

ECON 164: Theory of Economic Growth

Saki Bigio

UCLA

ECON 164: Theory of Economic Growth

- ▶ Instructor

- ▶ Prof. Saki Bigio

- ▶ A bit about me...

ECON 164: Theory of Economic Growth

▶ Instructor

- ▶ Prof. Saki Bigio

▶ A bit about me...

▶ TA's

- ▶ FAN, JINGYU (jfan411@ucla.edu)
- ▶ LAVROV, IVAN (ilavrov113@gmail.com)
- ▶ ZHANG, MENGBO (zmbruc@gmail.com)

ECON 164: Theory of Economic Growth

▶ Classes

- ▶ T-R (L1 - Bunche Hall 3178) 2-3:15pm (L2 - Public Affairs 1222) 3:30pm-4:45pm (can attend any class)
- ▶ Office Hours: Mondays 5:00 to 6:00pm 9282 Bunche Hall, set appointment after lab sessions.
- ▶ 2 Lab sessions: with TA's see schedule
- ▶ Lab Sessions with me will be at
Fridays (L1 Haines Hall 118) 11am-11:50am and (L1 Haines Hall 118) 12am-12:50am
I will announce whether we have or do not have lab sessions with me.

▶ Exams

- ▶ Midterm: R May 2, 2019
- ▶ Final: S June 9, 2019 3pm-6pm

▶ Exams

- ▶ Project presentation

▶ Grading

- ▶ Syllabus: Homework Assignments (10%), Term Paper (20%), Midterm (20%), Final (50%)
- ▶ I will set the instructions for the term paper by the end of second week

ECON 164: Theory of Economic Growth

Materials

- ▶ Required Material
 - ▶ Prof. Bigio's Lecture Notes
 - ▶ Posted night before each class
 - ▶ Sometimes I will only use the board / sometimes slides
 - ▶ Everything in these sources may enter in the exams

ECON 164: Theory of Economic Growth

Materials

▶ Required Material

- ▶ Prof. Bigio's Lecture Notes
 - ▶ Posted night before each class
 - ▶ Sometimes I will only use the board / sometimes slides
- ▶ Everything in these sources may enter in the exams

▶ Complementary sources

- ▶ Charles I. Jones and Dietrich Vollrath, Introduction to Economic Growth, 3rd Edition
- ▶ David N. Weil, Economic Growth, Third Edition,
 - ▶ The syllabus specifies covered chapters
- ▶ The Mystery of Growth, by Elhanan Helpman, Harvard University Press, 2010
- ▶ I will also upload papers and mention some books in class for further reading

ECON 164: Theory of Economic Growth

- ▶ Today and Next class we will cover some “classic” facts
- ▶ Facts motivate rest of course
 - ▶ Class focuses on theories to explain those facts
- ▶ Class focused on developing growth models
 - ▶ Most of your effort for this class will consist in solving models
 - ▶ Important: please do problem sets

ECON 164: Theory of Economic Growth

- ▶ Today and Next class we will cover some “classic” facts
- ▶ Facts motivate rest of course
 - ▶ Class focuses on theories to explain those facts
- ▶ Class focused on developing growth models
 - ▶ Most of your effort for this class will consist in solving models
 - ▶ Important: please do problem sets
 - ▶ The mathematical tools are always the same, all will be covered next Monday

ECON 164: Theory of Economic Growth

- ▶ Two questions
- ▶ Why do countries grow over time
- ▶ What Explains Differences across countries

I - Growth Facts

Growth Facts

- ▶ Additional reading: Chapters 1 and 2 from Weil's textbook.
- ▶ Additional reading: recommended readings in syllabus
—Jones' and Helpman's books—

The Object of Study: Economic Growth

- ▶ Differences in living standards across time and countries

Is there some action a government of India could take that would lead the Indian economy to grow like Indonesia's or Egypt's? If so, what, exactly? If not, what is it about the "nature of India" that makes it so? 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.

Robert E. Lucas, Jr, "On the Mechanics of Economic Development"

My Own Experience

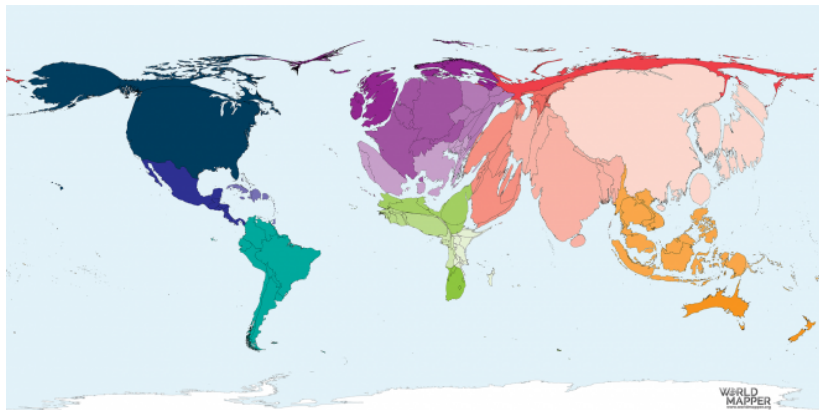
- ▶ My own experience: Growth in Peru since the 1980s.

A five minute presentation...

