

# Lecture 9: The Facts of Growth

## Intermediate Macroeconomics, Econ 102

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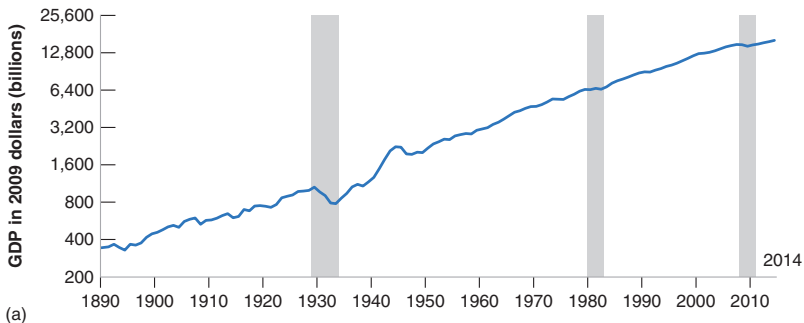
*"It's true, Caesar. Rome is declining, but I expect it to pick up in the next quarter."*

# Short run or long run?

- We have focused at the **short run determinants of output**:
  - ▶ more saving was detrimental to investment.
  - ▶ redistributive taxation from low MPC to high MPC was desirable.
- However, in the medium and long run :
  - ▶ saving also feeds capital accumulation, and investment.
  - ▶ high taxation of low MPC discourages entrepreneurship, etc.
- In the keynesian theory we studied, output was demand-determined. However, in the long run, what determines output is also the supply side. At some point, increases in demand face a constraint on supply.
- In particular, one question that obsesses economists is how can we increase **long run growth of output**. According to Robert E. Lucas, a Chicago economist: “The consequences for human welfare involved in questions like these are simply staggering: once one starts to think about them, it is hard to think about anything else.”

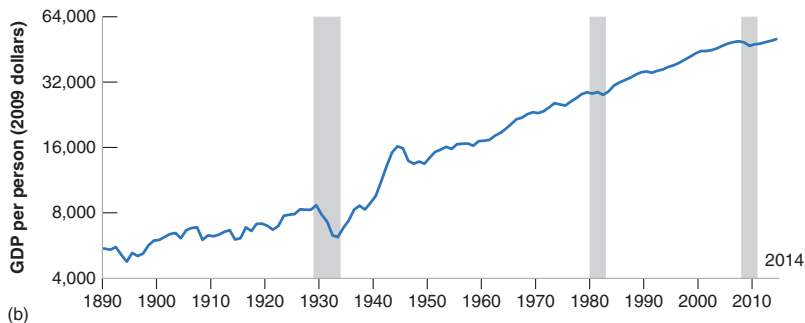
# U.S. GDP since 1890.

- US output, since 1980, and until 2014, has increased by a **factor of 46**.



## U.S. GDP per capita since 1890

- However, US output per capita, since 1980, and until 2014, has increased only by a **factor of 9**.
- U.S. population has increased from **63 million to more than 300 million** during this period.



- 1 Measuring the Standard of Living
- 2 Growth in Rich Countries since 1950
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## Measurement issues

- We care about growth because we ultimately care about standards of living. **Output per person** is better than output itself, is the variable we compare over time or across countries.
- **Output per worker** = compare the productivity of a labor force (labor force participation, age structure, etc.)
- **Output per hour worked** = even better: for example, Germany VS U.S.
- Finally, this is not enough. We also need to correct for **variations** in exchange rates and **systematic differences** in prices across countries. For this reason, we use **purchasing power parity (PPP) numbers**
  - ▶ The \$ increased and then decreased in the 1980s by roughly 50% vis-à-vis other currencies. Surely the standard of living did not change by that much!
  - ▶ GDP per person is \$1529 in India, in 2011, using the exchange rate then. Compared to \$47880 in the US, this is  $31.3\times$  more. But prices of basic goods are much lower in India.

# The construction of PPP numbers

- Consider this example. Exchange rate is  $1 \text{ USD} = 30 \text{ RUB}$ .
  - ▶ United States: Each year, people buy a new car for 10,000 USD, and spend another 10,000 USD on food. (Total = 20,000 USD)
  - ▶ Russia: People spend 20,000 RUB on cars (each lasts for 15 years) a year, and 40,000 RUB on food (same quantity).
- Thus, consumption per person in Russia is only 10% of U.S. consumption per person.
- If we use **U.S. prices** for both countries and assume people spend all money on food, then consumption per person is 20,000 USD (10,000 USD + 10,000 USD) in the U.S., but 10,700 USD  $[(1/15) \times 10,000 \text{ USD}) + (1 \times 10,000 \text{ USD})]$  in Russia, so Russian consumption per person is **53.5% of U.S. consumption per person**.
- Penn World Tables attempt to construct **PPP estimates**, using a common set of prices across countries.



