Economic Growth

Basic Theories of (Trend) Growth

?? What might be behind differences in growth and income?

Culture?

Institutions?

Economic setup?

Output == fn(Inputs, Efficiency)

Growth in output = fn(Growth in inputs, growth in efficiency)

Growth in production then comes from

1) growth in inputs – "factor accumulation"
2) growth in efficiency – "technological progress", etc.

Among inputs, economists have focused on capital.

Capital = tools, objects, goods that extend our ability to produce other goods and services

e.g. machines, buildings, infrastructure, vehicles, computers, software

[from Jones, p. 49]

Data show that in 2000, the average worker in ____ worked with ___ of capital :

U.S.	$148,091
Mexico	$42,991
India	$6,720

National Level:

Y_t – national income (GDP) at time t

K_t – national capital stock at time t [equipment]

$X_{1t},\ldots,X_{Jt}$ -- other inputs (e.g. human capital)

A – total factor productivity (TFP) (constant for now) [techniques]

A embodies knowledge, ideas, and methods of organizing inputs into output

N_t – population at time t

$y_t = Y_t/N_t$ – income per capita at time t

$k_t = K_t/N_t$ – capital per capita at time t

In general, lower case denotes per capita values

Production Function

$Y_t = AF(K_t,X_{1t},X_{2t},\ldots,X_{Jt},N_t)$

Assume F exhibits CRS in all factors of production together

$F(zK,zX_1,\ldots,zX_J, zN) = zF(K,X_1,\ldots X_J,N), z>0$

$y_t = Y_t/N_t = AF(K_t,X_{1t},\ldots,X_{Jt},N_t)/N_t$

$= AF(K_t/N_t,X_{1t}/N_t, ,\ldots,X_{Jt}/N_t,1)$

$= AF(k_t,x_{1t},\ldots,x_{Jt},1) \equiv Af(k_t,x_{1t},\ldots,x_{Jt})$

CRS implies per capita output depends only on per capita amounts of inputs

<u>AK Model:</u>

Key Elements:

1) Production Function – CRS in K

$Y_t = AF(K_t) = AK_t$

A, total factor productivity, here assumed constant over time

$y_t = AK_t/N_t = Ak_t = Af(k_t)$

2) Evolution of Capital

$\dot{K}_t = I_t - dK_t$

I_t – national investment at time t

d – rate at which capital depreciates (assumed constant over time)

3) Macroeconomic Balance: Savings = Investment

$S_t = I_t$

[Note from macro, production $Y_t = C_t + I_t (+ G_t + NX_t)$; income $Y_t = C_t + S_t$. So $S_t = I_t$.]

4) Savings Behavior – constant savings rate

$S_t = sY_t$

S_t – national savings at time t

s – savings rate (assumed constant over time)

5) Population Growth

$\dot{N}_t/N_t = n$

Overall goal: How fast will this economy grow, i.e. what is g_y?

First show $\frac{\dot{y}_t}{y_t} = \frac{\dot{k}_t}{k_t}$.

Next show $\frac{\dot{k}_t}{k_t} = \frac{\dot{K}_t}{K_t} - \frac{\dot{N}_t}{N_t}$

Let $g_x \equiv \frac{\dot{x}_t}{x_t}$; $g \equiv \frac{\dot{y}_t}{y_t}$

Rearrange to show $g_y = sA - d - n$:

$g_k = \frac{\dot{K}_t}{K_t} - \frac{\dot{N}_t}{N_t} = (I_t - dK_t)/K_t - n$ (Using 2&5)

$= S_t/K_t - d - n$ (Using 3)

$= sY_t/K_t - (n+d)$ (Using 4)

$= sy_t/k_t - (n+d)$

$= sAf(k_t)/k_t - (n+d)$ (Key Equation in general)

$= sA - (n+d)$ (Using 1)

IMPLICATIONS:

