

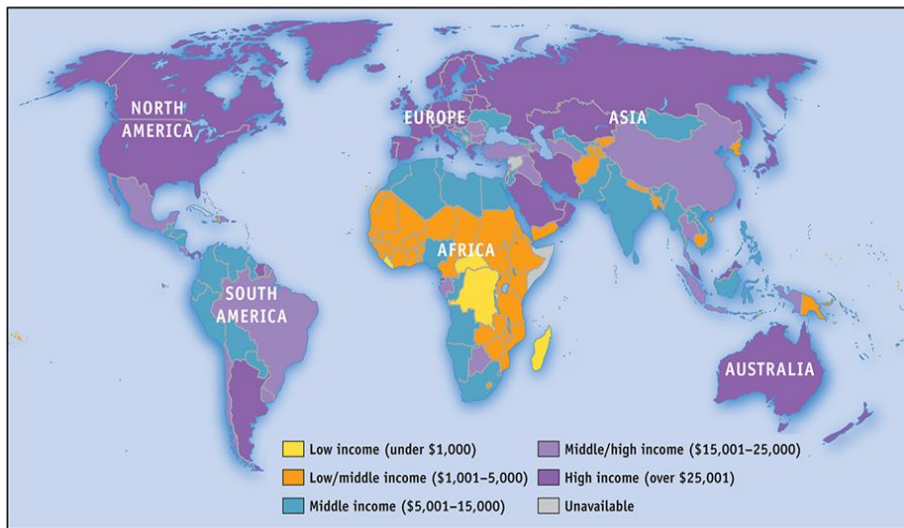
# Long Run Economic Growth

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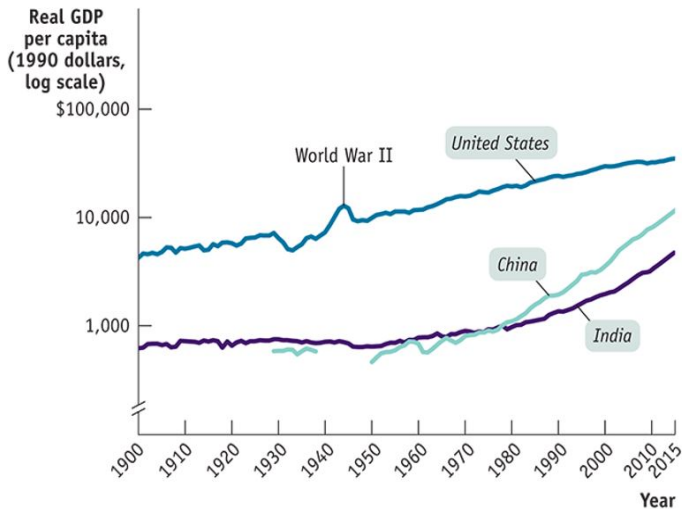
BSC

Fall 2021

# Some countries are richer than others



# Economic growth across countries



# Group presentation assignment

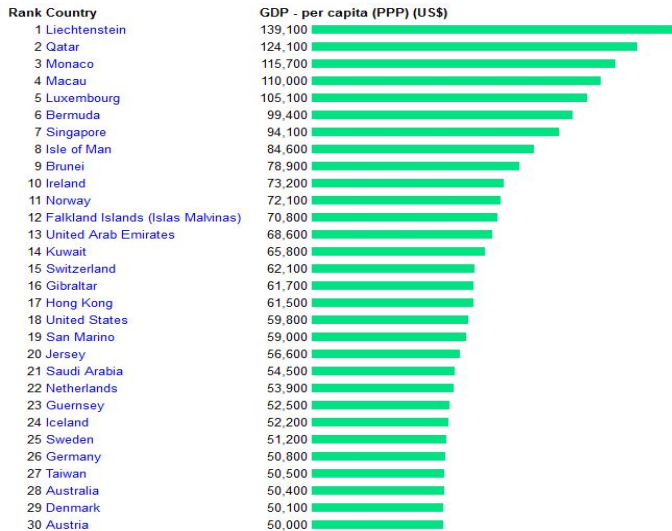
- ① Go to the [World Bank Database](#)
- ② Your job is to create the following two graphs
  - ① In the first plot, the GDP per capita in South Korea (Korea, Rep.), Singapore, and China
  - ② The second graph should plot the same data for Israel and Nigeria
- ③ What can we learn from the two graphs about what determines economic growth across countries?

