Introduction to Economic Growth

Felix Wellschmied

Universidad Carlos III de Madrid

Growth Theory

Practical Information

Felix Wellschmied

Office: 15.2.33

Office hours: Wednesday 10:00-12:00 or by appointment.

fwellsch@eco.uc3m.es

Grading

Final exam 50%.

2 midterms 40-50%.

Participation during reducidos 0-10%.

- Random calls on students during class about material.
- The probability to be called decreases in number of past calls.
- You obtain a 0 if you are not there when called.
- If (and only if) you are never called, the weight goes to the midterms.
- Presenting exercises or finishing computer exercises fast also counts as a participation.

Why study economic growth

What we will learn

Understanding economic growth will allow us

- to understand why we are so much richer than our grandparents.

- to understand why we are so much richer than developing countries.

- to understand growth miracles like Taiwan.

# How to assess economic well-being

How to assess economic well-being

- The focus of this course will be on GDP per hour (or per worker or per capita).

- In principle, this tells us how many material goods are available for each person.

Two issues:

- We may also care about inclusivity, i.e., the distribution of the material goods.

- We may also care about non-material things like freedom.
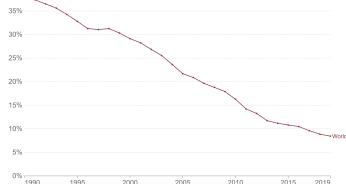
GDP and inequality
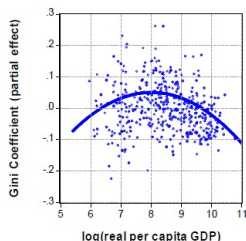
- Even when GDP per capita is high, all material resources may be owned by few people.

- Indeed, you hear sometimes the claim that economic growth benefits only the richest people in a country.

- Barro (2008) shows that, initially in the growth process, a country's inequality grows but it starts falling afterward.

Share of population living in extreme poverty, 1990 to 2019

Extreme poverty is defined as living below the International Poverty Line of $2.15 per day. This data is adjusted for inflation and for differences in the cost of living between countries.

Growth and Poverty in Indonesia		
	change in income per capita	change in # of persons living below poverty line
1984-96	+76%	-25%
1997-99	-12%	+65%

- In general, we observe that higher GDP per capita reduces the number of people living in poverty.

- Particularly the GDP growth in China and India has lifted billions of people out of extreme poverty.

GDP and inequality III

In the long run, the distribution of income matters little when total income is growing:
"You may have had a grandfather who has dug coal with a pickaxe. How did you get so much richer? Not by your union getting you higher wages and you still dig coal with a pickaxe [...] It is because you use a bulldozer."
(John Cocharne, 2016)

Daron Acemoglu provides two important examples from history where this was not the case: (i) The windmill increased productivity in the middle ages yet unfree peasants did not benefit. (ii) The spinning mil increased cotton productivity yet slaves did not benefit.
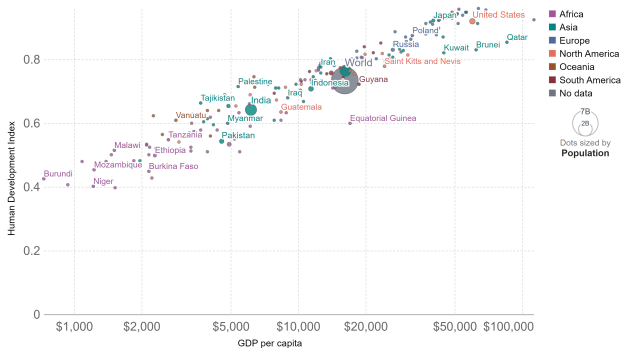
Other things than material well-being

Material well-being is not everything to a fulfilling life. Yet, measuring these other things is difficult.

One approach: The UN has developed the Human Development Index that includes measures of health and education: "*The HDI was created to emphasize that people and their capabilities should be the ultimate criteria for assessing the development of a country, not economic growth alone.*"

HDI and GDP per capita


Human Development Index vs. GDP per capita, 2020

GDP per capita is measured in constant international-$. This means it is adjusted for price differences between countries and adjusted for inflation to allow comparisons between countries and over time.

