



Lecture 9

AAE 374 Fall 2009

- Discuss Cotton Reaction Papers
- Road Map for Growth of Nations
- Getting Started on Capital Accumulation and Growth
- Growth and Convergence: First Look



Discussion of Cotton Reaction Paper

- Should the US completely eliminate its cotton subsidies?
- Do you think that the US will eliminate its cotton subsidies?
- Discussion of Cotton Lobby Arguments

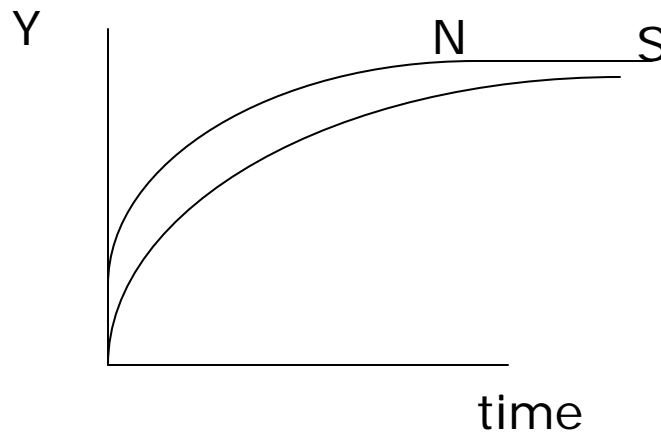


Introduction and Roadmap to Growth of Nations

- **Formal Models and Tummy Aches**
 - **Build from simple mathematical models to more complicated ones to capture the dynamics of economic growth**
 - Weil is your main guide; Easterly is your travel critic.
 - Looking to see predictions for growth of rich and poor countries.
- **Road Map**
 - **Harrod-Domar Model (today)**
 - only physical capital holdings matter,
 - growth is proportional to savings/inv.
 - growth but no convergence

Road Map Continued

- Simple Solow Model (Oct 8)
 - Add labor to capital accumulation and growth
 - Assume diminishing returns.
 - Assume no technological progress
 - Economy achieves steady state with no growth.
 - Rich and poor (N and S) converge



Road Map Continued

- Solow Model with human capital (Oct 8)
 - Add Education/health as factors of production.
 - Find conditional convergence (not unconditional convergence)
 - No growth in the Steady State
- Solow Model with exogenous technological progress (October 8-10)
 - Random or “exogenous” (dropped into the model with no underlying cause)
 - Find convergence and positive growth.





Road Map Concluded

- Endogenous Technological Change
 - Technological change is related to public and private choices (of course it is)
 - No simple predictions about convergence
 - Catching up policies for poor countries can help.
 - Innovation by rich countries can push them ahead.
 - Does technological change become “routinized”?
- History, Institutions, and Policy Matter
 - Great for cross-country/regional comparisons.



Capital Accumulation and Growth: A First Look

- ***Capital versus Consumption Goods***

- Consumed goods (food, clothing, etc.)
- Capital goods (seeds, machines, factories, infrastructure, labs, offices).

- ***Main Difference?***

- Capital goods are used in subsequent periods as a basis for production.
- Why are they viewed as important to growth?
- What do they embody?
- How do they affect learning?



Key Growth Model Features

- 1 Good economy: Corn, consumption and capital good in 1 (eat it, save it as seed).
- Savings = Investment; $S = I$
- Does it always?
 - Why not?
 - Ask John Maynard Keynes.
 - Ask Wall Street.
- We will assume $S = I$, but it may not in poor countries: examples
 - Food/Seeds (deterioration)
 - Money under the mattress
 - Livestock (may be ok)



Trade vs Growth Models

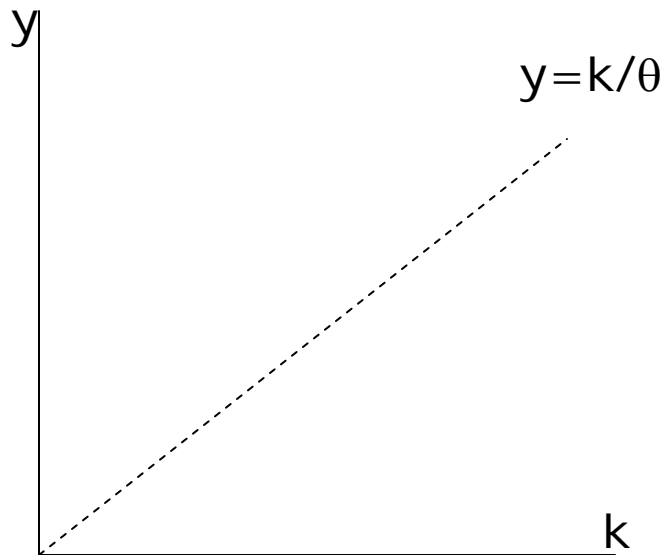
- International-Economic Man:
 - In trade models we have seen the big choice is *which* goods to produce
 - Endowments are static but markets change
- Macro-Economic Man:
 - Only gets one good (Corn) which (s)he makes herself, but it takes time
 - Big choice is about *when* to eat corn instead of saving