# Measuring Economic Growth

- Although GDP has certain limitations as we saw in Ch 7, it still is a good measure of output produced in the economy
- When we account for the effect of price changes, we have Real GDP
- Since the GDP is shared by the population residing in the economy, it makes sense to divide it by the population
- The resultant number is called **Real GDP Per capita**
- Real GDP Per Capita is a widely used measure of living standards

$$\text{Annual growth rate in GDP} = \frac{\text{GDP in year 2} - \text{GDP in year 1}}{\text{GDP in year 1}} \times 100$$

# Ranking countries by GDP per Capita



Source: [indexmundi.com](https://indexmundi.com)

# The Rule of 70

If an economy grows at a constant rate  $g$ , how long would it take to double its GDP?

- **The Rule of 70**

$$\text{Doubling time for } g = \frac{70}{\text{Annual growth rate of } g}$$

## Exercise 1:

The current real GDP per capita in the U.S. is \$58,388. Assuming the economy grows annually at 2% for the foreseeable future, how many years will it take for real GDP per capita to be approximately \$116,776?

# The Rule of 70

## Exercise 2:

India's GDP per capita is \$3,000, and let's assume real output per person grows at 5% per year. Using the rule of 70, how many years will it take for India to reach Italy's current level of GDP per capita, about \$24,000 per year?

*Hint: How many times will India's GDP have to double? How many years does it take to double once?*



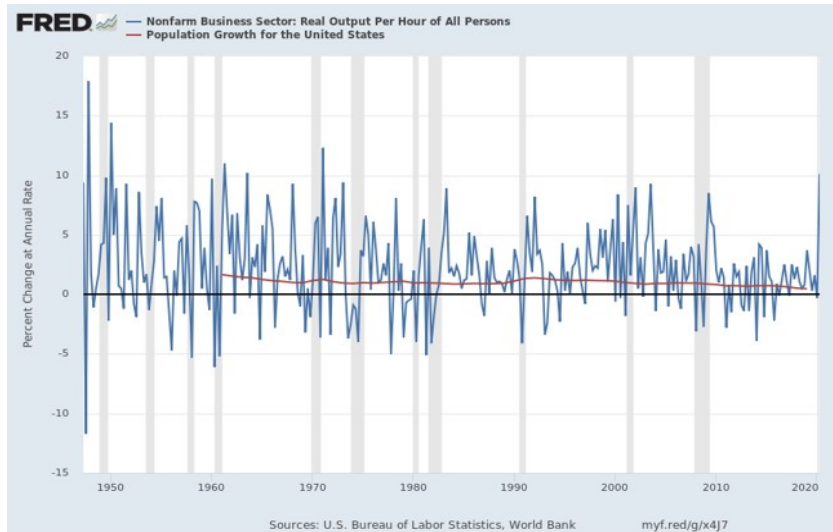
# The sources of long run economic growth

In the long run, output per worker (labor productivity) is a more appropriate measure of economic progress. Why?

- Labor productivity (or simply, productivity): output (real GDP) per worker (or, alternatively, output per work hour)
  - ▶ You may argue that why not just put more people to work and increase GDP. But that works only temporarily.
  - ▶ If you look at economic growth rate and population growth rate during the twentieth century (long run) in the U.S.
    - ★ Population grew at 1.3%
    - ★ Employment grew at 1.5%
    - ★ RGDP per capita grew at 1.9%
    - ★ of this 1.9%, 1.7% came from labor productivity growth alone

Here are a couple of videos illustrating productivity.  
Find more about labor productivity [here](#).

# The sources of long run economic growth



Source: **FRED**

# The sources of long run economic growth

- Thus any major increase in real GDP per capita must be result of output per worker or labor productivity.
- In other words, it must be due to *higher productivity*
- So, productivity is the key to long run economic growth
- But, what leads to higher productivity?