Source: UNDP, Human Development Report (2021-22); Data compiled from multiple sources by World Bank   CC BY

GDP per person is a reasonable approximation to the HDI.

Life satisfaction and GDP per capita
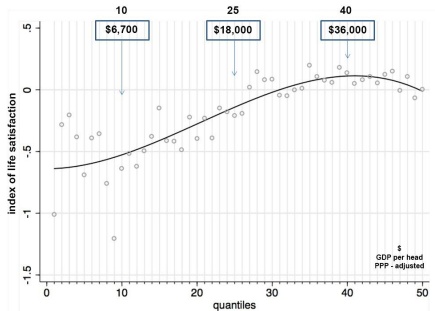
- Proto and Rustichini (2013) simply ask people about their life satisfaction.

- At least at low to medium income levels, a higher GDP per capita is associated with higher life satisfaction.

GDP per capita health and political rights

- In the poorest 20% of countries, the infant mortality rate is 200 per 1000 births, compared to 4 per 1000 births in the richest fifth.

- One fourth of the poorest countries have had famines during the past 3 decades.

- Poverty is associated with the oppression of women and minorities.

How to measure production and population

GDP vs GNP

GDP **Gross Domestic Product**	GNP **Gross National Product**	GNI **Gross National Income**
Value of national output produced in a country. - National income - National output - National expenditure	GNP = GDP + net property income from abroad.	Similar to GNP - Sum value of output by resident producers + net receipts of primary income from abroad + any product taxes (less subsidies) not included in the valuation of output.
Includes income of foreign multinationals	Excludes income earnt by multinational when profit is sent back to other country	A country which earns positive net income on FDI will include in GNI, but not GDP

- We want to relate production to conditions within a country.

- For that, we will focus on GDP, i.e., the value of production occurring in a country.

- Measuring GDP entails several issues. We will ignore these but it is good to be aware of them.

We can compute the market value of cell phones sold today. Optimally, we would also like to know how much production an economy in 1800 would be willing to sacrifice to have cell phones. The only way to do so is to ask how we value a common good (bread) today relative to having cell phones. But the tradeoff may look very different in 1800.

Are cross-country/time comparisons meaningful?
Better products

The Iphone 12 costs more than the Iphone 11, however, it is technically also better. Ignoring the latter underestimates GDP growth.
One possibility: While both are sold, we can measure the price difference and assign that to quality differences. However, that requires constant mark up pricing.

Are cross-country/time comparisons meaningful?
Products without prices

Much of the Internet 2.0 does not charge prices to consumers but only uses their data. When prices are zero, the contribution to GDP is zero.

Most government services charge no prices or heavily subsidized prices. However, we think that they should be counted in GDP. One way is to look at salaries.

Home production has no prices and is generally missing from GDP.

To avoid double counting, we should not count intermediate inputs in production. However, drawing boarders is often fuzzy when it comes to services.

A tax lawyer adds nothing to GDP. A government bureaucrat approving building permits adds nothing to GDP.

The entire advertisement industry adds, if any, little to GDP.

A significant fraction of agricultural output in developing economies is produced informally and information on their production is imprecise. Even in emerging economies, countries in Latin America have informality rates around 50%. When computing GDP in these economies, many heuristics are needed.

Nothing we can do about these issues.

Are cross-country/time comparisons meaningful?
The problem of the exchange rate

East Asian countries produced 7.9% of world output (measured using exchange rate) in 1985. They produced 7.2% of world output in 1990.

East Asian countries grew at the highest rate within that period.

Instead of using exchange rates, we need to use domestic prices.

Are cross-country/time comparisons meaningful?
Purchasing power parity

Purchasing power parity (PPP) asks what is the price of the same basket of goods in two different countries. For example:

- The basket of goods costs 2 Euros in Europe.

- The basket of goods costs 10 Dinar in Tunisia.

- The PPP ratio is $1/5$, i.e., for the same standard of living, I need five times more Dinars than Euros.