Harrod-Domar: Constant Capital-Output Ratio Technology

- Capital is the only factor in the economy.
- Labor is “slack”, always available to work capital but not explicitly modeled.
- $Y(t) = (1/\theta(t))K(t)$, where we assume that $\theta(t)=\theta$ for all t .
 - No inventions!
 - Capital productivity measured by θ : Amount of machines needed per unit of output.
- Can rewrite in per-capita terms as $y(t)=(1/\theta)k(t)$ where lower case values are per-capita.
- Interpret this as saying something about living standards:
 - More capital per capita, more income.
 - More productive capital (lower θ), more income.

Graphic Representation of HD Model



Note the constant return to capital assumption. This will change in later models.

Per-Capita Capital Stock (k)	Per-Capita Income (y) ($y = k/\theta = 2k$)	Marginal Returns to Capital ($\approx \Delta y / \Delta k$)
0	0	
4	8	2
5	10	**2**
10	20	2

Harrod-Domar: A helpful mnemonic device

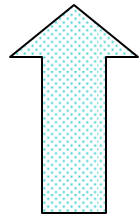


Generic Structure of Growth Models

Old Capital depreciates:

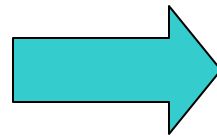
$$(1-\delta)K(t-1)$$

Increment t
by one



Save some output:

$$S(t) = sY(t)$$



Augment old Capital with savings:

$$K(t) = (1-\delta)K(t-1) + I(t-1)$$



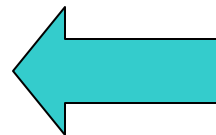
Produce some output:

$$Y(t) = F(K(t))$$



Consume some output:

$$C(t) = (1-s)Y(t)$$





Where is the Economy headed?

Deriving the Growth Rate

Key question to answer is “How fast are we accumulating stuff?”, answered by the growth rate:

$$g = [Y(t+1) - Y(t)]/Y(t)$$

Macroeconomic Balance

$$(1) \quad S(t) = I(t)$$

Capital Accumulation

$$(2) \quad K(t+1) = (1-\delta)K(t) + I(t)$$

Savings Rate

$$(3) \quad S(t) = s(t)Y(t) = sY(t)$$



Harrod-Domar Model Continued

- Technology and the Capital-Output Ratio

$$(4) Y(t) = K(t)/\theta \text{ or } K(t) = \theta Y(t)$$

- Assembling the model

$$(5) K(t+1) = (1-\delta)K(t) + S(t), \text{ combines 1 and 2 above}$$

$$(6) \theta Y(t+1) = (1-\delta)\theta Y(t) + sY(t);$$

- $\theta Y(t+1) - \theta Y(t) = -\delta\theta Y(t) + sY(t)$

- $\theta[Y(t+1) - Y(t)] = [s - \delta\theta]Y(t)$

$$(7) [Y(t+1) - Y(t)]/Y(t) = s/\theta - \delta$$

$$(8) g = s/\theta - \delta$$

Growth is a positive function of savings, negative function of capital output ratio and depreciation.

Lower capital-output ratio means higher growth.

Harrod-Domar Growth Model cont.



Since we assumed that s , θ and, δ are all time invariant (not sensitive to time), then growth is constant.

What does this mean for convergence?

No convergence unless poor countries
Have a higher s , lower θ or δ .



What else is going on? Growth Rates Everywhere...

$$[Y(t+1)-Y(t)]/Y(t) = \mathbf{g} = \mathbf{s}/\theta-\delta$$

$$[C(t+1)-C(t)]/C(t) =$$

$$[(1-s)Y(t+1)-(1-s)Y(t)]/(1-s)Y(t) =$$

$$[Y(t+1)-Y(t)]/Y(t) = \mathbf{g} = \mathbf{s}/\theta-\delta$$

What about $[K(t+1)-K(t)]/K(t)$?



Growth Rates Cont'd

- Easterly: Big point is GDP growth will be proportional to the share of investment
- Scenarios you might think about:
 - (Corrupt Government) A tax is placed on capital so some $K(t)$ goes to great leader's "retirement account" each year?
 - (Forced Saving) A tax is placed on consumption which is invested in capital?
 - (Debt Crisis) Savings rates fall to zero for a decade?
 - (DARPA Spinoffs) Technology improves?
 - Think about Figure 2.2 of Weil in light of these relationships



Next Time

- Real World determinants of Growth Rates and Output
- Mix in second factor (Labor) to HD to get new insights