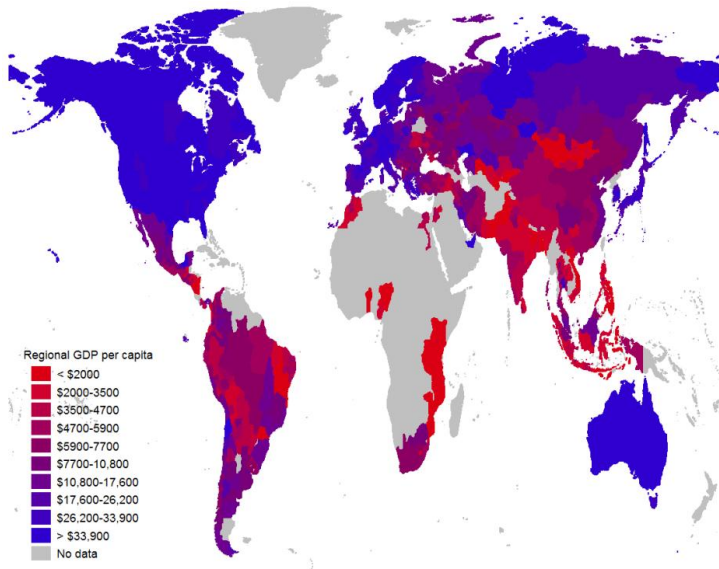
<http://www.gapminder.org/videos/200-years-that-changed-the-world/>

Distorted World Map

- ▶ Total GDP who is who 2018? (source: <https://worldmapper.org/>)



World Income Distribution per Capita: very Unequal

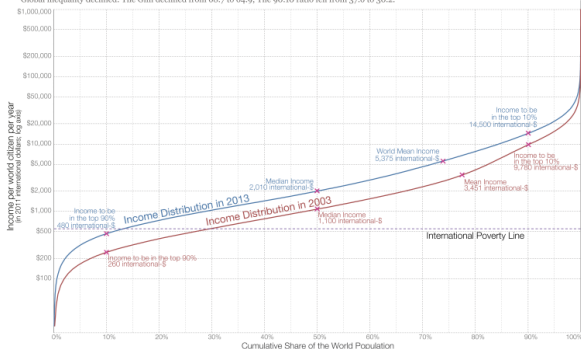


Fact 1: World Income Distribution: very Unequal

The global income distribution in 2003 and 2013

Incomes are adjusted for price changes over time and for price differences between countries (purchasing power parity (PPP) adjustment).
Global inequality declined: The Gini declined from 68.7 to 64.9; The 90:10 ratio fell from 37.6 to 30.2.

Our World
in Data



Data source: Tomáš Hlebebrandt and Paolo Mauro (2019) – The Future of Worldwide Income Distribution, working paper.
The data visualization is available at [OurWorldInData.org](https://ourworldindata.org). There you find the raw data and more visualizations on this topic.

Licensed under CC-BY-SA by the author Max Roser.

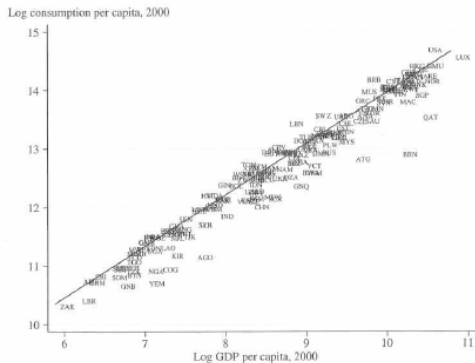
- ▶ Income distribution, skewed to the right (e.g. mean > median)
 - ▶ 50% of countries earned less \$2,010
 - ▶ US income per capita: \$51394

Fundamental Q: Why care about Income (GDP) per Capita?

- ▶ Why is income per capita a summary of well-being?
- ▶ Obvious answers
 - ▶ Material wealth
 - ▶ Correlates with objective measures: health, quality of work and living, violence, etc.

Why focus on Income per Capita?

Positive Correlation - Income Per capita and Consumption



A Philosophical Matter: Are we obsessed with material wealth?

- ▶ Classic criticism:

- Hunter-gatherers consumed less per capita than any other group of human beings. The original affluent society was none other than the hunter's - in which all the people's material wants were easily satisfied.

- This is a view shared for example by Harari, author of Homo Sapiens.

- Authors like Amarty Sen or Joseph Stiglitz criticize GDP measures

- ▶ According to this view "happiness" is not equal to consumption

- ▶ Still, what does current data say?

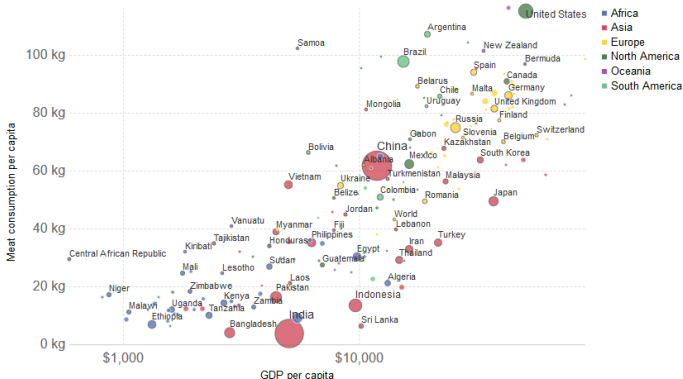
- ▶ Sometimes GDP doesn't capture progress...but

Why focus on Income per Capita?

Positive Correlation - Income Per capita and Protein Consumption

Meat consumption vs. GDP per capita, 2013

Average meat consumption per capita, measured in kilograms per year versus gross domestic product (GDP) per capita measured in 2011 international-\$. international-\$ corrects for price differences across countries. Figures do not include fish or seafood.