Assume the Dinar per Euro exchange rate is 20. Using the exchange rate, we would conclude that someone earning 10 Dinars earns only 0.5 Euros. Using PPP, we conclude, however, that her standard of living is equivalent to 2 Euros.

Why are exchange rates imperfect?

- Exchange rates are a "good" approximation for tradable goods.

- Non-tradable goods, many services, can have very different prices across countries.

- Often, these goods are cheaper in countries with low incomes.

PPP is not perfect either:

- Consumption habits differ across countries making comparisons difficult.

- Different relative prices imply different consumption weights.

GDP per what?

$$\frac{GDP}{?} \qquad (1)$$

- So far, we have talked about how to measure the numerator.

- When assessing the well-being of a country, we care about all people, i.e., we should measure the population (GDP per capita).

- However, our theory is based on a production process and not the entire population is working. To compare the model to the data, we should use GDP per worker.

$$\frac{GDP}{?} \tag{2}$$

- An even better model comparison takes into account that across countries, working hours per worker are not the same. For example, in the Netherlands, part time work is much more prevalent than in Spain. Thus, we should measure GDP per hour.

- Sometimes, data restrictions limit what we can measure. In general, population data is measured with the least error and always available.

- The good thing is that all these measures are highly correlated. In this course, we will use the different measures mostly interchangeably.

Data facts

Fact 1: Growth in GDP is a modern phenomenon

GDP per capita in England
Adjusted for inflation and measured in British Pounds in 2013 prices.

Source: Broadberry, Campbell, Klein, Overton, and van Leeuwen (2015) via Bank of England (2020)
Note: Data refers to England until 1700 and the UK from then onwards.
OurWorldInData.org/economic-growth • CC BY

- This course will mostly describe economies after 1945. Since then, we observe tremendous growth in GDP per capita.

- We should realize, however, that for most of human history, we did observe little growth.
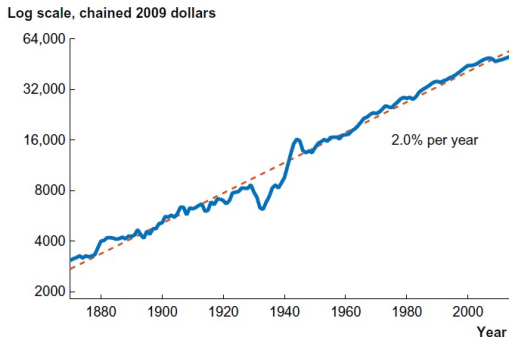
Year	GDP per person	Growth rate	Population (millions)	Growth rate
1	590	–	19	–
1000	420	−0.03	21	0.01
1500	780	0.12	50	0.17
1820	1240	0.15	125	0.28
1900	3350	1.24	280	1.01
2006	26,200	1.94	627	0.76

Source: Jones (2016)

- Even the world as a whole did not grow for most of its history.

- The Stone Age lasted for 2.6 million years.

Fact 2: Since 19th century, growth is exponential

Source: Jones (2016)

- Since the late 19th century, GDP per person is growing approximately at an exponential growth rate of 2% in the US.

Mathematical primer: exponential growth

An exponential growth rate g implies

$$y(t) = y_0 \exp(gt), \tag{3}$$

where t is time and y_0 is the initial level of income per capita.

Hence, we have

$$g = \frac{1}{t}(\ln y(t) - \ln y_0). \tag{4}$$

Plug in $y_0 = y_{t-1}$ and, hence $t = 1$, we have:

$$g = \Delta \ln y(t), \tag{5}$$

i.e., a constant change in the logs as seen on the last slide.