# What leads to productivity growth?

- Physical capital
  - ▶ human-made tools in the broadest sense: pencils, tractors, desks, computers, hammers, factories, roads, bridges, machines, buildings
- Human capital
  - ▶ “Tools in the mind”: the stuff in people’s head that makes them productive/efficient.
  - ▶ Developed over time through investment in education, training, and experience
- Technological progress
  - ▶ an advance in technical means of production of goods and services, is developed through investment in research and development
  - ▶ Has been the primary factor in the long-run economic growth

# What leads to productivity growth?

- Incentives and Institutions

- ▶ Incentives: market rewards efficiency—South Korea vs. North Korea



source: <https://paulromer.net/rules-change-north-vs-south-korea/>

# What leads to productivity growth?

- Incentives and Institutions

- ▶ Institutions

- ★ property rights: collective vs private property rights
    - ★ honest government: Zimbabwe government could take your property any time
    - ★ political stability: civil wars
    - ★ a dependable legal system: In India it takes about 56 procedures and about 1,420 days to collect debt; in U.S. it takes about 17 procedures and 300 days.
    - ★ competitive and open markets: efficiency

- Question: how much does output increase when we increase these inputs?

# Aggregate production function

How much does output change when we change inputs?

- **Aggregate production function** helps us answer it

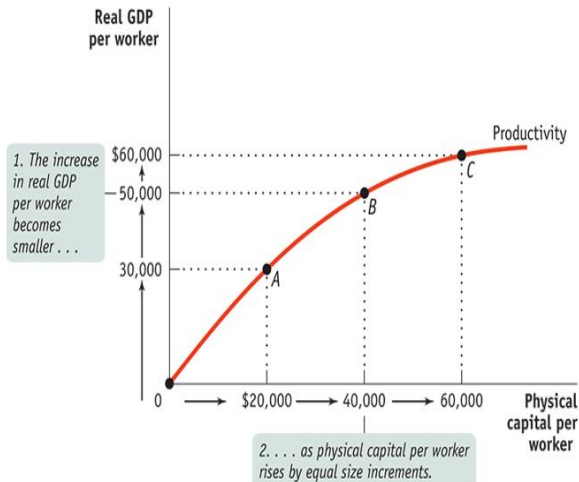
Aggregate production function is a hypothetical function that shows how productivity (real GDP per worker) depends on the quantities of physical capital per worker and human capital per worker, as well as the state of technology

# Aggregate production function

## Production function

GDP Per capita =  $T \times (\text{physical capital per worker})^{0.4} (\text{human capital per worker})^{0.6}$

$T$  is the level of technological development



Physical capital per worker	Real GDP per worker
\$ 0	\$ 0
20,000	30,000
40,000	50,000
60,000	60,000



# Aggregate production function

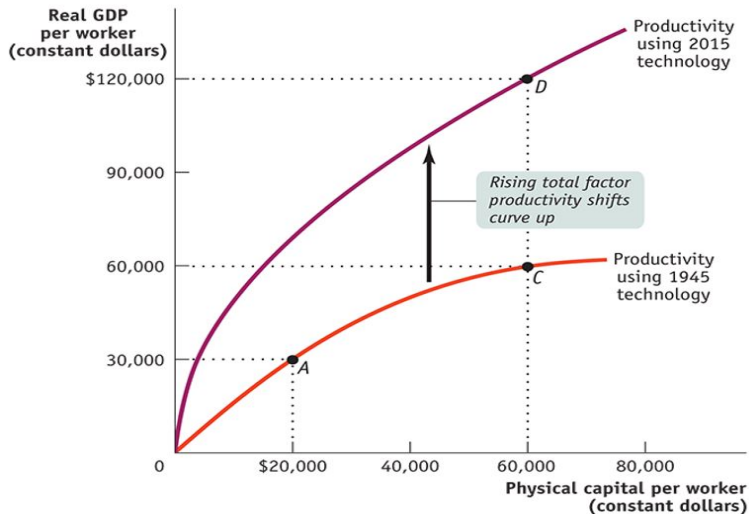
The production function shows **Diminishing returns to physical capital**

- Holding the amount of human capital per worker and the state of technology fixed, each successive increase in the amount of physical capital per worker leads to a smaller increase in productivity
- For example, A second computer improves one's productivity, but not by as much as the first computer did.

# Aggregate production function

- Note that diminishing marginal returns is “other things remaining equal/constant” phenomenon. We are keeping level of human capital and technology constant and increasing only physical capital
- What if we increase human capital or technology or both?
  - ▶ Diminishing returns may disappear! Let's find out how.

