AAE International Studies & AAE 374
Growth and Development of Nations in the Global Economy

Lecture 9
October 6, 2009

I. Discussion of Cotton Reaction Paper

A. Should the US completely eliminate its cotton subsidies?

B. Do you think that the US will eliminate its cotton subsidies?

C. Discussion of Cotton Lobby Arguments

II. Introduction and Roadmap to Growth of Nations

A. Formal Models and Tummy Aches

1. Next few lectures, we will delve again into the mathematical side by developing formal models of the growth process. Purpose is to create a simpler representation of the world that allows us to understand better how certain aspects of the economy may work or behave. Start with very simple model and then add complexity. Implications change as we add complexity. Economists believe that these models help us to piece together the role of different key factors.

2. Hope is to sharpen our thinking. Problems arise when we do not understand the limitations of what models can and cannot tell us. Again, one of our goals in this course is to help you to learn how to use them critically.

B. Road Map – We just finished a simple model (HO) about why trade is good for all countries (though specific groups may oppose it). Now we will start with some simple models that depict under what conditions poor countries can catch up with rich countries in their growth processes. Later we will add complexity to see when poor countries might not catch up.

1. Harrod-Domar Model – Today's focus. Model where only physical capital holdings matter, and growth is proportional to savings/investment. Get

growth but no convergence unless we assume that poor countries have higher capital productivity (more income from an additional unit of capital).

2. Simple Solow Model (may start into this one today). Add labor to the accumulation and growth story. Assume diminishing returns to increasing one factor while holding the other constant. Without technological progress, growth in income eventually halts as economy reaches a "steady state". Get convergence but no growth in the steady state.

3. Solow Model with human capital (next week). Add Education/health as factors of production. Find conditional convergence (not unconditional convergence) but again no growth in the Steady State

4. Solow with exogenous technological progress. Random or "exogenous" (dropped into the model with no underlying cause) that lead to convergence and positive growth.

5. Endogenizing technological progress. Technological change is purposeful, and the logic needs to be explained if we are to understand its key role in growth and development. Part of the challenge is that knowledge, information, and learning are rather distinct as economic "goods" or processes, and may be subject to increasing returns (Silicon Valley, UW-Madison, etc.), so may cut against convergence.

III. Capital Accumulation and Growth: A First Look

A. Capital versus Consumption Goods

1. Economy typically has goods that are consumed (e.g., food) and goods/services that are invested, capital goods.

2. Capital goods are used in subsequent periods as a basis for production.

3. Examples of capital goods? Machinery, factories, transportation infrastructure, labs, offices, stores. Others?

4. Why are they viewed as important to growth?

B. Savings and Investment Balance (Assume below S=I)

1. 'In-House Balance of Traditional Agriculturalist—the corn economy.

All of the models we will develop over the next week are 1 good ("corn") economies. Why corn? You can eat it, save some to plant, and grow more corn the next period. Represents the growth process of the economy as if it were a single good managed in effect by a single agent.

2. Intermediation between Distinct Agents in More Complex Economy

Real world is of course more complex and key to understanding how savings get translated into investment is one of the fundamental issues.

C. Harrod-Domar/Constant Capital-Output Ratio View of Technology

1. Capital is the only factor in the economy. Implicitly, labor is "slack", always available to work the available capital.

2. Capital productivity measured by θ which is the amount of machines needed per unit output.

3. Write the relationship as follows: $Y(t) = (1/\theta(t))K(t)$*, where we assume that* $\theta(t)=\theta \ \forall$ t (stress assumption here—also notation); Assumption for now is that capital productivity is constant. Discuss later what it means when it changes.

4. *Can rewrite 3 as:,* $y=(1/\theta)k$*, where lower case values are per-capita.*

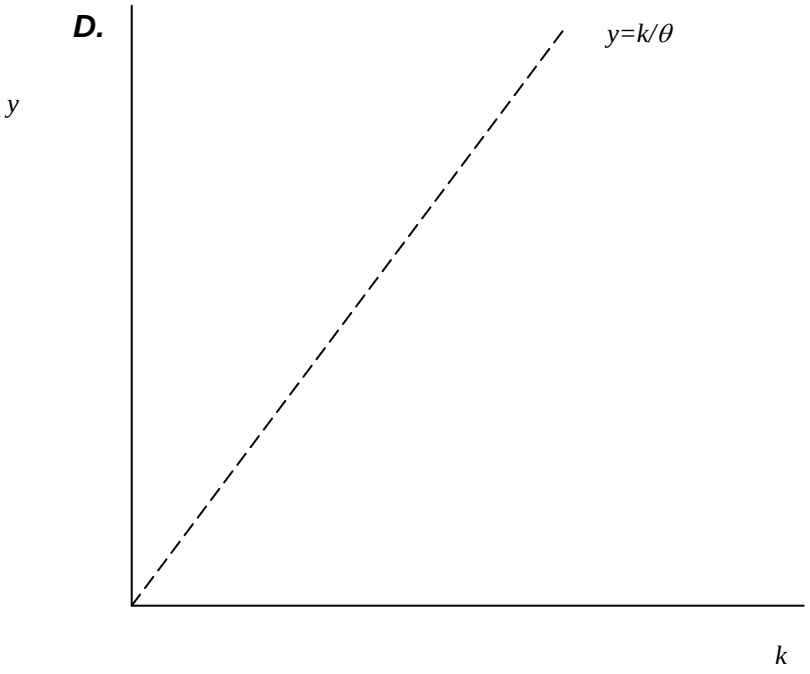
5. *Interpret this as saying something about living standards* – More capital per capita, more income. More productive capital (lower θ), more income.