Mathematical primer: exponential growth II

In discrete time, how does the exponential growth rate g relate to the percentage growth rate?

$$\frac{y(t)}{y(t-1)} - 1 = \exp(\ln y(t) - \ln y(t-1)) - 1 \tag{6}$$

$$= exp(g) - 1. \tag{7}$$

The first order Taylor series approximation of $\exp(g)$ around zero is $1 + g$. Hence, we have, for g small:

$$\frac{y(t)}{y(t-1)} - 1 \approx g. \tag{8}$$

Exponential growth and the rule of 0.7

Suppose we want to know when the size of the economy will double:

$$2y_0 = y_0 \exp(gt) \tag{9}$$

$$t = \frac{\ln 2}{g} \tag{10}$$

Note, $\ln 2 \approx 0.7$. Hence, every $\frac{0.7}{g}$ years, the economy will double in size. For the U.S., this is every 35 years. With a growth rate of 8 percent (China), it takes less than 9 years.
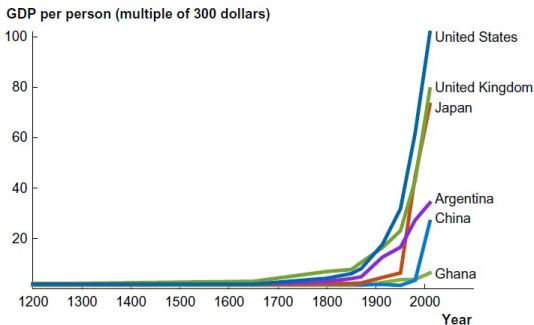
Fact 3: Large cross country differences

there are enormous differences in per capita income...

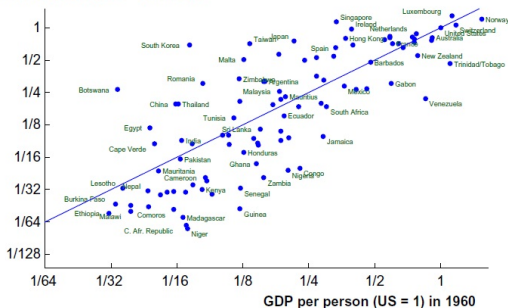GDP per person (multiple of 300 dollars)

Source: Jones (2016)
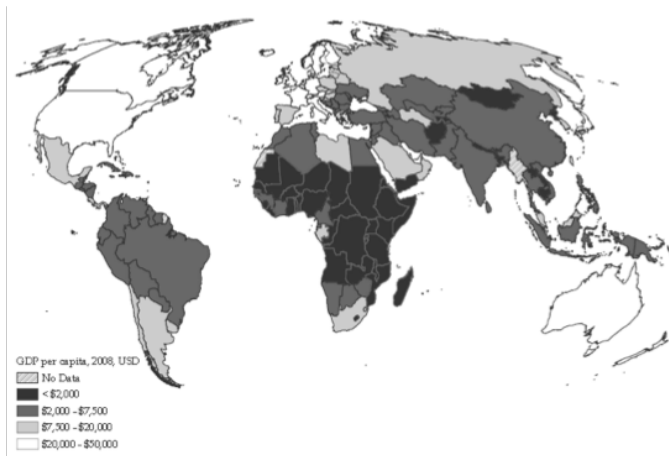
Source: Jones (2016)

Fact 4: Rates of economic growth vary substantially
some countries are growth miracles while others are growth disasters

Source: Jones (2016)

Possibilities

"I do not see how one can look at figures like these without seeing them as representing *possibilities*. Is there some action the government of India could take that would lead the Indian economy to grow like Indonesia's or Egypt's? [...] 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." Lucas Jr (1988)

Mathematical primer: why use log scales

|	U.S.	China
$y(0)$	$50000	$1000
g	2%	10%
$y(10)$	$60950	$2594
$y(52)$	$140000	$142000

In growth economics, we are mostly interested in relative instead of absolute differences. For example, we just saw that the U.S. started out 20 times richer than China. Within 10 years, that ratio is reduced to 10 even though, in absolute terms, the difference has become larger. Yet, after 52 years, China will have overtaken the U.S. in absolute terms.