# Shift in the aggregate production function



# Technology and productivity

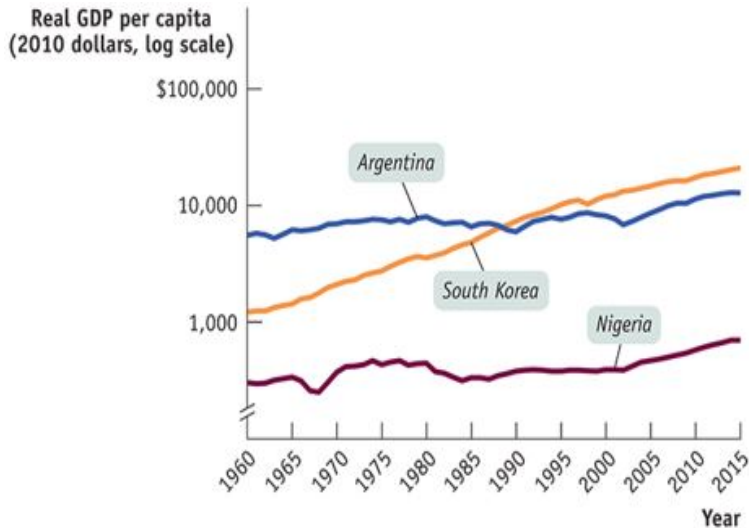
- Increases in **total factor productivity** (TFP) likely measure the economic effects of technological progress.
- TFP is a measure of the amount of output that can be produced with a given amount of factor inputs
  - ▶ when TFP increases, economy can produce more output with the same amount of inputs
- Why is technology so important for economic growth?
  - ▶ technological progress usually leads to higher TFP and thus higher economic growth.

**Rising TFP is the key to long-run economic growth. TFP is usually interpreted as the effect of technological progress. Higher TFP improves productivity.**

# Natural resources and economic growth

- In the modern world, human or physical capital matter more than natural resources for the great majority of countries
- One reason is that natural resources are finite
- Second, although natural resource rich countries did make good progress in the nineteenth century, in the modern world, countries such as Japan and Israel have made progress without much natural resources while oil rich countries such as Nigeria have flagged. There are a few middle-eastern countries which are doing well due to abundant oil.

# Why do economic growth rates differ across countries?



# Why do economic growth rates differ across countries?

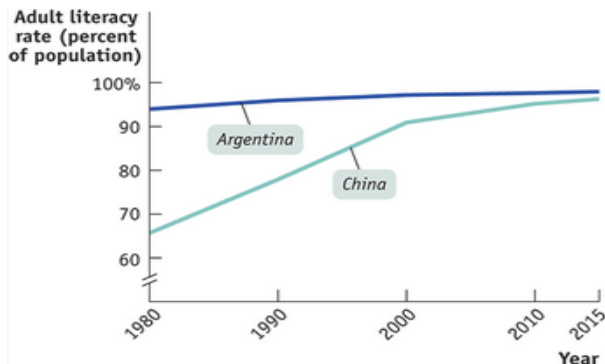
Countries that grow rapidly tend to do the following three things well:

- Savings and investment spending
  - ▶ Rapidly add to their physical capital through high savings and investment spending
  - ▶ China, East Asia in the 90s.
- Research and development
  - ▶ USA, Germany

# Why do economic growth rates differ across countries?

## • Education

- ▶ East Asian countries, China invested well in education
- ▶ Adult literacy rate in China has risen much faster than in Argentina



**FIGURE 9-7** Krugman/Wells, *Macroeconomics*, 5e, © 2018 Worth Publishers  
Data from: World Development Indicators, World Bank.



