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**International Studies & AAE 374**  
**Growth and Development of Nations**

*Lecture 13*  
20 October 2009

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**I. Outline:**

- A. Growth and Tech
- B. Solow Residuals and Tech Growth

**II. Economics of Ideas**

A. Intro :

1. We have seen that:
  - (a) We can only partially explain differences in world income levels if assume same technology and try to explain via differences in factor accumulations
  - (b) Similarly, growth rates only partially show what would expect from a conditional convergence perspective
  - (c) Finally, see continuing long-run growth, contradicting key implication of basic Solow model (diminishing returns and static technology)
2. All of these observations suggest that need to think more about technology

$$y = Ak^\alpha h^{1-\alpha}$$

3. Going forward we will
  - (a) Consider peculiar nature of technology as a form of knowledge
  - (b) Consider some ways of measuring
  - (c) Examining what happens if incorporate technology into basic Solow framework (the Geek Model of Technological Progress)
  - (d) Suggest Geek model still does a poor job of accounting for observed patterns
  - (e) Move on through econ history and then more theory and evidence on nature of technological, and especially implications for government policy

### III. Conceptualizing and Measuring Technology and Technological Change using the Production Function

A. Recall our basic production function:

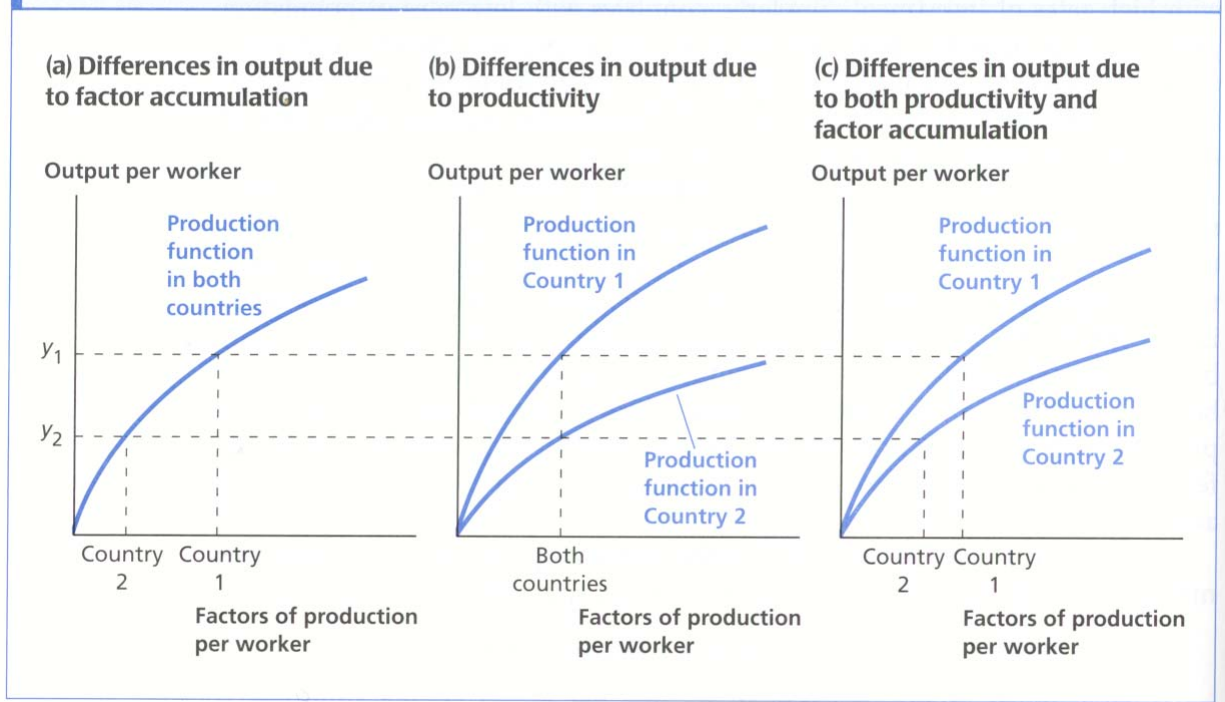
$$Y = AK^\alpha L^{1-\alpha} \text{ or rather } y = Ak^\alpha$$

B. Possible Sources of Differences in output per worker

1. Same production tech ( $A$ ), more accumulated  $k$  per-worker
2. Same  $k$ , but higher technology level
3. Higher tech and higher accumulated  $k$  per-worker