We have seen that log differences give us approximately percentage differences. Moreover, they are scale independent:

$$\ln 50000 - \ln 1000 = \ln\left(\frac{50000}{1000}\right) = \ln\left(\frac{5}{1}\right) = \ln 5 - \ln 1. \qquad (11)$$
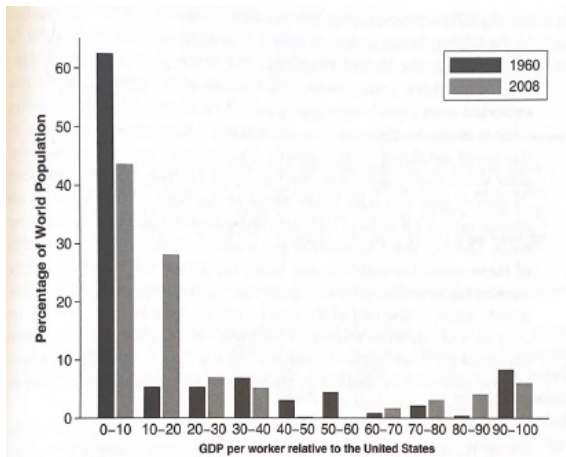
Fact 5: It is unclear whether we observe convergence
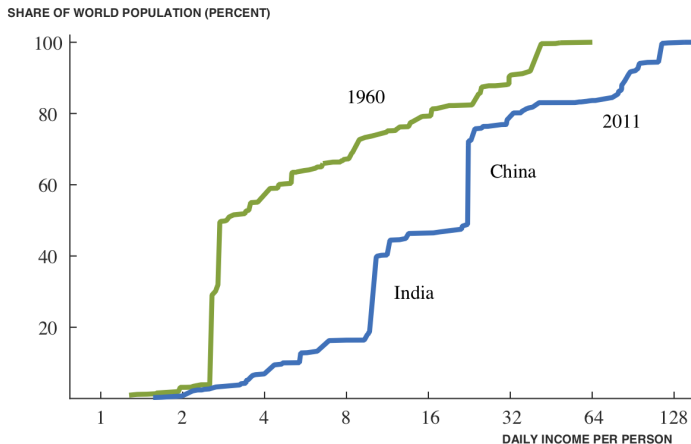
when looking across countries, we see no convergence
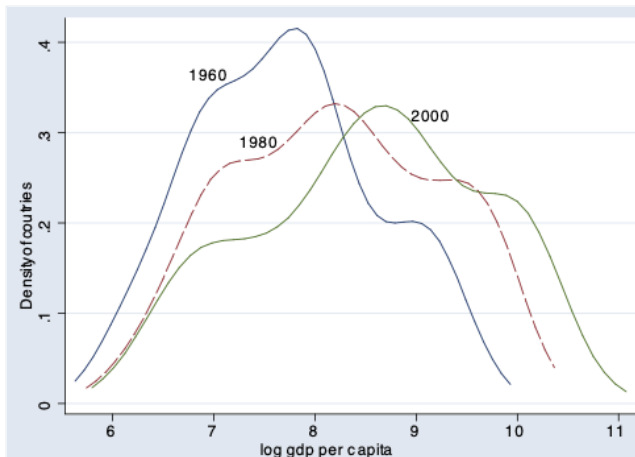
Fact 5: It is unclear whether we observe convergence
when looking at the world population, we see convergence

Outlook of the course

1. The curse of fixed factors: Why we saw no growth in the middle ages.

2. It is all about physical capital accumulation: The Solow model.

3. A quantitative assessment of the Solow model.

4. Non-renewable resources: Are we back to zero growth?

5. Endogenous growth: What matters are new ideas.

6. Adoption: How copying is simpler than discovering.

7. Institutions: The politics behind economic growth.

References

BARRO, R. J. (2008): "Inequality and growth revisited," Tech. rep., ADB Working paper series on regional economic integration.

JONES, C. I. (2016): "The facts of economic growth," in *Handbook of macroeconomics*, Elsevier, vol. 2, 3–69.

LUCAS JR, R. E. (1988): "On the mechanics of economic development," *Journal of monetary economics*, 22, 3–42.

PROTO, E. AND A. RUSTICHINI (2013): "A Reassessment of the Relationship between GDP and Life Satisfaction," *PLoS ONE*, 8.