Romer's Model of Expanding Varieties

Econ 4960: Economic Growth

The AK model and Policy Debates

- The fact that savings rate can affect the growth rate (and in a big way) made the AK model very popular in policy discussions.
- It makes government policy very important for growth.
- In a famous paper, Lucas (1990) called tax cuts on savings as the "*largest genuinely free lunch I have seen in 25 years in this business*."
- Even today when candidates fiercely debate about taxes, an important part of discussion revolves around growth

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The AK model and Policy Debates

- King and Rebelo (1990, JPE): The "welfare effect" of a 10 percent increase in income tax is 40 times larger in an (AK) endogenous growth model (65% of consumption) than it is in a neoclassical growth model (1.6% of consumption)
- Stokey and Rebelo (1995) and Lucas (1990) argue that if endogenous growth models are calibrated to plausible values the effect on welfare is not likely to be large.
- Note that this "gift" of the AK model is also its "curse."
- Because if tax differences are so important for growth, how come countries like Sweden with extremely high tax rates grow as fast as the US?

Shortcomings of the AK model

- Growth is the outcome of accidents---actions that are completely unintentional.
- Externalities must be substantial: For example, the capital bought by an investor contributes twice as much to others' production than to his/her own. Same for human capital: Your education benefits others more than it benefits you.
- Alternatively stated, the Social return on many types of investments far exceed their private return.
- If externalities are really that big, individuals will typically find a way to capitalize on them (A doctor will not distribute advise on the street, etc.)
- Exponent on externality must be exactly $1-\alpha$. Otherwise, there will be no BGP

Back to Romer's Model

- A key concept in Romer's model will be the production of ideas.
- But ideas are inherently difficult to even define, let alone measure.
- One imperfect measure is the number of patents, although it tells us little about the value of patents.
- Another measure is the resources devoted to R&D

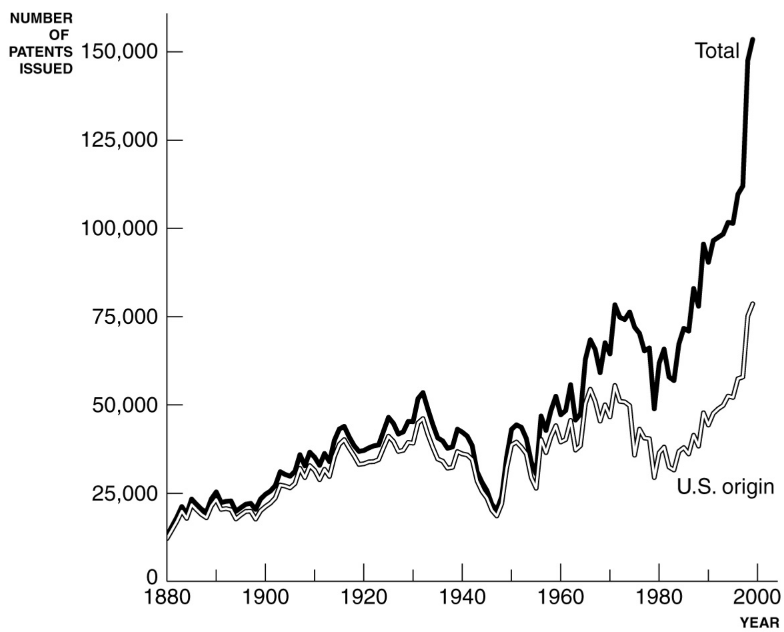

FIGURE 4.5 PATENTS ISSUED IN THE UNITED STATES, 1880–1999

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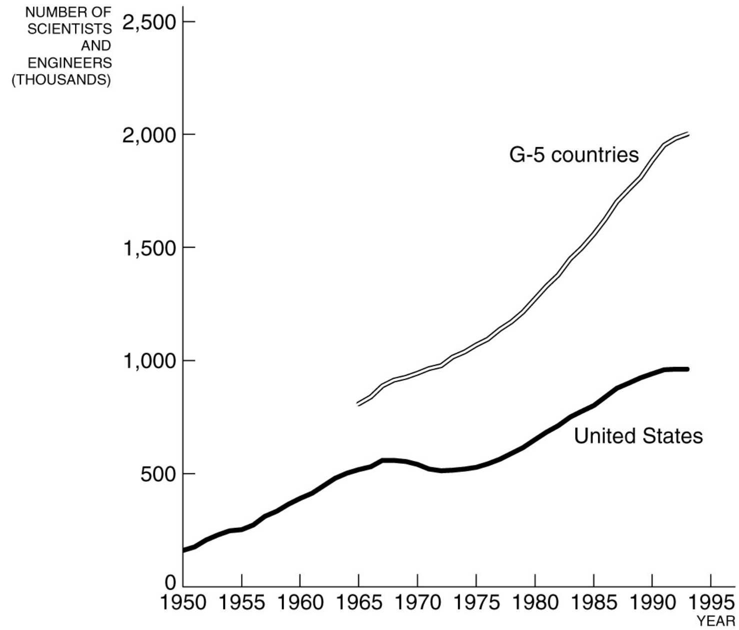