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# Measurement issues

**Table 10-1** The Evolution of Output per Person in Four Rich Countries since 1950

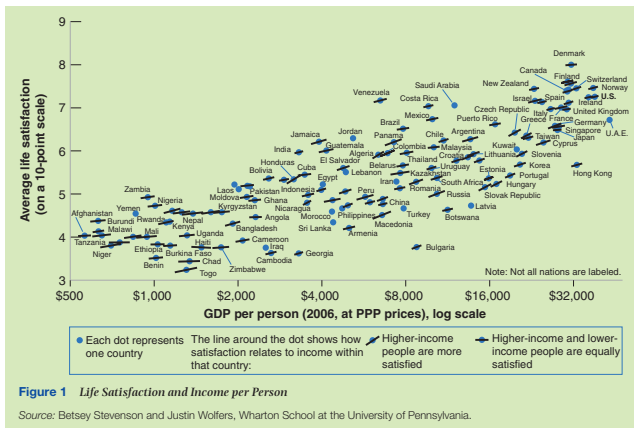
	Annual Growth Rate Output per Person (%)	Real Output per Person (2005 dollars)		
	1950–2011	1950	2011	2011/1950
France	2.5	6,499	29,586	4.6
Japan	4.1	2,832	31,867	11.3
United Kingdom	2.0	9,673	32,093	3.3
United States	2.0	12,725	42,244	3.3
Average	2.4	7,933	33,947	4.3

*Notes:* The data stop in 2011, the latest year (at this point) available in the Penn tables.  
The average in the last line is a simple unweighted average.

*Source:* Penn Tables. <http://cid.econ.ucdavis.edu/pwt.html>

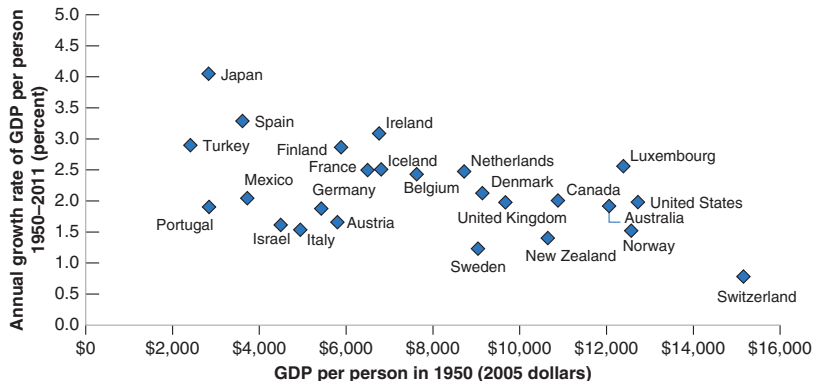
- Small differences in growth rates (4.1% for Japan, versus 2.0% in the US) lead to large differences in output per person growth over 61 years: this is due to the **force of compounding**.
- There has been a **convergence** of output per person across countries.

# Does money lead to happiness?



- The relationship is not that tight.
- **Easterlin paradox:** Once basic needs are satisfied, higher income per person does not increase happiness, and the level of income relative to others, rather than the absolute level of income, matters.

# Convergence in OECD Countries



- Convergence again: Countries with lower levels of output per person in 1950 have typically grown faster.

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# Measurement issues

- From the end of the Roman Empire to roughly year 1500, Europe was in a **Malthusian trap** or **Malthusian era**:
  - ▶ stagnation of output per person.
  - ▶ most workers were in agriculture with little technological progress.
- After 1500, growth of output per person turned positive:
  - ▶ 1500-1700: around 0.1% per year in Europe.
  - ▶ 1700-1820: around 0.2% per year in Europe.
  - ▶ Starting with the industrial revolution, growth rates increased. But between 1820 and 1950, U.S. growth was still 1.5% per year.
- High sustained growth has been known only since 1950.

# Convergence in 85 Countries



- In a larger panel of 85, countries, there is no clear relation between the growth rate of output since 1960 and the level of output per person in 1960.



# Convergence in 85 Countries

- For the OECD countries, there is clear evidence of convergence, just as we saw in a previous scatterplot.
- Convergence is also visible for many Asian countries:
  - ▶ **Japan** was the first country to take off in Asia.
  - ▶ In the 1960s, four countries (Singapore, Taiwan, Hong Kong, and South Korea) – sometimes called the **four tigers** – started growing as well.
- We see a different picture, however, for African countries:
  - ▶ Most African countries were very poor in 1960, and most of them have not done well over the period.
  - ▶ Some of them had negative growth of output per person between 1960 and 2011 due in part to internal or external conflicts.
  - ▶ Countries with favorable natural resources, such as Botswana and Equatorial Guinea are exceptions.

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# The Aggregate Production Function

- We introduced an aggregate production function  $F$  previously, which was very simple with:

$$Y = F(N) = N$$

- We now introduce capital and write the production function as follows:

$$Y = F(K, N)$$

where  $Y$  is output,  $N$  is labor, and  $K$  is **capital**.