Source: UN FAO; World Bank, World Development Indicators

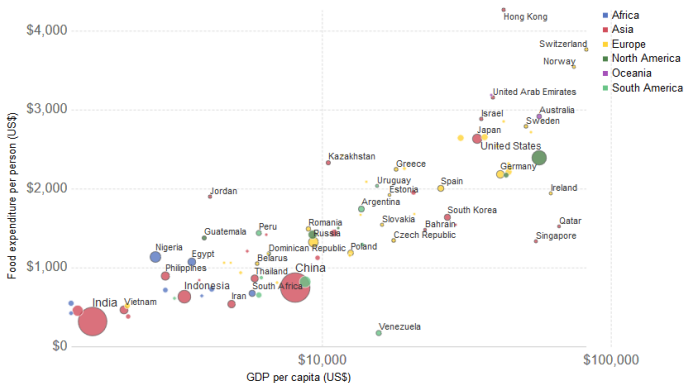
OurWorldInData.org/meat-and-seafood-production-consumption/ • CC BY

Why focus on Income per Capita?

Positive Correlation - Income Per capita and Protein Consumption

Annual food expenditure per person vs. GDP per capita, 2015

Average annual food expenditure per person, versus gross domestic product per capita, both measured in US\$. Food expenditure relates only to food bought for consumption at home (i.e. it excludes out-of-home food purchases).



Source: World Bank, Consumer expenditure on food - USDA (2017)

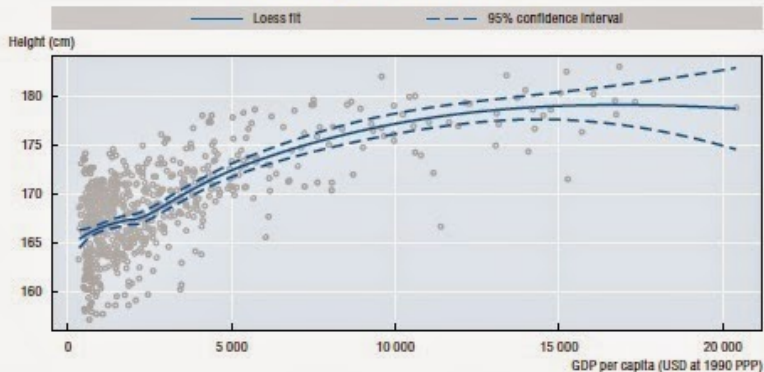
OurWorldInData.org/food-prices/ - CC BY

Is Income Per Capita the Right Measure?

Positive Correlation - Average Height

Figure 7.2. Population heights and GDP per capita

Centimetres and US dollars at 1990 PPP



Notes: For an assessment of data quality, see Table 7.1. In reproductions, please cite as Baten and Blum, 2014 (in: European Review of Economic History).

Source: Clio Infra, www.clio-infra.eu.

StatLink  <http://dx.doi.org/10.1787/888933095875>

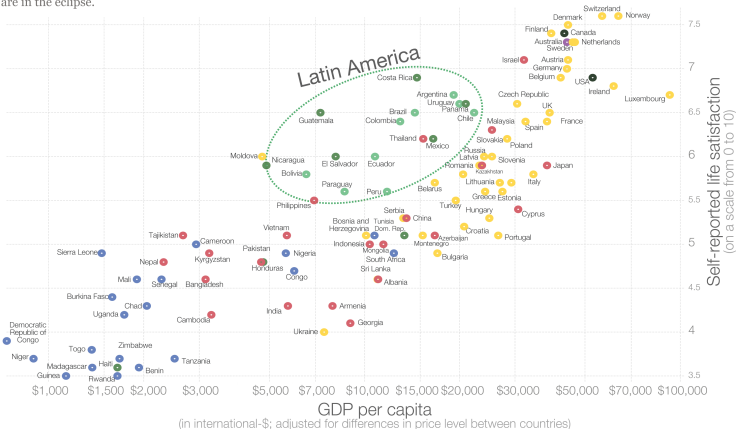
Is Income Per Capita the Right Measure?

Positive Correlation - Income Per capita and Self-Reported Happiness

Self-reported life satisfaction vs GDP per capita, in 2015

The color represents the continent of the country. All Latin American countries, with the exception of the Dominican Republic, are in the eclipse.

OurWorld
in Data



Data sources: World Bank for GDP per capita; Gallup World Poll for self-reported life satisfaction.

The data visualization is available at [OurWorldinData.org](https://ourworldindata.org). There you find the research and more visualizations on this topic.

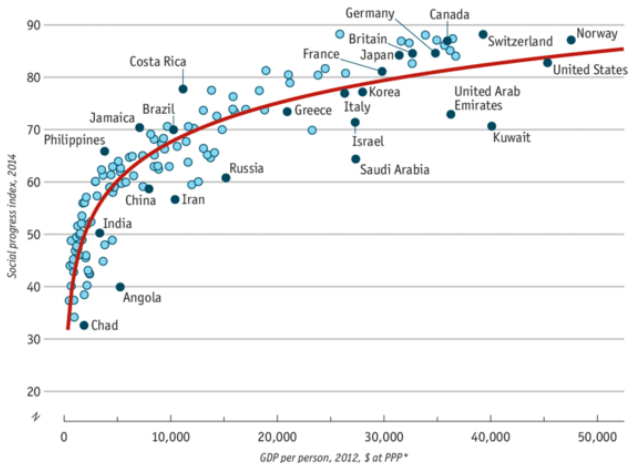
Licensed under CC-BY-SA by the author Max Roser.