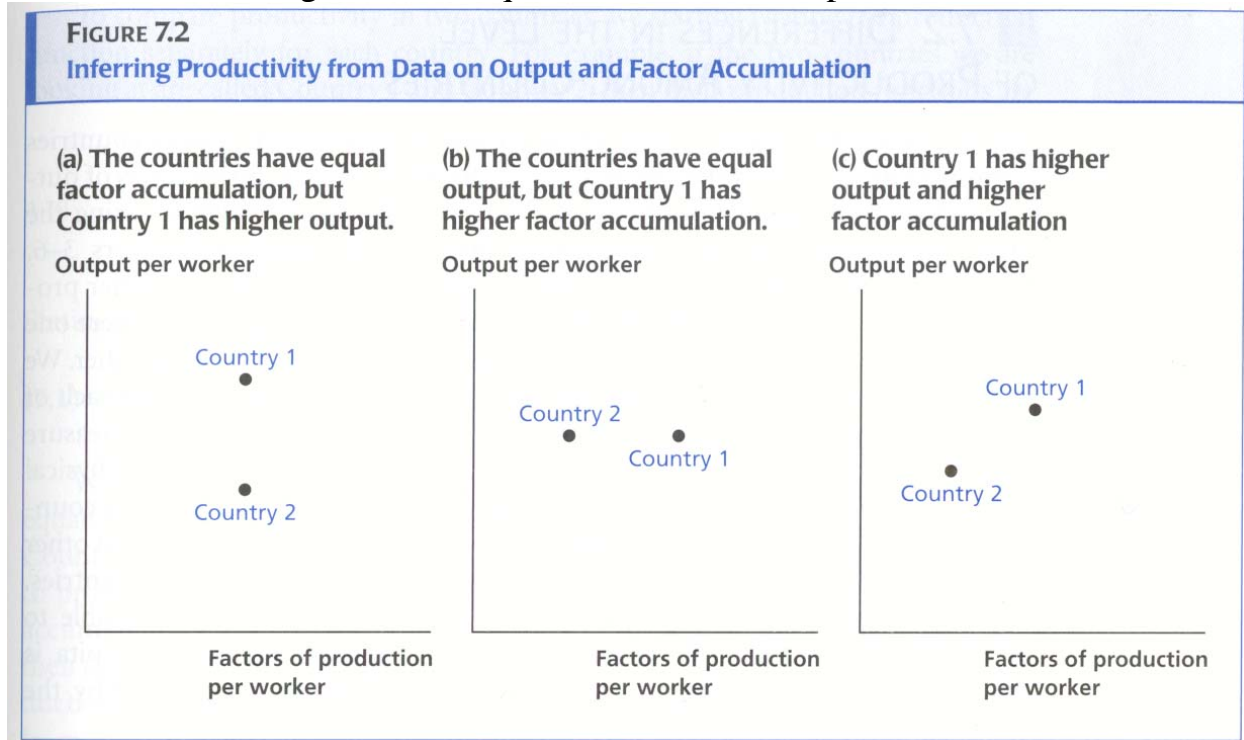
FIGURE 7.1

Possible Sources of Differences in Output per Worker



C. *Inferring Technology given data on output and Accumulation*

1. Vertical displacement
2. Horizontal displacement
3. Ambiguous SW-NE displacement
4. Unraveling this case requires information on production function.



D. *Measuring Technological Change as a ‘Residual’ (getting ready for Problem Set 3):*

$$Y = A K^\alpha S^\beta P^{1-\alpha-\beta}$$

1.  $Y$  is output
  2.  $A$  is the technology multiplier (total factor productivity) term
  3.  $K$  is physical capital
  4.  $S$  is human capital
  5.  $P$  is the size of the labor force.
- E. Because this is a constant returns to scale production function, we can express per-worker output as:

$$y = A k^\alpha s^\beta$$

where (as always) the lower case letters indicates per-worker figures. (Note:  $s$  represents per worker human capital in this case.)