- The function  $F$  tells us how much output is produced for given quantities of capital and labor, and should be thought of as a **recipe**. It depends on the state of technology.

# The Aggregate Production Function

- Imagine that we double the number of workers and the amount of capital in the economy. What would happen to output? A reasonable answer would be that output is doubled as well. In this case, there are constant returns to scale:

$$2Y = F(2K, 2N)$$

- More generally, for any  $x$ , we have that:

$$xY = F(xK, xN)$$

- There are **decreasing returns to capital**. (cf Econ 101) Each new machine is less and less efficient at allowing you to produce more output (capital and labor are complementary)
- There are **decreasing returns to labor**. Similarly, if workers do not have computers, or if a plant building cars does not increase the number of machines, then output will eventually increase less for each additional unit of labor.

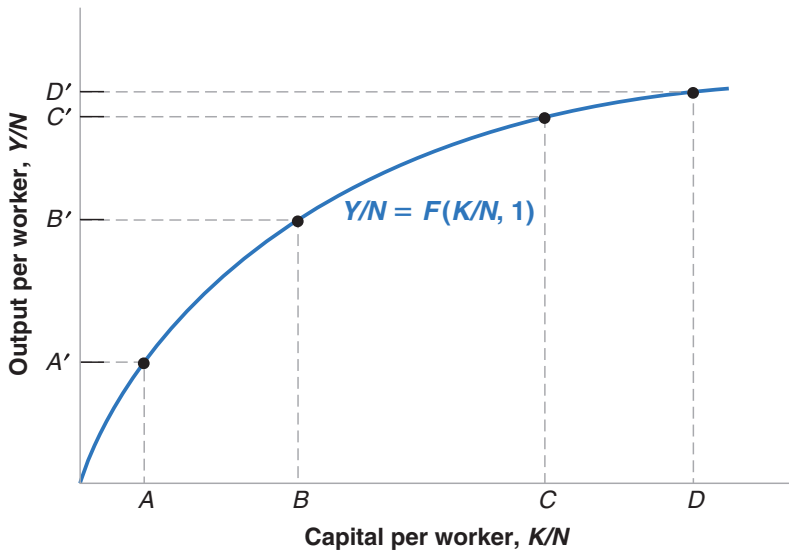
# The Aggregate Production Function

- The production function and constant returns to scale imply a simple relation between output per worker ( $Y/N$ ) and capital per worker ( $K/N$ ):

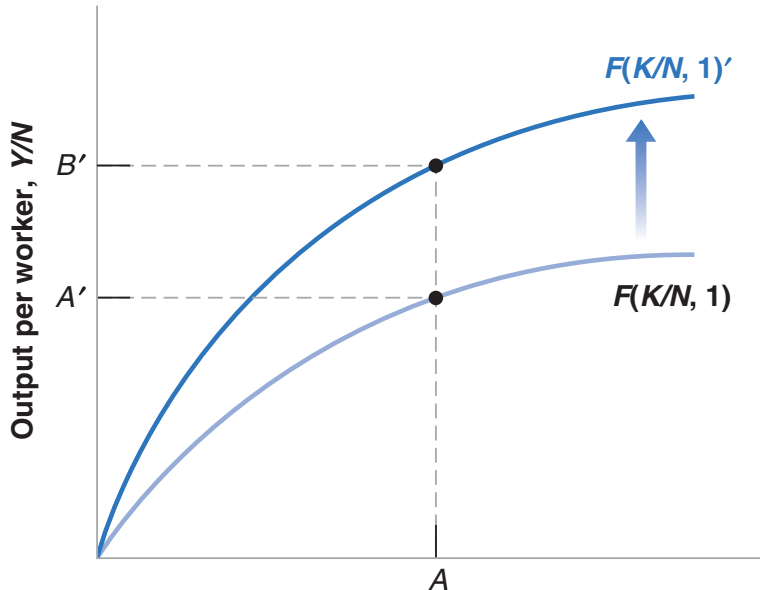
$$\frac{Y}{N} = F\left(\frac{K}{N}, \frac{N}{N}\right) = F\left(\frac{K}{N}, 1\right)$$

- Increases in capital per worker lead to movements along the production function.
- In contrast, an improvement in the state of technology leads to a shift in the production function.
- Overall, growth in GDP per capita may come from both:
  - ▶ **capital accumulation** (resulting from a higher saving rate)
  - ▶ **technological progress**. (resulting from an improvement in the state of technology)

# Capital accumulation



# Improvement in Technology



## Suggested Readings / Exercises

- ☞ Chapter 10, *Macroeconomics*, 7th Edition, Olivier Blanchard.  
Foreign Investment in Africa, *The Economist*, January 23, 2015. [Link](#)
- Henderson, J. Vernon, Adam Storeygard, and David N. Weil. “Measuring Economic Growth from Outer Space.” *American Economic Review* 102, no. 2 (April 2012): 994–1028. [Link](#)