# Government's role in promoting economic growth

- Government policies
  - ▶ Infrastructure
  - ▶ Subsidies to education, subsidies to R & D
  - ▶ Robust financial system
  - ▶ Strong telecommunication network (Ireland)
  - ▶ Stable power supply (no frequent power failures)
  - ▶ Public health system—clear drinking water, disease control
- Property rights
  - ▶ For example, intellectual property rights
  - ▶ Ease of land acquisition
- Political stability and good governance
  - ▶ Civil wars lead to massive economic damages
  - ▶ Corruption hinders economic growth

# What is holding Africa back?



# What is holding Africa back?

- Corruption in the government
  - ▶ Nigeria
- Political instability and civil wars
  - ▶ Sudan, Somalia, Libya
- Unfavorable geography
  - ▶ Haiti, Somalia, Ethiopia
- Weak public health infrastructure
  - ▶ Malnutrition
  - ▶ Tropical diseases such as malaria

# Is growth sustainable?

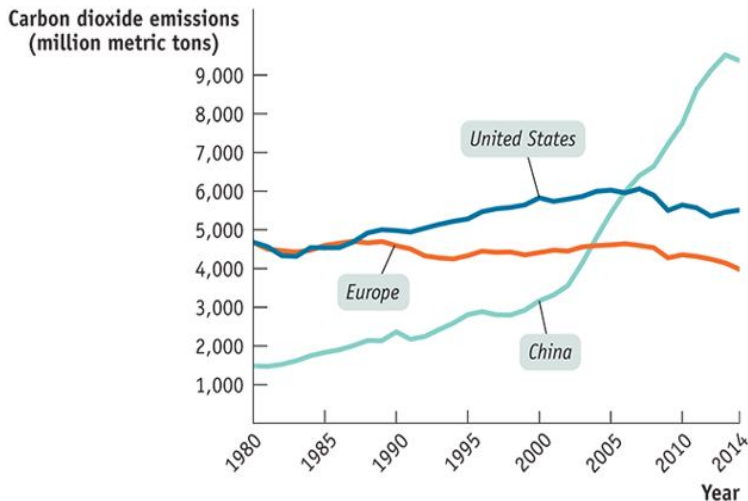
What's the impact of limited natural resources on long run economic growth? Depends on three questions:

- How large are the supplies of key natural resources?
- How effective will technology be at finding alternatives to natural resources?
- Can long-run economic growth continue in the face of resource scarcity?

Long-run growth is **sustainable** if it can continue in the face of the limited supply of natural resources and the impact of growth on the environment.

# Economic growth and environment

Economic growth tends to increase the human impact on the environment.



# Economic growth and environment

- Unlike resource scarcity, environmental problems don't automatically provide incentives for changed behavior. Why?
  - ▶ what is the incentive for reducing carbon emissions?
  - ▶ Lack of international consensus
- But there was some hope in 2015!
  - ▶ Paris Agreement of 2015: 196 countries agreed to reduce their greenhouse gas emissions in an effort to limit the rise in Earth's temperature to no more than 2 degrees centigrade.

# In-class problem #1

- Which of the following is the most important driver of productivity growth, and therefore an important influence on long-run economic growth of output per capita?
  - ▶ Natural resources
  - ▶ human resources
  - ▶ physical capital
  - ▶ technological progress

## In-class problem #2

The country of Androde is currently using Method 1 for its production function. A technological breakthrough introduces Method 2 in the production function. Assume that human capital per worker is fixed.

Method 1		Method 2	
Physical capital per worker	Real GDP per worker	Physical capital per worker	Real GDP per worker
0	0.00	0	0.00
50	35.36	50	70.71
100	50.00	100	100.00
150	61.24	150	122.47
200	70.71	200	141.42
250	79.06	250	158.11
300	86.60	300	173.21
350	93.54	350	187.08
400	100.00	400	200.00
450	106.07	450	212.13
500	111.80	500	223.61

Suppose the economy of Androde initially has 100 units of physical capital per worker and is using Method 1. Then over the course of 70 years, it increases its physical capital per worker to 400 while also increasing its technology to Method 2. Which percentage of the annual productivity growth is due to higher total factor productivity?

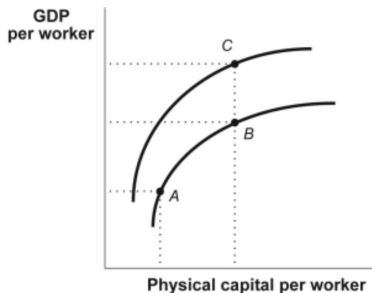


## In-class problem #3

Suppose that a panel of economists predicts that a nation's real GDP per capita will double in approximately 20 years. According to the rule of 70, what must be the predicted annual growth rate of real GDP per capita?

## In-class problem #4

The following graph shows two production functions.



- 1 What causes a movement from point A to B?
- 2 What causes movement from point B to C?