Is Income Per Capita the Right Measure?

Positive Correlation - Income Per capita and HDI index

Measuring development

Social progress index and GDP per person

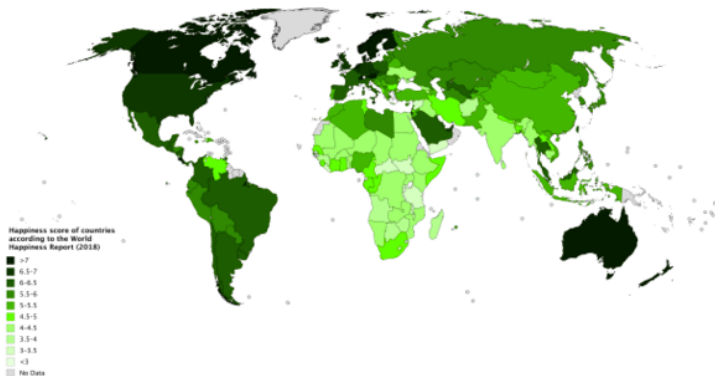


Source: Social Progress Imperative

*Purchasing-Power Parity, 2005 prices

Is Income Per Capita the Right Measure?

Positive Correlation - World Happiness Report



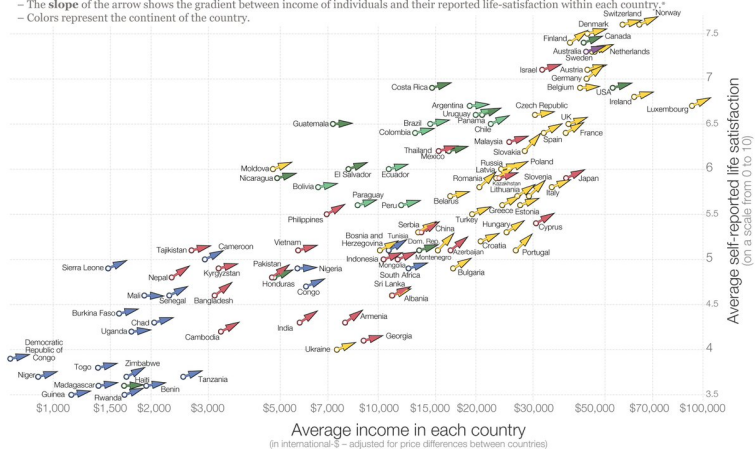
Is Income Per Capita the Right Measure?

Income per Capita and Self-Reported Happiness holds in the US

People in richer countries tend to be happier and within all countries richer people tend to be happier

OurWorld
in Data

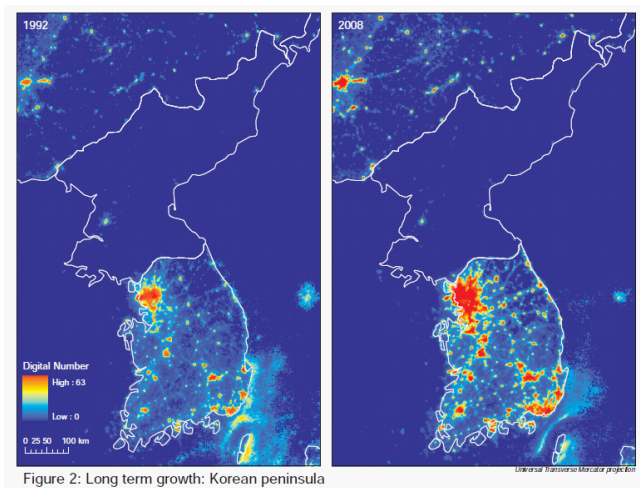
- The **position** of the arrow shows the average life satisfaction reported by the population of a country (vertical axis) and the average income of that country (horizontal axis).
- The **slope** of the arrow shows the gradient between income of individuals and their reported life-satisfaction within each country.*
- Colors represent the continent of the country.



* The gradients correspond, country by country, to the regression coefficients between income quintiles and the related average life satisfaction reported by people within each income quintile.
Data sources: World Bank for data on incomes by quintile (based on income shares by quintile and GDP per capita as the mean income); Gallup World Poll for life satisfaction by income quintile.
The visualization is available at [OurWorldInData.org](https://ourworldindata.org). There you find the research and more visualizations on life satisfaction.
Licensed under CC-BY-SA by the author Max Roser.

Is Income Per Capita the Right Measure?

Access to Basic Utilities



Source: Henderson, Storeygard, and Weil (*American Economic Review*, 2012)

Is Income Per Capita the Right Measure?

Summary

- ▶ Positive correlation between GDP per capita and measures of welfare
- ▶ Obviously, other aspects of life besides income also matter
- ▶ GDP per capita is an important policy target

Review: comparing standards of living across time and space

- ▶ Comparing living standards across countries raises a few issues
 - ▶ Differences in exchange rates
 - ▶ Differences in relative prices
 - ▶ Accounting for inflation
 - ▶ How is GDP measured?

Relative Prices Across Countries?

