W05: Economic Growth Theory

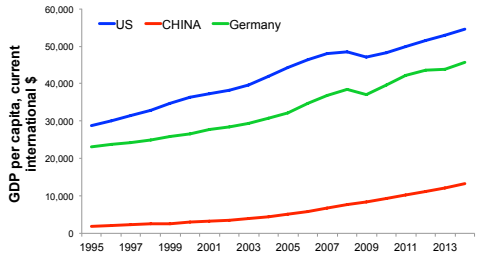
- Growth rates
- Exponential growth
- Catch-up vs. sustained growth
- Aggregate production function
- Generating economic growth
- Fundamental vs. proximate causes of growth
- Economic institutions

Reading: lecture notes

HW03: assigned 2/11, due 2/19

Economic Growth

Economic growth of an economy is the increase in its real GDP per capita (per person)



Calculating Growth Rates

- The **economic growth rate** is the percentage change of real GDP per capita
- The economic growth rate tells us how rapidly the total economy is expanding

$$\text{growth rate}_{t,t+1} = \frac{Y_{t+1} - Y_t}{Y_t}$$

Economic Growth Example: U.S.

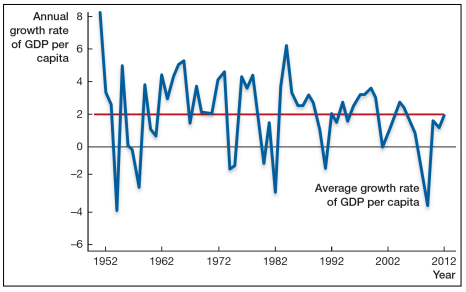
YEAR	GDP per capita (2005 dollars)
2005	$42,482
2006	$43,215
…	
2012	$45,336
2013	$45,835

Economic Growth Example: U.S.

$$g_{2005,2006} = \frac{\$43,215 - \$42,482}{\$42,482} = 0.017 = 1.7\%$$

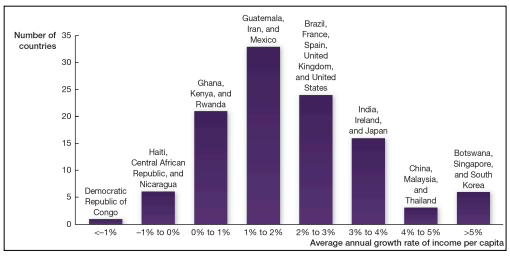
$$g_{2012,2013} = \frac{\$45,835 - \$45,336}{\$45,336} = 0.011 = 1.1\%$$

Economic Growth Example: U.S.



(2005 constant dollars)

Economic Growth in the World



Average Growth Rates of GDP per Capita from 1960 to 2010
(PPP-adjusted 2005 constant dollars)

Exponential Growth

- A process by which a quantity, like GDP per capita, grows at a constant proportion or growth rate

- Suppose *Y* in 2000 is growing at 10% each year
- What would be the value of *Y* in 2015?

$Y_{2001} =$

$Y_{2002} =$

$Y_{2003} =$

....

$Y_{2015} =$

Exponential Growth

- If a variable X grows at a constant rate *g* between the times *t* and *t+n*, then the value of the variable at time *t+n* is:

$$X_{t+n} = X_t(1+g)^n$$

Exponential Growth

- Consider three countries with the same starting level of GDP per capita, Y_{1810} = $1,000
- What would be GDP per capita in 2010 (200 years) if each country grew at 0%, 1% , and 2%?

Y_{2010} = if annual growth is 0%

Y_{2010} = if annual growth is 1%

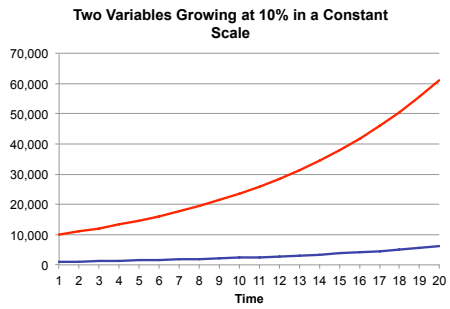
Y_{2010} = if annual growth is 2%

Exponential Growth

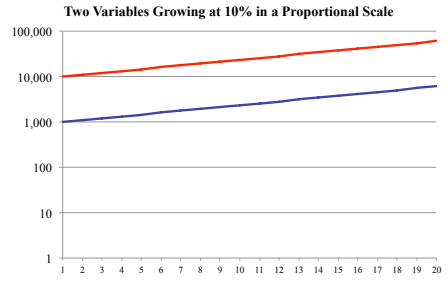
- An important implication of exponential growth:

Small changes in growth rates lead to large differences in the level of GDP per capita

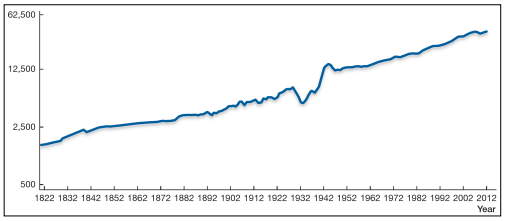
Plotting Variables that Grow Exponentially



Plotting Variables that Grow Exponentially



Economic Growth in U.S. (Proportional Scale)



(2005 constant dollars)

Catch-up vs. Sustained Growth

1. **Catch-up growth:**
   - Poor countries tend to grow faster, or "catch up," to rich countries as they adopt the production and technologies of the richest countries
   - Chile, Hong Kong, and South Korea
2. **Sustained growth:**
   - Some countries experience positive and relatively steady growth rates over 50- , 100-, and even 200-year periods
   - United Kingdom, United States, France, and Spain

Understanding the Observations

- Why do some countries grow faster than others?
- How can the economic growth be sustained?

Aggregate Production Function

$$Y = A \times F(K, H)$$

where

Y is GDP

K is the physical capital stock

H is the total efficiency units of labor

A is an index of technology

F is a function operator

Aggregate Production Function

Human capital:

- The stock of skills embodied in labor to produce output
- This stock of skills, or total efficiency units of labor, is written:

$$H = L \times h$$

where

l is total number of hours worked
h is the average human capital or efficiency

Aggregate Production Function

Physical capital

- The stock of business structures (plants) and equipment (machines) used for production

Aggregate Production Function

Technological change

The process in which new technologies and new goods and services are invented, introduced, and used in the economy

- Technology can be embodied or contained in *H*:
  - *(1)* ***knowledge*** of how to produce new goods
  - *(2)* ***knowledge*** of how to perform certain tasks more efficiently
- Technology can be embodied or contained in *K*:
  - *(1)* ***knowledge*** of how to produce new goods
  - *(2)* ***knowledge*** of how to run certain software

Aggregate Production Function

- The aggregate production function has the same two properties as the production function of an individual firm:

1. **"More is better":** an increase in either physical capital or total efficiency units of labor, holding the other factor constant, leads to an increase in GDP
2. **Law of diminishing marginal product:** the *marginal* contribution of either physical capital or total efficiency units of labor to GDP diminishes when we increase the quantity used of that factor (holding all other factors of production constant)

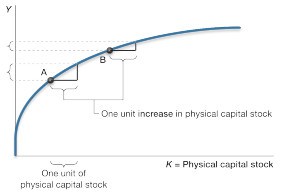
Aggregate Production Function

- An example of a production function:

$$Y = A \times K^{1/3} \times H^{2/3}$$

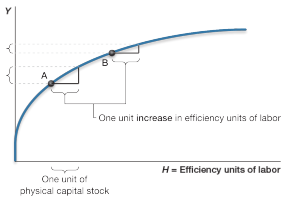
- This is called a Cobb-Douglas production function
- Empirical approximation to data

Aggregate Production Function



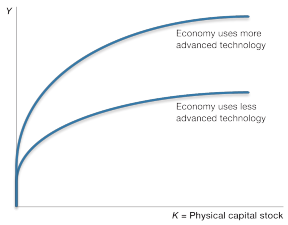
The Aggregate Production Function with Physical Capital Stock on the Horizontal Axis (the total efficiency units of labor held constant)

Aggregate Production Function



The Aggregate Production Function with the Efficiency Units of Labor on the Horizontal Axis (physical capital stock held constant)

Aggregate Production Function



The Shift in the Production Function Resulting from More Advanced Technology

Generating Economic Growth

A nation can increase its GDP by:

1. Increasing its stock of physical capital, *K*
2. Increasing the total efficiency units of labor, *H*
3. Improving its technology, *A*

But which of these channels can help a country achieve the sustained growth?