F. By taking logs and differentiating, we can decompose the rate of per-capita growth in the economy as:

$$\hat{y} = \hat{A} + \alpha\hat{k} + \beta\hat{s}$$

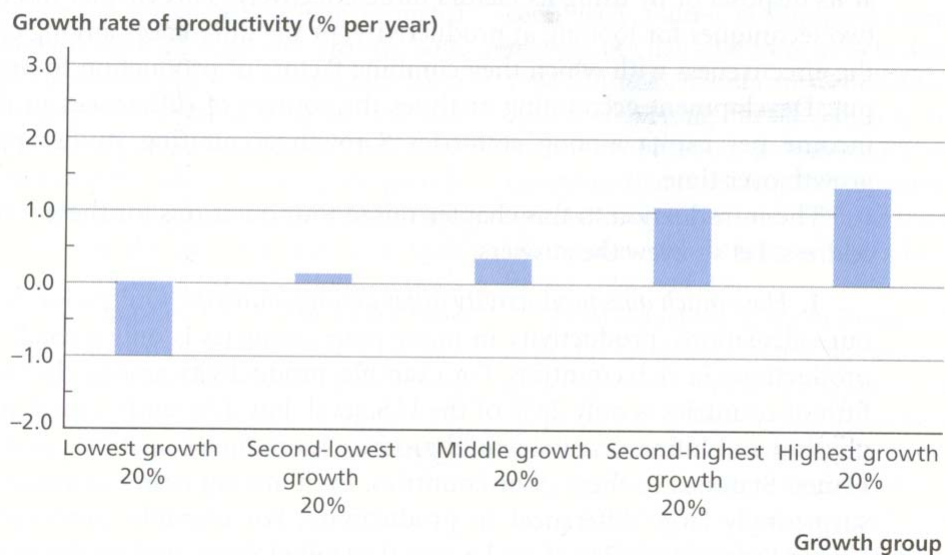
Simple algebra allows us to rewrite this expression as,

$$\hat{A} = \hat{y} - \alpha\hat{k} - \beta\hat{s}$$

where  $\hat{y}$ ,  $\hat{k}$ ,  $\hat{s}$  and  $\hat{A}$  are, respectively the growth rates of output per-worker, capital per-worker, human capital per-worker, and total factor productivity.

1. The terms  $\alpha$  and  $\beta$  are elasticities of output with respect to physical and human capital.
2. For example, in the Problem Set you'll assume that  $\alpha = 0.39$  and that  $\beta = 0.27$ .

**FIGURE 7.6**  
**Role of Productivity in Determining Growth, 1960–1998**



For sources, see Table 7.2.

#### IV. TFP is just another name for Technological Change, and it ain't free

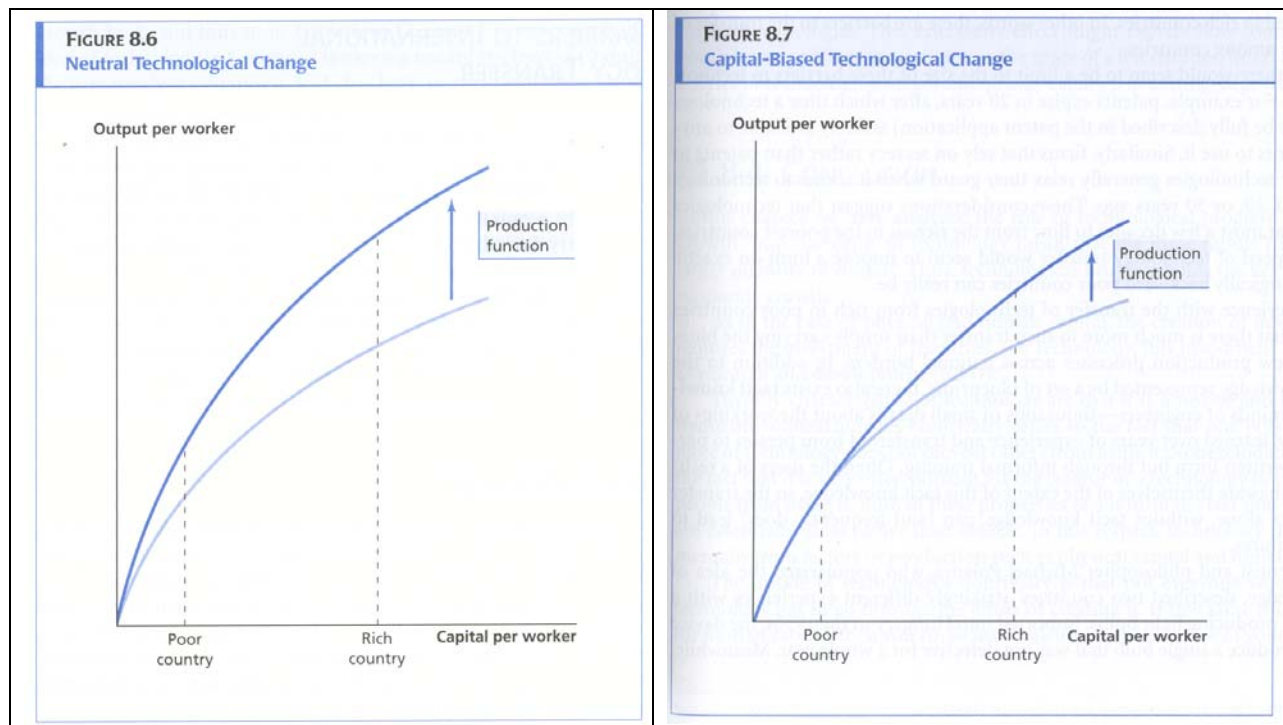
##### A. Total Factor Productivity Growth:

It is the residual after accounting for factors in production (physical capital, human capital, etc.)

$$\hat{A} = \hat{y} - \alpha \hat{k} - \beta \hat{s}$$

1. The change in A is technological change (TC) in the Solow model. Not the only way to think of technological change, because technological change could be “embodied” in physical or human capital, but in this model the change in A is the way we represent TC.
2. What does it mean if we get high TFP measures in one place and low TFP measures elsewhere? What does it mean for the economic growth?

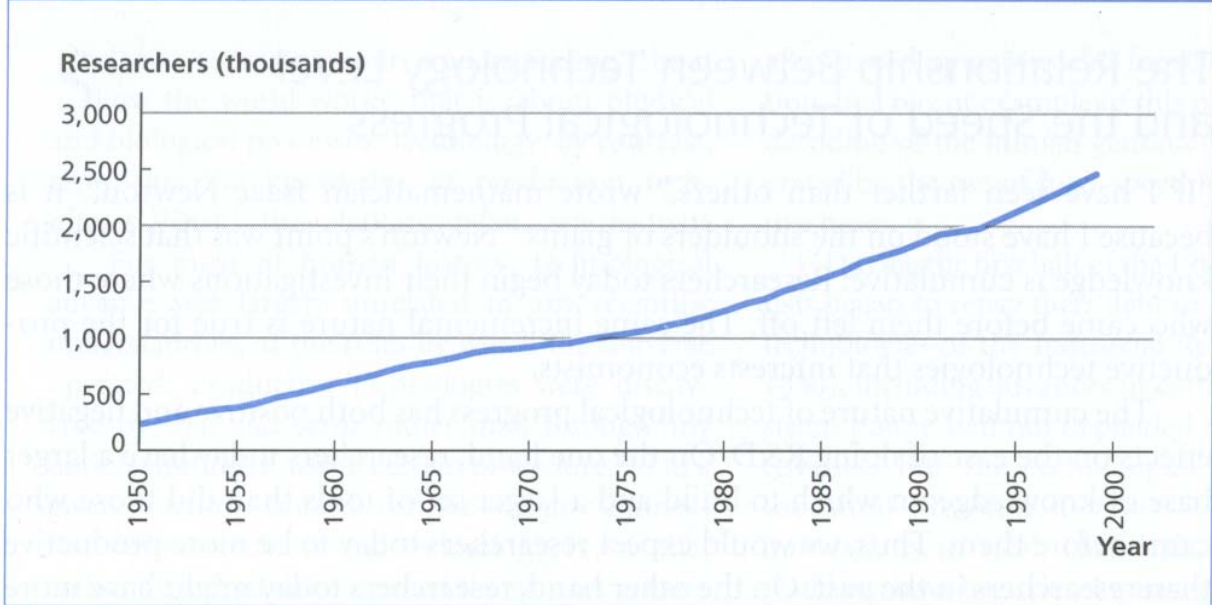
##### B. What does it mean for conditional convergence ideas?



1. What does it mean for divergence?
2. Can technological change help to explain both convergence in some cases and divergence in others?

C. Is productivity “just a residual” or can we tie it to something?

**FIGURE 9.4**  
**R and D Researchers in the G-5 Countries, 1950–1999**



Sources: Jones (2002); OECD Main Science and Technology Indicators database.