1- Growth continues indefinitely at a constant rate depending on s, A, d, and n

2- g increases in the savings rate, s, and the level of productivity, A

g decreases in population growth, n, and rate of depreciation of capital, d

3- changes in s, A, n affect the growth rate permanently

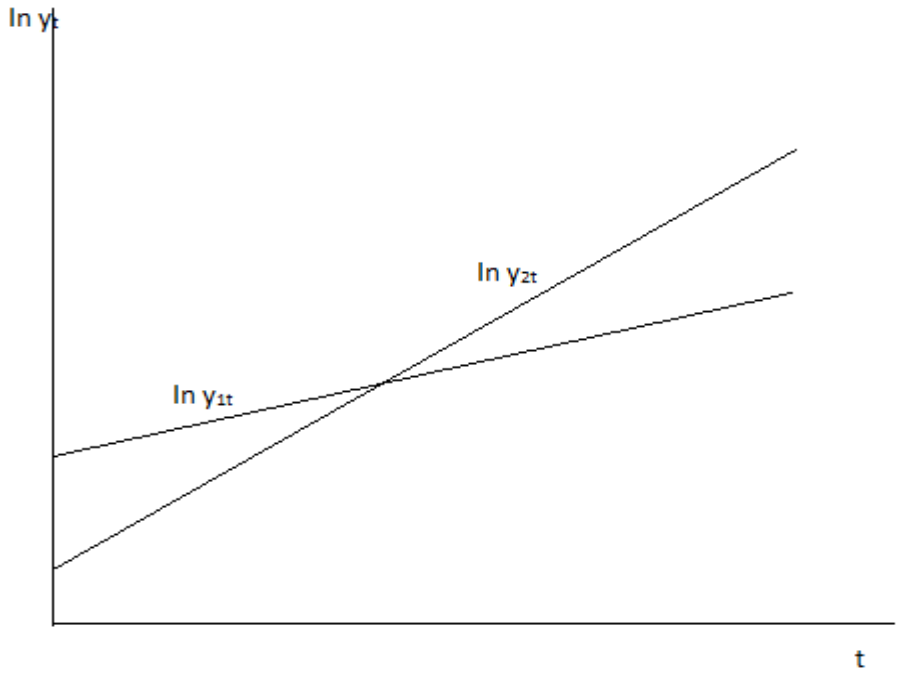
4- No force for convergence or catch-up in GDP/capita

Ex. A =0.5, n = 2%, d = 8%; s_1 = 22%, s_2 = 28%.

⇒ $g_1 = 0.5*0.22 - 0.08 - 0.02 = 1\%$ (in 50 years, $e^{0.01*50}$ = 1.6x as well off)

$g_2 = 0.5*0.28 - 0.08 - 0.02 = 4\%$ (in 50 years, $e^{0.04*50}$ = 7.4x as well off)

GRAPH COUNTRIES – they diverge over time



What is optimal savings rate?

s=1 maximizes growth, since g = sA – d – n

C_t – national consumption at time t

$C_t = Y_t - S_t = Y_t - sY_t = (1-s)Y_t$

$c_t \equiv C_t/N_t$ – consumption per person at t

*** $c_T = (1-s)\, y_T = (1-s)\, y_t\, e^{g(T-t)}$

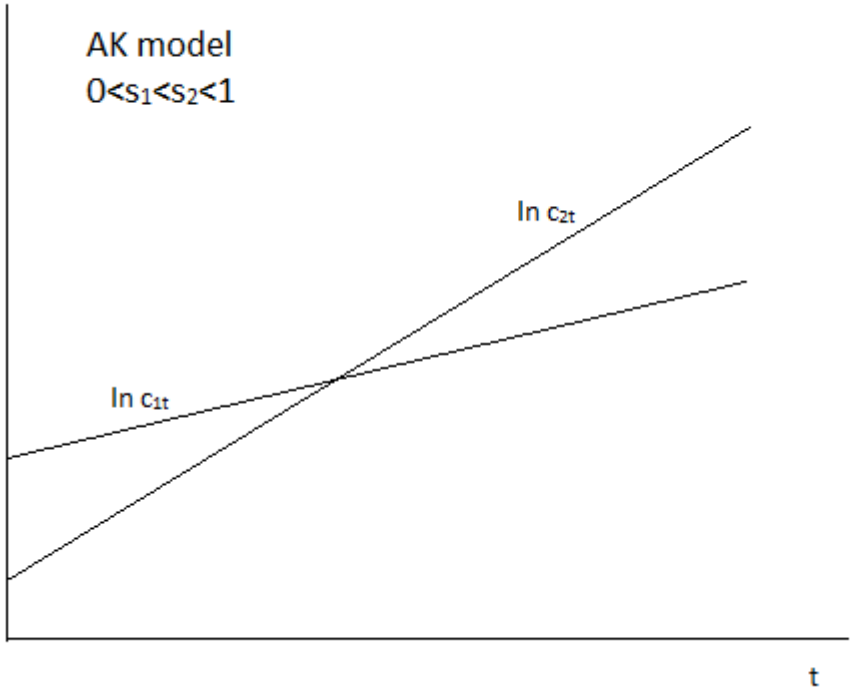
But then $c_T = 0$ if s=1.

