tag{3}$$

Note: Behavior of A is independent of K and Y.

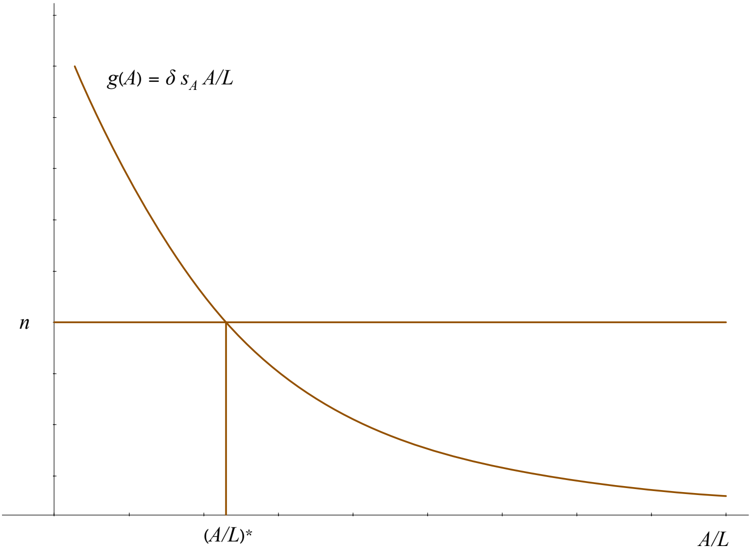
Simplify by assuming $\lambda = 1$ and $\phi = 0$ so that

$$g(A) = B \ s_A \ L \ / \ A \tag{4}$$

Balanced growth rate:

$$g(A) = n$$

R&D Subsidies



R&D Subsidies

On a **BGP**, (4) determines A/L:

$$g(A) = n = Bs_A L/A \tag{5}$$

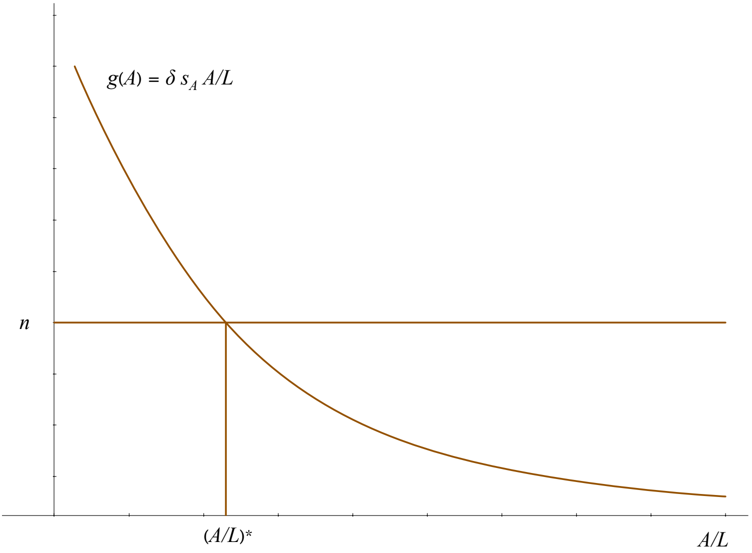
implies

$$(A/L)^* = \frac{B\ s_A}{n} \tag{6}$$

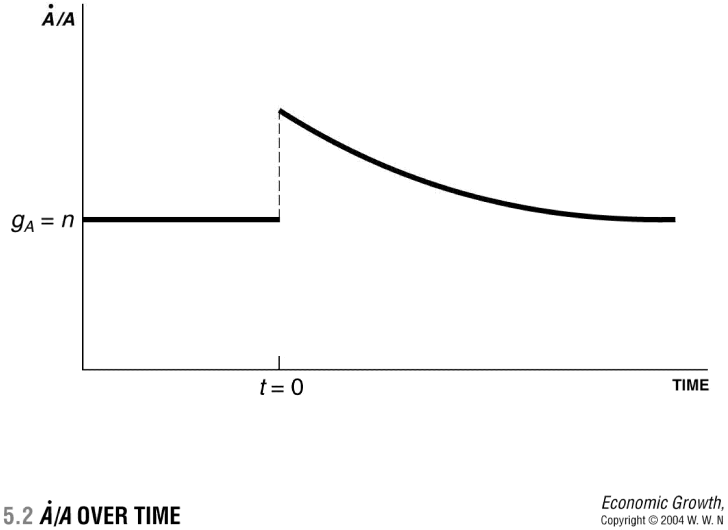
Transition:

- As long as L/A is above BGP, $g(A) > n$ is above BGP.
- Therefore, $g(A)$ declines over time until it reaches n.
- The BGP is stable.

Transition path after an increase in s_A



Time path of the growth rate of ideas



A period of faster innovation builds up more ideas.

Time path of A

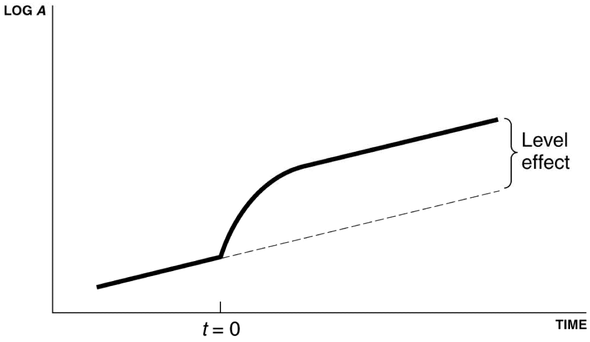


FIGURE 5.3 THE LEVEL OF TECHNOLOGY OVER TIME

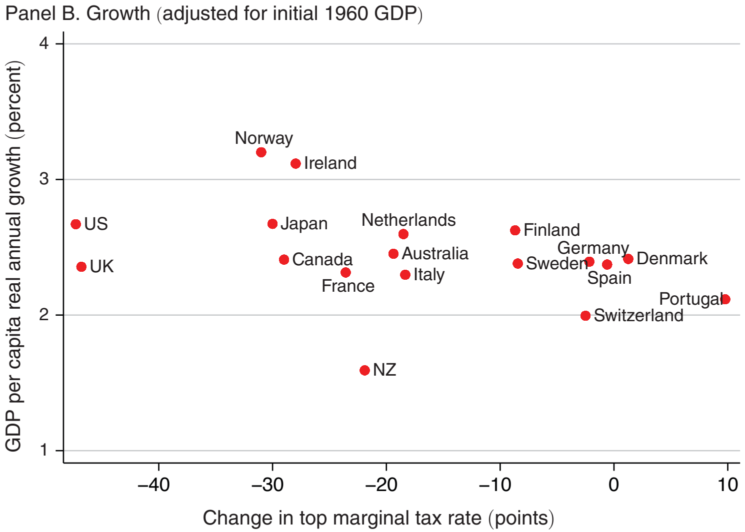
Eventually growth levels off, but the higher level of A remains forever.

Policy implications

- Patent protection, R&D subsidies, and other policies affect s_A.
- These policies can raise the growth rate of output, although not in the long run.
- Policies do affect long-run levels of Y/L.

How could the hypothesis that taxes do not change long-run growth be tested?

Empirical evidence



Source: Piketty et al. (2014)

Is Growth Sustainable?