- ▶ A few important patterns have been systematically documented, e.g.:
 - ▶ "Balassa-Samuelson" effect
 - ▶ "Law of one price" for traded goods:
 - ▶ However, price of non-traded goods and services, relative to traded goods is lower in low-income countries

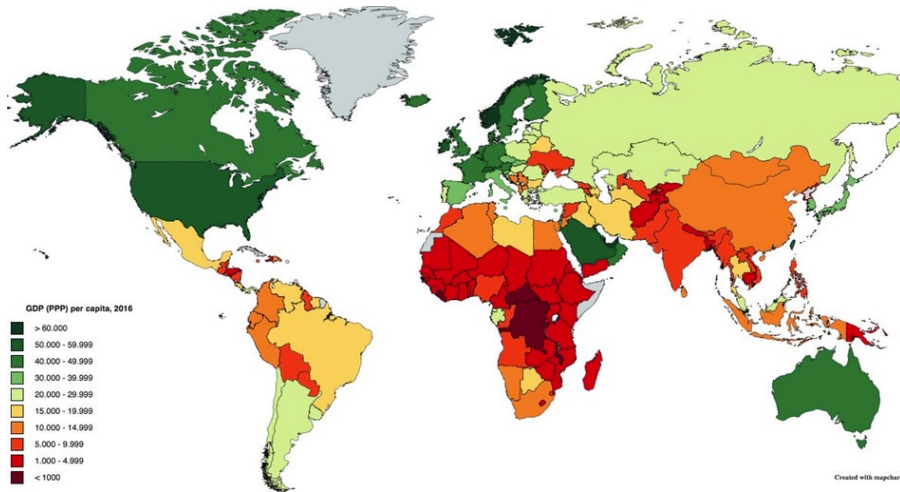
Relative Prices Across Countries?

- ▶ A few important patterns have been systematically documented, e.g.:
 - ▶ "Balassa-Samuelson" effect
 - ▶ "Law of one price" for traded goods:
 - ▶ However, price of non-traded goods and services, relative to traded goods is lower in low-income countries
- ▶ What would happen with measurement of GDP if we converted to a common currency?
 - ▶ With and without adjustment for these relative prices?

Relative Prices Across Countries?

- ▶ A few important patterns have been systematically documented, e.g.:
 - ▶ "Balassa-Samuelson" effect
 - ▶ "Law of one price" for traded goods:
 - ▶ However, price of non-traded goods and services, relative to traded goods is lower in low-income countries
- ▶ What would happen with measurement of GDP if we converted to a common currency?
 - ▶ With and without adjustment for these relative prices?
- ▶ The common approach: use PPP (Purchasing Power Parity) which compares real price levels between countries

Back to Fact 1: Income Distribution (PPP) still very Unequal



What Happened to the World Income?

- ▶ Has there been convergence in the world income distribution?
- ▶ First, take a very long-run view
- ▶ Then, focus on growth over the last 50 years

Fact 2: World has grown a lot over time

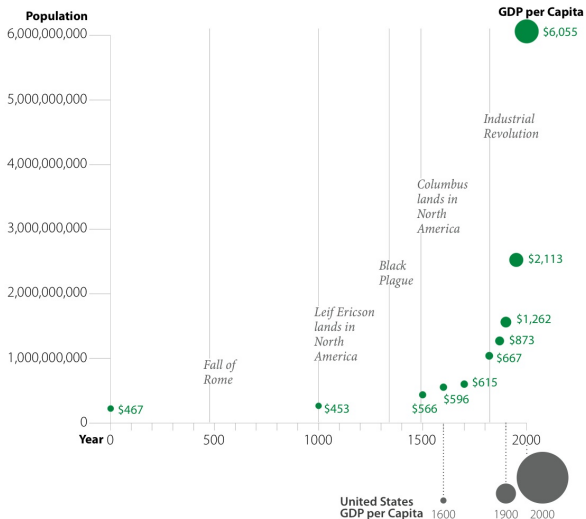


Visualizing Economics
Making the Invisible Hand Visible

Visit www.visualizingeconomics.com
to view more examples

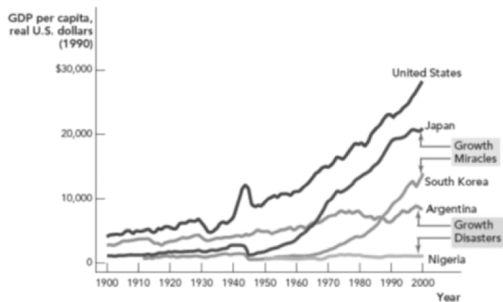
World Income and Population for last 2,000 Years

Adjusted for inflation using 1990 International Geary-Khamis dollars



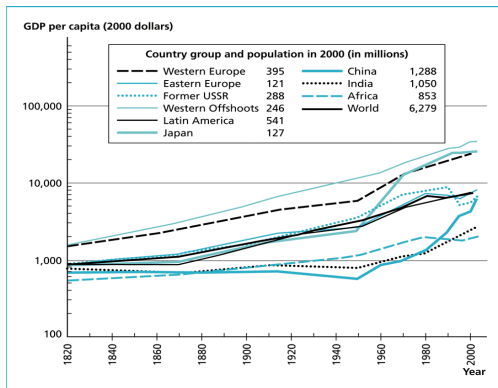
Source: Angus Maddison, University of Groningen

Growth Miracles and Debacles, 1900-2000 (Maddison 2007)



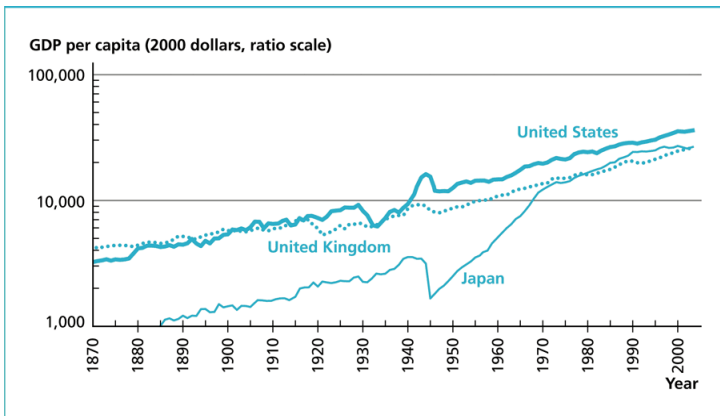
Convergence?