6. Note, however, that this vision of technology has some strong (and unsatisfactory) implications

7. Graphically, this will appear as follows on the assumption that θ=0.5:

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

D.



E. Saving, Investment and Growth in Harrod-Domar Corn Economy

1. Macroeconomic Balance (Stress time notation)

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

2. Capital Accumulation

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

3. Savings Rate

(3) $s(t) = S(t)/Y(t) = s \ \forall t$ (stress assumption here)

s is a constant but could also be time dependent.

4. Technology and the Capital-Output Ratio (from above)

(4) $Y(t)= K(t)/\theta$ (from above)
or,
$K(t) = \theta Y(t)$

5. *Assemblage*

(1)→(2)➔

(5) $K(t+1) = (1-\delta)K(t) + S(t)$

(3)&(4)→(5)➔

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

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

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

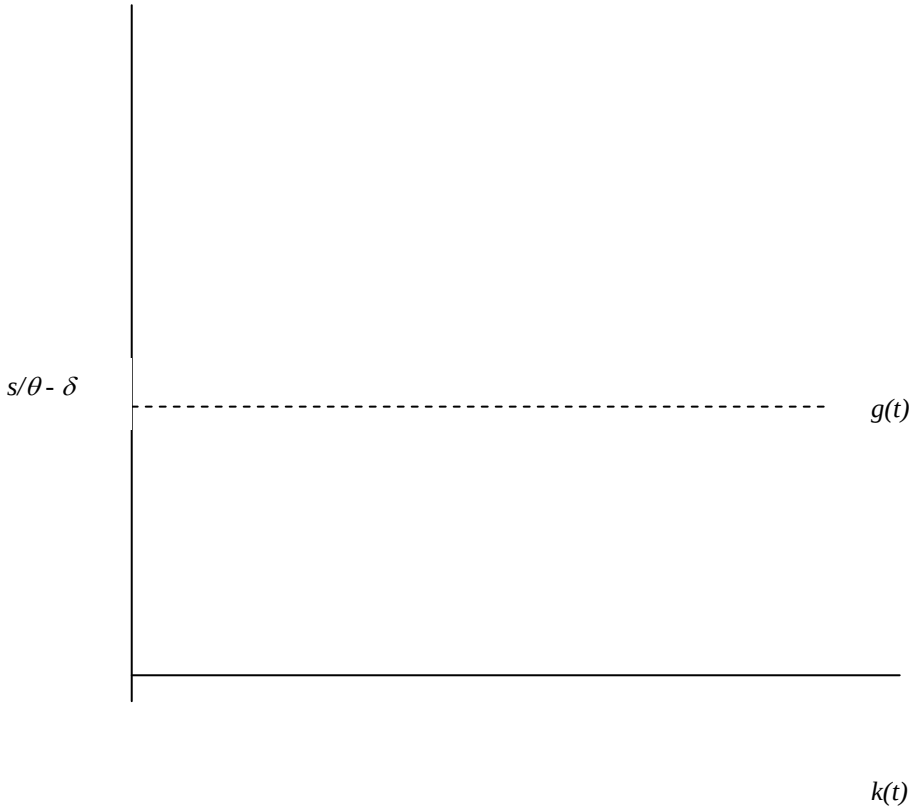
or,

$$\frac{Y(t+1)-Y(t)}{Y(t)} = \frac{s}{\theta} - \delta$$

Note that $g(t) = \frac{Y(t+1) - Y(t)}{Y(t)}$, *so that*

$$(7) \qquad g(t) = \frac{s}{\theta} - \delta = g \; \forall t$$

F. Pictorially (variation on figure 3.2)



G. Reformulating Harrod Domar in Per-Capita Terms

1. Define:

(8) $$\frac{P(t+1)-P(t)}{P(t)} = n(t) \;\; \{= n \forall T\}$$

(9) y(t) = Y(t)/P(t) (lower case as per-capita)

(10) $$g^* = \frac{y(t+1)-y(t)}{y(t)}$$

2. Now lets look at per-capita growth:

   Divide both sides of (6) by population P(t):

   (11) $$\theta y(t+1)\frac{P(t+1)}{P(t)} = (1-\delta)\theta y(t) + sy(t);$$

   or,

   (12) $$\frac{y(t+1)}{y(t)}\frac{P(t+1)}{P(t)} = (1-\delta) + \frac{s}{\theta}$$

   Noting that *(y(t+1))/(y(t)=1+g**) and that *(P(t+1))/(P(t))=1+n*, rewrite (12) as:

   (12') $$(1+g^*)(1+n) = (1-\delta) + \frac{s}{\theta};$$

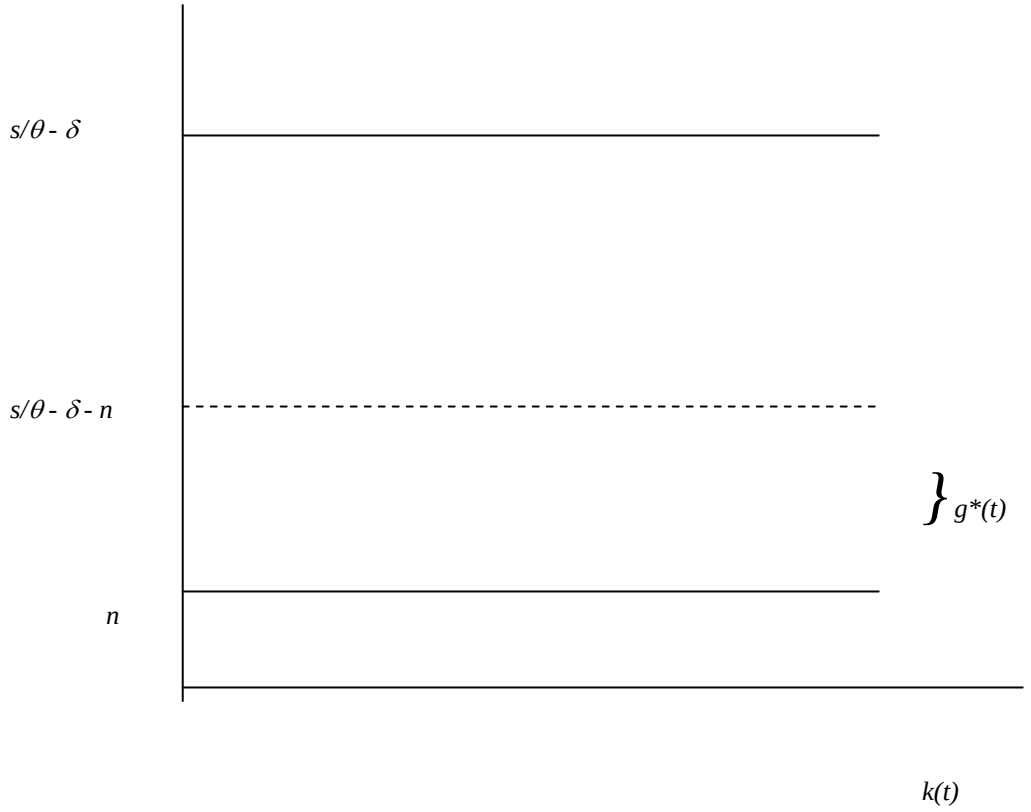
   rearranging terms gives:

   $$g^* = (\frac{s}{\theta} - \delta) - n - ng^*$$

   or since *ng** is tiny, we get that approximately:

   (13) $$g^* \approx \frac{s}{\theta} - \delta - n \approx g - n$$

3. Pictorially:



IV. Growth & Convergence According to Harrod-Domar

A. Convergence in the Long Run—assume that g=7% for both countries on the assumption that parameters are the same across all countries (s=5.5%, θ=0.5, δ=2%, and n=2%):*

Country	*Year 0*	*Year 1*	*Year 10*	*Year 20*
South	1000	1070	2000	4000
North	30,000	32,100	60000	120,000
Ratio	30:1	30:1	30:1	30:1
Absolute Difference	29,000	31,030	58,000	116,000

B. So what is the policy implications (Stalin meets Easterly)

Absolute difference gets larger and larger which makes for divergence.
Countries that saved and accumulated more earlier will get richer faster than those who did not.

Stalin's Russia was one with a lot of forced savings which was seen as being good for growth. Under H-D model it would be.

View of foreign aid was that it could help to close the S-I gap that poor countries faced. I = S + F. But does it? What does Easterly say about this?

C. Suppose now that South boosts its savings rate to 9.25% (→ g=14.5% and y doubles every 5 years):*

Country	*Year 0*	*Year 1*	*Year 10*	*Year 20*	*Year 50*
South	1000	1,145	3,873	15,000	871,514
North	30,000	32,100	59,015	116,091	883,711
Ratio	30:1	28:1	15:1	7.7:1	1:1
Absolute Difference	29,000	30.955	55,142	101,091	12,197

South catches up in 50 years – but in the meantime, divergence in income levels for awhile but ratio is closing the entire time.

Questions for Data:

1. **Does foreign aid lead to investment? Does it increase Investment 1:1, or at what fraction of 1:1?**

2. **Does investment lead to growth?**

3. **If FA = I and led to growth, then there should be some rich African countries by now.**

4. **More on this later but it raises questions about both FAid and Investment as key to growth.**

Move on next lecture to Solow model.