

## Ch 9: Growth

# Where we are going

- Remember that all models are incomplete.
  - They are good at a few things but not everything.
  - Most tend to be good in one area.
- We have models for:
  - Business cycles
  - Growth

The models don't always play well together. This is about Growth

# We Tend to focus on Per Capita GDP

We focus on per capita real GDP when talking about growth.

- We are talking about production, not welfare, so GDP is the right measure.
- We don't want to be fooled by price changes so *real* is appropriate.
- We don't want to be fooled by scale.

# Lets Look at some

<https://www.indexmundi.com/g/r.aspx?v=67>

- There are a lot of tax havens/banking hubs in the top
  - And some playgrounds for the rich and famous.
  - And OIL
- European nations are near the top, except Moldova.
- Much of Africa is near the bottom.

# The real key is not where you start

The rate that you grow is key.

- You can make up for starting low by growing fast.
- Book gives a “Rule of 70”.
  - You may also hear it as “Rule of 72” or “Rule of 69”.
  - Divide 70 or 72 or 69 by the growth rate and it tells you how long to double.

## Example

How long to double \$100 when the growth rate, i.e., the interest rate, is 10%?

$$\frac{70}{10} = 7 \text{ years}$$

How long to double \$100 when the growth rate, i.e., the interest rate, is 5%?

$$\frac{70}{5} = 14 \text{ years}$$

# What I mean by Growth Rate Dominates

Caution exact calculations!

Two accounts:

- One with \$100 and an interest rate of 10%.
- One with \$1,000 and an interest rate of 3%.

Who gets to \$10,000 first?

# Well

$$F = P(1 + i)^N$$

You can solve for N

$$\frac{\ln(F) - \ln(P)}{\ln(1 + i)} = N$$



## In this case

\$100 and an interest rate of 10% grows to 10K in:

$$\frac{\ln(10000) - \ln(100)}{\ln(1 + .1)} = 48.32 \text{ years}$$

\$1000 and an interest rate of 3% grows to 10K in:

$$\frac{\ln(10000) - \ln(1000)}{\ln(1 + .03)} = 77.9 \text{ years}$$

# Crazy things

- In 1900 Argentina had higher per capita real GDP than most European countries.
- Except for the last few centuries, China and India where most of world GDP.

What happened? Different growth rates.

# So, How Do you Grow Per Capital Real GDP?

- Increase per capita physical capital.
- Increase per capita human capital
- Technical progress that makes human and/or physical capital more productive.

# Physical Capital

Give people more machines to do their job.

- How to get to school?
  - Walk - 3.2hrs (I timed myself but stopped for a cup of coffee).
  - Drive 10K car - 25 min ~ 0.5 hrs

# Human Capital

Education and skills of the population. If you don't believe this, why are you here?

# The most important: Technological Progress

- This is:
  - New tools and ideas that didn't exist. Like IDEs for programming.
  - Yes, this is massive increase in physical capital, but a technological improvement on people with the finest cross cut saws in the world.  
<https://www.youtube.com/watch?v=m0ZELXwFZkc>
- It is even:
  - Printed receipts
  - Phones where you don't have to remember the phone number.

# We Can Summarize the Effect of All Three

$$GDP \text{ Per Capita} = T(\text{Per Capita Physical})^{.4}(\text{Per Capita Human})^{.6}$$

- The T is technology
- The .4 and .6 are approximations estimates based on US data.
  - Don't take the exact numbers seriously
  - They are the right scale, physical counts for less than human and technology trumps them all.

# What Does that Mean

$$GDP \text{ Per Capita} = T(\text{Per Capita Physical})^4(\text{Per Capita Human})^6$$

- Technology helps
- You can add human and physical capital and get more real GDP per capita but you should balance it out and add both – not just one.



## See what I mean

$$GDP \text{ Per Capita} = (\text{Per Capita Physical})^{.4}(\text{Per Capita Human})^{.6}$$

- Mostly Physical:  $4^{.4} + 1^{.6} = 1.74$
- Mostly Human:  $1^{.4} + 4^{.6} = 2.3$
- Balance:  $2^{.4} + 3^{.6} = 2.55$

Investments in human and physical capital suffer from declining returns. The more you invest the smaller the benefit of investing more.

# Graphical Summary

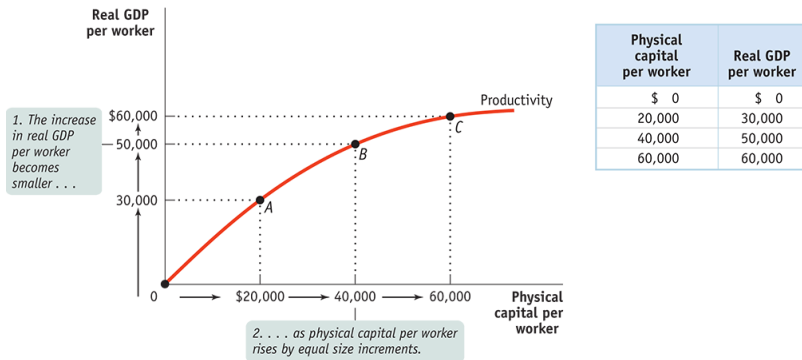


FIGURE 9-4 Krugman/Wells, *Macroeconomics*, 5e, © 2018 Worth Publishers

Figure 1:

# So what does T do?

T is the effect of technology

- The special name is “total factor productivity”.
- Cool kids say “TFP”
- We have other kinds of technical change to, e.g., labor augmenting, but not in this class.
- It stretches the curve up.