FIGURE 4.6 **SCIENTISTS AND ENGINEERS ENGAGED IN R&D, 1950–93**

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Economic Forces Underlying Technical Progress

Preliminary ideas

- In contrast to Solow model, Romer's model is better interpreted as a model of the growth of the World economy.
- Or alternatively stated: how the world technology frontier moves forward
- Notice that this interpretation of Romer's model is rather new.
- Implication: One has to think about different factors than emphasized here to understand how poor countries catch up with the rich, growth miracles, etc.

Elements of the Model

- We start from a simple version and progressively build towards the more general model.
- Here assume that production function is Cobb-Douglas:

$$Y = K^{\alpha}\left(AL_Y\right)^{1-\alpha}$$

- Remember from last lecture that this production function exhibits IRS in all three inputs (because of the non-rivalrous nature of ideas).
- Capital accumulation: $\dot{K} = s_K Y - dK$
- Population growth: $\dot{L} / L = n$

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Novel component: Production of Ideas

- The previous three equations are the same as in the Solow model. So what's new?
- Romer assumes that the growth rate of new ideas is proportional to the number of people trying to discover new ideas: $\dot{A} = \bar{\delta} L_A$
- Where $\bar{\delta}$ is the rate at which new ideas are discovered.
- Question: Should $\bar{\delta}$ be constant, increasing or decreasing in A?
- Write: $\bar{\delta} = \delta A^{\phi}$. If the exponent is positive (negative) ideas will be easier (harder) to invent as more ideas are around

Novel component: Production of Ideas

- **Question:** Does it make sense of the growth rate of ideas to be linear in the number of "inventors"?
- That is, if we increase the number of medical researchers by 10-fold are we going to cut down the time necessary to cure cancer, AIDS, etc., by tenfold?
- A better specification may be: $\dot{A} = \delta L_A^{\lambda} A^{\phi}$
- A plausible assumption is that $\lambda < 1$, which indicates a negative externality (or congestion effects, such as in traffic, labor markets, etc.)
- Therefore, $\lambda < 1$ is called "stepping on toes effect."
- $\phi > 0$ is called "standing on shoulders effect"

Allocation of Labor Across Uses

- We have: $L_Y + L_A = L$
- How does the society decide on optimal allocation of labor between production and innovation?
- To answer this fully, we would need some high-tech math (Dynamic programming to be exact) and solve for utility maximization.
- Here we will make a Solow-like assumption and assume that it is given by a constant: $L_A / L = s_R$

Solving the Model

- A key question to ask in any model of economic growth: Is there a BGP?
- Short answer: yes.
- Now we need to show how.
- First, we have: $g_y = g_k = g_A$
- How can you show this? (Exercise!)
- So if we can find the rate of growth of A, we can find the growth rate in the economy.

Solving the Model (cont'd)

- What is the rate of technological progress along the BGP?

$$\dot{A} = \delta L_A^{\lambda} A^{\phi} \Rightarrow g_A \equiv \frac{\dot{A}}{A} = \delta \frac{L_A^{\lambda}}{A^{1-\phi}}$$

- By definition of BGP, we must have g_A is a constant. Which implies: $0 = \lambda \frac{\dot{L}_A}{L_A} - (1-\phi)\frac{\dot{A}}{A}$ (*)
- Notice that along a BGP we need this: $\frac{\dot{L}_A}{L_A} = \frac{\dot{L}}{L} = n$
- Substitute this into (*): $g_A = \frac{\lambda n}{1-\phi}$
- We've just solved the model!

What does this equation tell us? $g_A = \frac{\lambda n}{1-\phi}$

- So this is the solution to the basic version of Romer's model. What does it mean?

1. There is no growth without population growth.
   - To understand this consider the case when $\lambda=1$, $\phi=0$.
   - Is this implication plausible? How do you test it?
2. Romer's model has a special case that implies long run growth even with zero population growth: $\lambda = 1$ and $\phi = 1$

$$\dot{A} = \delta L_A A \rightarrow \frac{\dot{A}}{A} = \delta L_A$$

3. But this specification would imply that TFP growth in the world should have accelerated dramatically in the past 200 years!

Policy and other Implications

- Notice that saving rate has no effect on long-run growth rate. (as in the Solow model)
- The fraction of population employed in R&D has no effect on long-run growth.
- They do however have level effects (as in Solow).