Growth since 1820



- ▶ Acceleration in world growth rates
- ▶ Divergence between groups of countries
- ▶ Some countries seem to discover formula for growth

Differences in Growth Rates: US vs. current Rich Countries since 1870



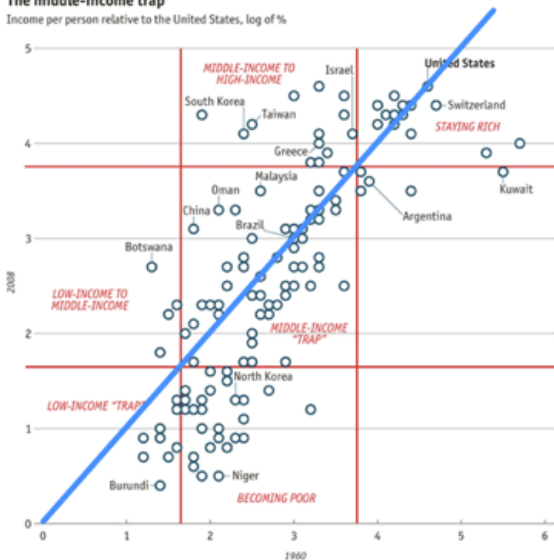
Source: Maddison (1995), Heston, Summers, and Aten (2006), World Bank (2007a).

Between 1950 and 1990, Japan grew at 5.1% so that in 40 years converged to income per capita of UK

GDP Per Capita in 1960 and 2008

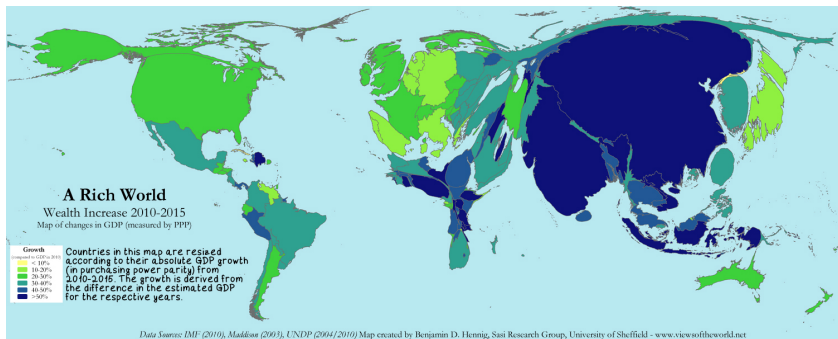
The middle-income trap

Income per person relative to the United States, log of %



Source: World Bank

Differences in Growth Rates: The last decade



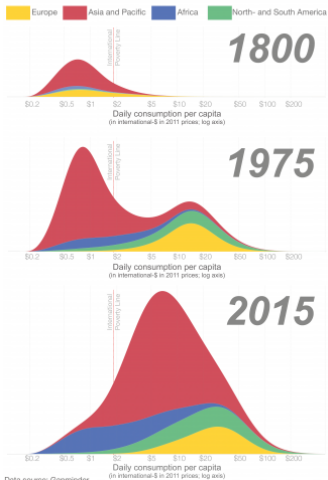
Similar pattern over the last 10 years. Some countries fail to discover the formula

Evolution of the World Income Distribution

Density of Countries by GDP per capita in 1800, 1975, and 2015

Global income distribution in 1800, 1975, and 2015

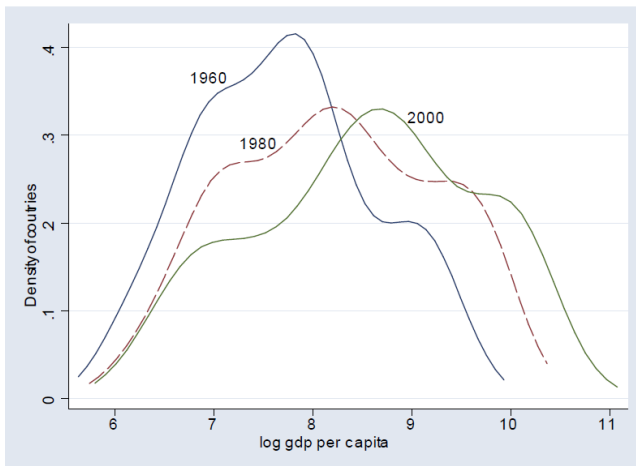
Income is measured by adjusting for price changes over time and for price differences between countries (purchasing power parity (PPP) adjustment). These estimates are based on reconstructed National Accounts and within-country inequality measures. Non-market income (e.g. through home production such as subsistence farming) is taken into account.



This visualization is available at OurWorldinData.org where you find more visualizations and research on global development. Licensed under CC BY-ND 4.0 by the author, Max Roser.