So growth maximization may not be the best goal – need some intermediate savings rate.

What is the optimal savings rate?

A higher savings rate always lowers consumption now but raises it in the future (provided s<1)

GRAPH of ln c_t vs. time for two different savings rates



The more patient (or future-regarding) you are, the higher your optimal savings rate

?? <u>Policy Implications of this model:</u>

IF THE GOAL IS TO INCREASE GROWTH RATE

Increase the savings rate.

Government saving – tax, and invest in firms or public capital (e.g. Soviet Union)

Reduce taxes on saving/investing (assuming elastic)

e.g. capital gains tax, tax on interest income, corporate tax, estate tax

Firm-level investment subsidies

Increase productivity.

Technology assimilation programs

Protect intellectual property rights

Govt.-funded research

Create a business-friendly, competition-friendly environment (not over-regulated)

Lower population growth

Coercion, tax incentives, women's education, etc.

KEY EQUATION, USEFUL ACROSS MODELS:

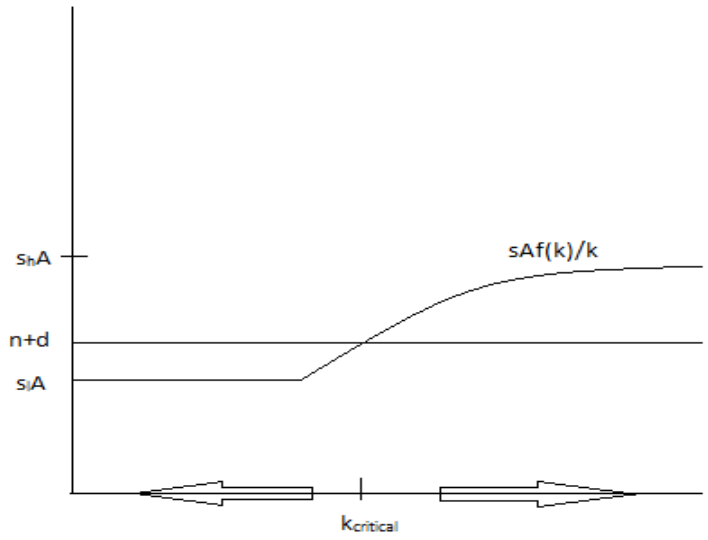
**$g_k = sAf(k_t)/k_t - (n+d)$

1) What if s varies with y?

In general, **Poverty trap:** low income ⇒ low growth ⇒ low future income …

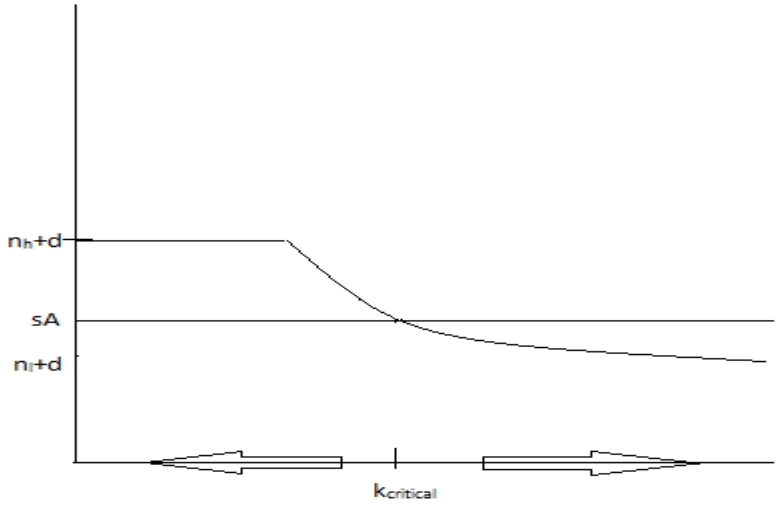
Savings-based poverty trap: low income ⇒ low savings/investment per worker ⇒ cannot maintain or grow the capital stock ⇒ low growth ⇒ low income …

Assume AK model, except that marginal propensity to save is s_l below some income level, and s_h above that level. Graphically:



2) What if n varies with y? Assume n is high when income is low, n is low when income is high

Population-growth based poverty trap: low income ⇒ high population growth ⇒ higher investment requirements to maintain high capital/worker ⇒ cannot maintain or grow the capital stock ⇒ low growth ⇒ low income …



(3) Health-based poverty trap: low income ⇒ poor nutrition, health ⇒ low productivity ⇒ low income per worker ⇒ savings/investment per worker ⇒ cannot maintain or grow the capital stock ⇒ low growth ⇒ low income …