Generating Economic Growth

- Thomas Malthus, writing in 1798, argued that humankind was destined to live at the *subsistence level*
- According to the **Malthusian cycle**, any increase in income per capita above the subsistence level would lead to higher fertility rates
- That in turn, fuels higher population growth, which would drive income per capita back down to the subsistence level
- Without any technological advances, *pre-modern times* were stuck in the Malthusian cycle of little to no sustained growth in income per capita

Generating Economic Growth

Two trends led Britain and then other countries to break out of the Malthusian cycle:

1. The introduction of new machines and methods of production (**Industrial Revolution**)
2. The movement of people from rural agriculture to urban manufacturing led to a drop in fertility rates (**demographic transition**)

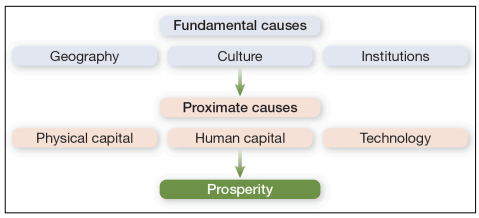
The *post-industrial Revolution* period:

- dramatic innovations in transportation, communications, electricity, and computers

Economic Growth: Recap

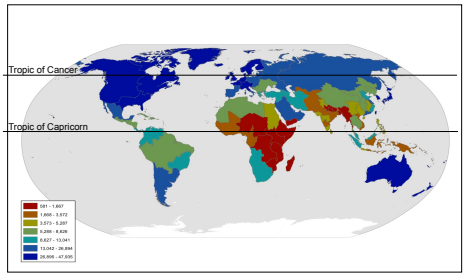
1. Understanding how GDP can be increased:
   Aggregate production function
2. Understanding the factors of production:
   Labor, Capital
3. Understanding technological progress
4. But why does technology improve in some countries and not in others?
   Fundamental causes of growth

Proximate vs. Fundamental Causes of Economic Growth



Geography Hypothesis

Differences in geography, climate, and ecology are ultimately responsible for the large differences in prosperity



Culture Hypothesis

- Different values and cultural beliefs are ultimately responsible for the large differences in prosperity

Institutions Hypothesis

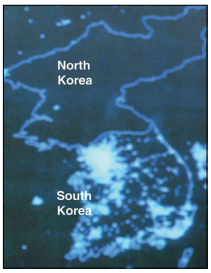
Differences in the way societies organize themselves and shape the incentives of individuals and businesses are ultimately responsible for the large differences in prosperity observed around the globe

Institutions have three important features:

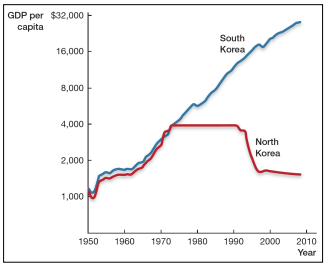
1. They are determined by individuals
2. They place constraints on behavior
3. They shape human behavior by determining incentives

Institutions Hypothesis: a Test

- The "natural experiment" of the two Koreas
- In the 1940s, North and South Korea were a single country
- In 1947, the country was split into two countries along the 38th parallel by an agreement between the United States and the Soviet Union



Institutions Hypothesis: a Test



GDP per Capita in North and South Korea (in PPP-adjusted 2005 constant dollars)

Economic Institutions

Economic institutions include:

- Protection of property rights and ownership
- Impartiality of the justice system
- Financial arrangements between savers and borrowers
- Regulations concerning new businesses or occupations

Economic Institutions

Inclusive economic institutions encourage economic transactions:

- Protect private property
- Uphold law and order
- Allow and enforce private contracts
- Allow free entry into new lines of business and occupations

Extractive economic institutions remove resources from the economy:

- Do not protect private property
- Do not enforce private contracts
- Interfere with the workings of markets
- Restrict entry into new lines of business and occupations

Is Foreign Aid a Solution?

- If the root of poverty is extractive economic institutions, then foreign aid given within these institutions will not fix the fundamental causes of poverty