# Graphical Summary

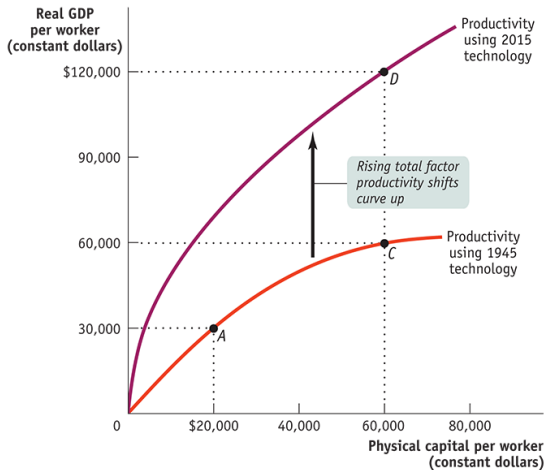


FIGURE 9-5 Krugman/Wells, *Macroeconomics*, 5e, © 2018 Worth Publishers

# What About Natural Resources?

The math says, it is like starting with more.

- Remember the example of 100 at 10% growth and 1000 at 3%?
- You need to turn it into growth.
- Some do and some don't

# Natural Resources are often a curse

Often “The Resource Curse” or “Dutch Disease”

- Because the extraction industry is so big.
- Most investment is in that industry.
- The industry pays more and attracts lots of human capital, starving the others.
- When prices of the resource change, incomes change a lot. The price of any one good is more volatile than many.

Examples:

- West Virginia and Coal
- Venezuela and Oil

One of the hazards of over-specialization.

# So how do you grow?

Don't spend all your money. Save it and invest:

- Buy lots of physical capital
- Spend lots of education
- Try to increase technological progress.

# Who invests in physical capital

We are looking for countries where I, Gross Domestic Private Investment, is a large fraction of GDP.

[https://en.wikipedia.org/wiki/List\\_of\\_countries\\_by\\_gross\\_fixed\\_investment\\_as\\_percentage\\_of\\_GDP](https://en.wikipedia.org/wiki/List_of_countries_by_gross_fixed_investment_as_percentage_of_GDP)

Check the relative rankings of:

- China with 7.13% per capita growth from 2010 - 2016
- World with 1.53%
- EU with 0.71%
- US with 1.33%

BTW, they are in order of percent investment



# So What Do Countries Do

The short list:

- Build infrastructure
- Subsidize education
- Subsidize R&D
- Well functioning financial system
- Enforce property rights
- Be good at governing and be stable.

# Build infrastructure

What is infrastructure?

- Roads
- Electric and Natural Gas pipeline networks
- Telecommunications
- Water distribution and storage

# US Examples

- Federal Aid Highway Act of 1956 – Authorized our interstate highway system
  - Officially completed in 1992.
  - Without this, no long-distance trucking.
- Rural Electrification Act of 1936
  - Zero interest loans for the poles
  - Free install of a few circuits and lights.

# Typical Problem with Infrastructure

- Building it is sexy. Maintaining it isn't.
- The US has a \$1T backlog

# Subsidize Education

- This could be as simple as basic literacy.
- It could also mean more people completing secondary education (HS) or post-secondary education.
- Not all subsidies go where they are intended
  - Some evidence that subsidies to you, low interest loans, provides more rewards to others.
  - <https://github.com/woodsjam/AAUP-Numbers/blob/master/TuitionSalary.pdf>

# Subsidize R&D

- This is mostly private not public funded.
- Public funding tends to be towards basic research, not applied.
- There is a problem with the last touch, applied research, getting the financial benefits.
  - Analogous to the goal scorer getting credit winning the game.

# Well Functioning Financial System

- This is institutionalizing a trust.
  - Trust that deposits can be withdrawn.
  - Trust that loans are based on merit.
  - Trust that transactions will be completed.

# Enforce property rights

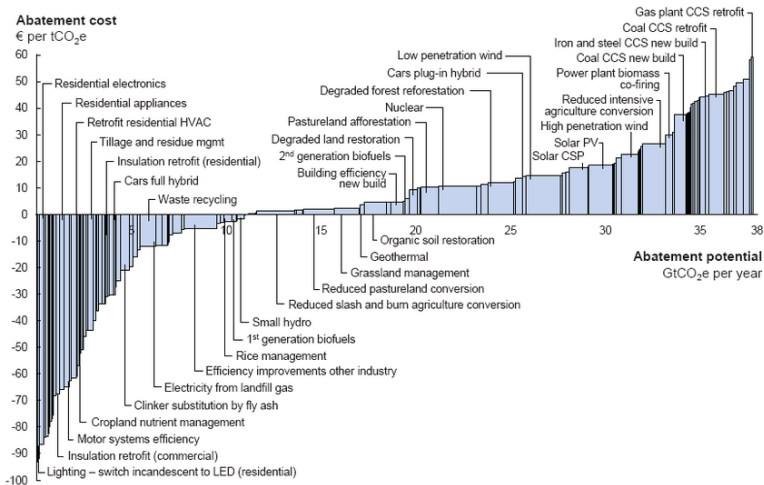
- This is a complex topic
- Often this is about intellectual property rights, copyright and patents.
- Could also be about not having your property seized without compensation.
- Not selling off public assets to well placed friends.



# Be good at governing and be stable.

- Often this is about corruption
  - [https://www.transparency.org/news/feature/corruption\\_perceptions\\_index\\_2017#table](https://www.transparency.org/news/feature/corruption_perceptions_index_2017#table)
  - Keep in mind that this can be very regional in large countries
- Or about low bureaucratic overhead

# Can We Do This Sustainably (Just Energy)



# Summary

- We do plenty of things now that are cost more than the more sustainable path
  - Other things, perception, perceived risk, get in the way.
  - Cheaper than doing nothing.
- The key is that doing things sustainably produces new winners and losers.