Outlook for U.S. growth

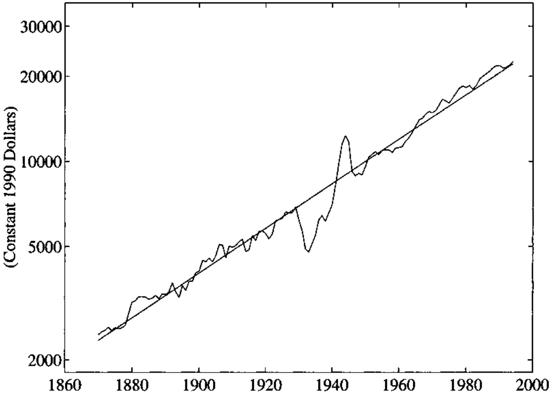


FIGURE 1. U.S. GDP PER CAPITA, LOG SCALE

Source: Jones (2002)

U.S. growth has been constant for a long time.
But are we on a balanced growth path?

Will growth level off?

The basic idea of Jones (2002):

- Over the past 100 years, inputs that improve productivity have been rising: years of schooling; R&D spending / output.
- Eventually, these must level off.
- Then output growth must slow down.
- By how much?

Inputs that increase productivity are rising

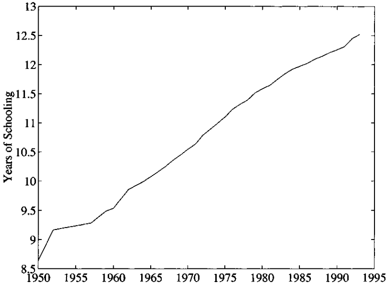


FIGURE 3. AVERAGE U.S. EDUCATIONAL ATTAINMENT, PERSONS AGED 25 AND OVER

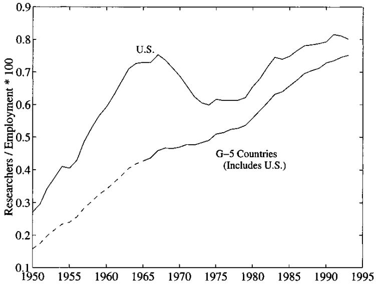


FIGURE 4. RESEARCH INTENSITY IN THE G-5 COUNTRIES

What happens when these inputs stop growing?

A Model

Extend the Romer model to incorporate:

1. Human capital in the production of output.
2. Human capital in R&D.

Output production:

$$Y_t = A_t^{\sigma} K_t^{\alpha} \left(h_t L_{Yt}\right)^{1-\alpha} \tag{7}$$

Then

$$y_t = Y_t / L_t = \left(K_t / Y_t\right)^{\alpha/(1-\alpha)} l_{Yt} h_t A_t^{\sigma/(1-\alpha)} \tag{8}$$

Output growth

Along the transition:

$$g(y) = \frac{\alpha}{1-\alpha} g(k/y) + g(l_Y) + g(h) + \frac{\sigma}{1-\alpha} g(A) \tag{9}$$

Balanced growth rate:

K/Y and l_y must be constant over time

$$g(y) = g(h) + \frac{\sigma}{1-\alpha} g(A) \tag{10}$$

In addition: $g(A)$ will slow down when R&D inputs stop growing.

We expect the balanced growth rate to be lower even than past TFP growth.

R&D sector

$$\dot{A}_t = B\left(l_{At} h_t L_t\right)^{\lambda} A_t^{\phi} \tag{11}$$

so that

$$g(A) = \frac{\left(h_t l_{At} L_t\right)^{\lambda}}{A_t^{1-\phi}} \tag{12}$$

Balanced growth:

$$g(A) = \frac{\lambda\left(g(h) + n\right)}{1 - \phi} \tag{13}$$

Assume long-run $g(h) = 0$ because schooling levels off (strong assumption).

Then (just like in our textbook model):

$$g(A) = \frac{\lambda}{1 - \phi} n \tag{14}$$

BGP output growth

$$g(y) = \frac{\sigma}{1-\alpha} g(A) = \underbrace{\frac{\sigma}{1-\alpha} \frac{\lambda}{1-\phi}}_{\gamma} n \tag{15}$$

Normalize $\sigma = 1 - \alpha$. Then $\gamma = \lambda / (1 - \phi)$.