Evolution of the World Income Distribution in Logs

Density of Countries by Log-GDP per capita in 1960, 1980 and 2000



- ▶ Increase in Dispersion in log-GDP per Capita
- ▶ Most of convergence has to do with China

Fact 3: Conditional Convergence

- ▶ Previous fact is: conditional convergence
- ▶ Not all countries to converge in income levels but convergence achieved given certain country characteristics
- ▶ Which ones? Next Class, Why?
- ▶ Core theories of our class:

Fact 3: Conditional Convergence

- ▶ Previous fact is: conditional convergence
- ▶ Not all countries to converge in income levels but convergence achieved given certain country characteristics
- ▶ Which ones? Next Class, Why?
- ▶ Core theories of our class:
 - ▶ Population Growth

Fact 3: Conditional Convergence

- ▶ Previous fact is: conditional convergence
- ▶ Not all countries to converge in income levels but convergence achieved given certain country characteristics
- ▶ Which ones? Next Class, Why?
- ▶ Core theories of our class:
 - ▶ Population Growth
 - ▶ Factors of Production, Capital

Fact 3: Conditional Convergence

- ▶ Previous fact is: conditional convergence
- ▶ Not all countries to converge in income levels but convergence achieved given certain country characteristics
- ▶ Which ones? Next Class, Why?
- ▶ Core theories of our class:
 - ▶ Population Growth
 - ▶ Factors of Production, Capital
 - ▶ Technology

Fact 3: Conditional Convergence

- ▶ Previous fact is: conditional convergence
- ▶ Not all countries to converge in income levels but convergence achieved given certain country characteristics
- ▶ Which ones? Next Class, Why?
- ▶ Core theories of our class:
 - ▶ Population Growth
 - ▶ Factors of Production, Capital
 - ▶ Technology
 - ▶ Geography and Climate

Fact 3: Conditional Convergence

- ▶ Previous fact is: conditional convergence
- ▶ Not all countries to converge in income levels but convergence achieved given certain country characteristics
- ▶ Which ones? Next Class, Why?
- ▶ Core theories of our class:
 - ▶ Population Growth
 - ▶ Factors of Production, Capital
 - ▶ Technology
 - ▶ Geography and Climate
 - ▶ Institutions: Rule of Law, Finance, Trade

Fact 3: Conditional Convergence

- ▶ Previous fact is: conditional convergence
- ▶ Not all countries to converge in income levels but convergence achieved given certain country characteristics
- ▶ Which ones? Next Class, Why?
- ▶ Core theories of our class:
 - ▶ Population Growth
 - ▶ Factors of Production, Capital
 - ▶ Technology
 - ▶ Geography and Climate
 - ▶ Institutions: Rule of Law, Finance, Trade
 - ▶ Disasters: Wars

Summary of Class 1:

- ▶ Fact 1: enormous differences across countries in GDP
- ▶ Reasons to be interested in GDP
- ▶ Fact 2: some countries have grown a lot over time
- ▶ Fact 3: some grow and catch up, other don't

Fundamental Question: where do Differences in Income Per capita come from?

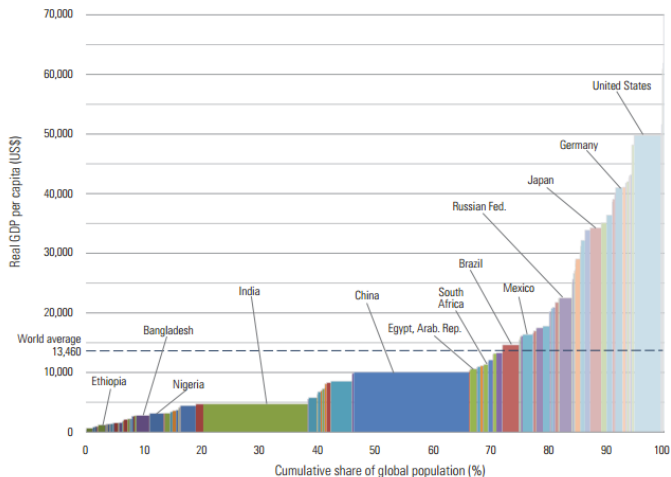
- ▶ Describing today's income differences, Robert Lucas writes this analogy with a horserace:

Imagine all the economies lined up in a row behind the kind of mechanical starting gate used at the race track. In the race to industrialize, the gates do not open all at once, the way they do at the track. Instead, at any date t a few of the gates that have not yet opened are selected. When the bell rings, these gates open and some of the economies that had been stagnant are released and begin to grow. The rest must wait their chances at the next date. In any year after 1800, then, the world economy consists of those countries that have not begun to grow, stagnating at the \$600 income level, and those countries that began to grow at some date in the past and have been growing every since.