Key point

Transitional growth has several sources: $g(h)$, growth of A in excess of γn, and balanced A growth of γn.
Only the γn part is sustainable!

Quantifying the slowdown

We observe: $g(y) = 2\%$ per year

Balanced growth: γn where $n = 1.2\%$ per year.

So the value of γ determines the slowdown.

How big is γ?

Key idea (roughly):

$$g(A) = \frac{(h_t l_{At} L_t)^{\lambda}}{A_t^{1-\phi}} \tag{16}$$

- We observe $g(A), h, L_A$.
- If $g(A)$ was constant over time (roughly true), the we can estimate $\gamma = \lambda / (1-\phi)$.

Result: $\gamma \approx 1/3$.

Key implication

Only 1/3 of past TFP growth is sustainable once transitory increases of h and l_A comes to an end.

Growth accounting implications

Post-war average growth $g(y) = 0.02$

$n = 0.012$

Balanced growth = $\gamma n = (1/3) \times 1.2\% = 0.4\%$

Transition dynamics

We can simulate the model path to find out how rapidly growth slows down.

Result: Growth slows by half (relative to γn) every 40 years.

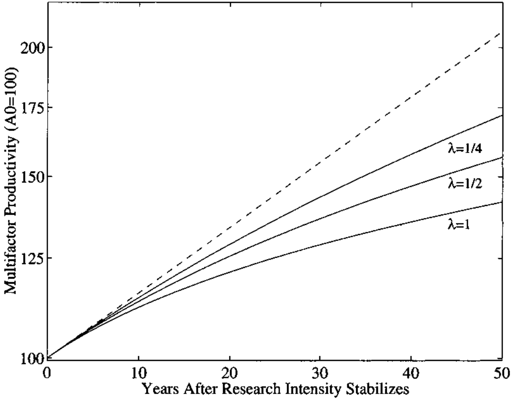


FIGURE 5. THE TRANSITION OF MULTIFACTOR PRODUCTIVITY TO STEADY STATE

Discussion

Thoughts?

Summary

- Innovations are produced just like regular goods, but they are non-rival.
- Therefore, we have scale effects: larger markets support more rapid innovation.
- The growth rate of Y/L is proportional to the population growth rate.
- A one-time increase in R&D effort (higher L_A) raises the rate of innovation permanently.
  - But this is not enough to sustain higher long-run growth.
- Policies only have level effects.

Final Example

What is the effect of a permanent increase in

1. research productivity (easy)
2. population (holding k fixed or not)
3. population growth (Europe)

Reading

- Jones (2013b), ch. 5.
- The section on the outlook for US growth is based on Jones (2002).

Optional:

- Romer (2011), ch. 3.1-3.4
- Jones (2013a), ch. 6

Advanced Reading

- Jones (2005) talks in some detail about the economics of ideas.
- Lucas (2009) and McGrattan and Prescott (2009) on openness and growth

References I

Jones, C. I. (2002): "Sources of US economic growth in a world of ideas," *The American Economic Review*, 92, 220–239.

——— (2005): "Growth and ideas," *Handbook of economic growth*, 1, 1063–1111.

——— (2013a): *Macroeconomics*, W W Norton, 3rd ed.

Jones, Charles; Vollrath, D. (2013b): *Introduction To Economic Growth*, W W Norton, 3rd ed.

Lucas, R. E. (2009): "Trade and the Diffusion of the Industrial Revolution," *American Economic Journal: Macroeconomics*, 1–25.

McGrattan, E. R. and E. C. Prescott (2009): "Openness, technology capital, and development," *Journal of Economic Theory*, 144, 2454–2476.

References II

Piketty, T., E. Saez, and S. Stantcheva (2014): "Optimal taxation of top labor incomes: A tale of three elasticities," *American economic journal: economic policy*, 6, 230–271.

Romer, D. (2011): *Advanced macroeconomics*, McGraw-Hill/Irwin.