Size Doesn't Matter

Correlation - GDP per Capita and Size of Countries

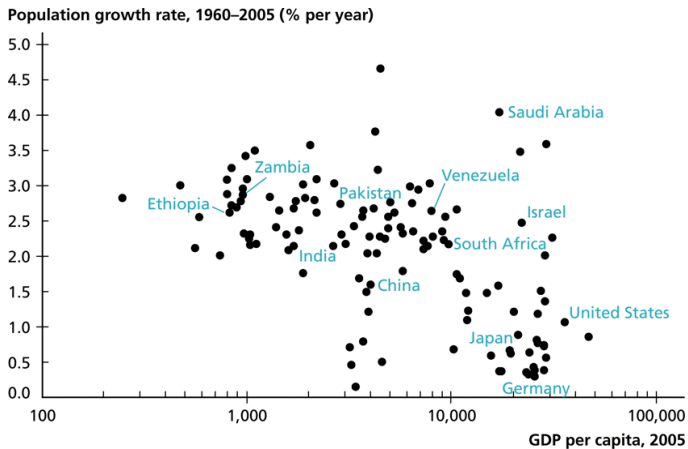
FIGURE 7.3 Real GDP Per Capita and Shares of Global Population, ICP 2011



- ▶ Largest and Richest Economies in the World (in 2005)

Population Growth and Output Per Capita

Correlation - Population Growth



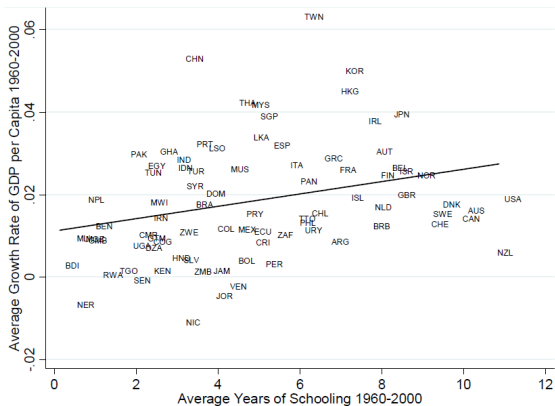
Explaining Differences in Income: Direct Causes

Correlation - Physical Capital Accumulation



Explaining Differences in Income: Direct Causes

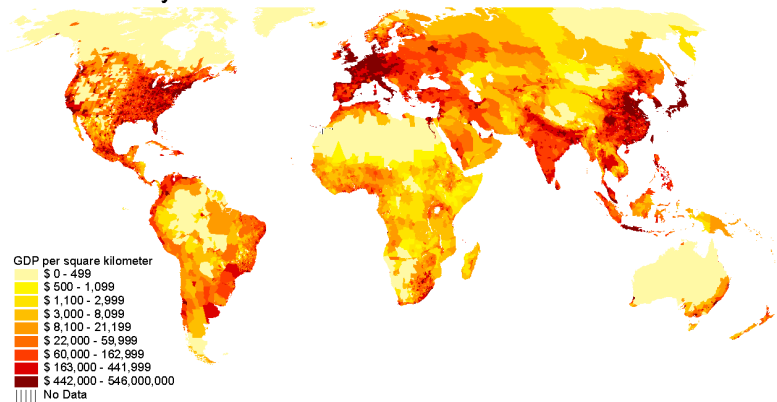
Correlation - Human Capital



Explaining Differences in Income: Fundamental Determinants

A map of GDP Density

Figure 3.
GDP Density



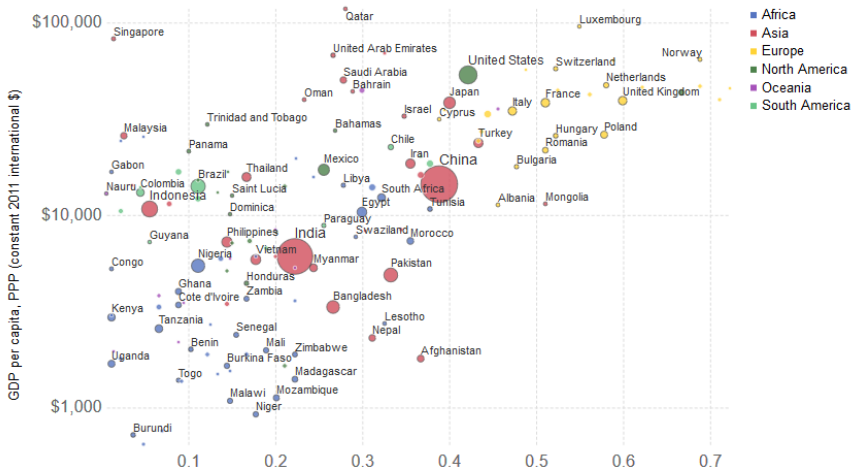
Differences in Income: Fundamental Determinants

Correlation - Geographic Position

GDP per capita vs Latitude, 2016

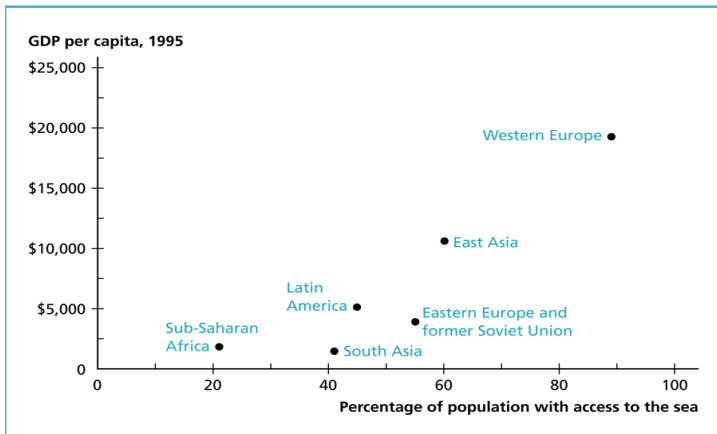
Gross domestic product (GDP) per capita, measured in 2011 international-\$ versus latitude of a given country's capital city (divided by 90 to give an absolute value between 0 and 1).

Our World
in Data



Explaining Differences in Income: Fundamental Determinants

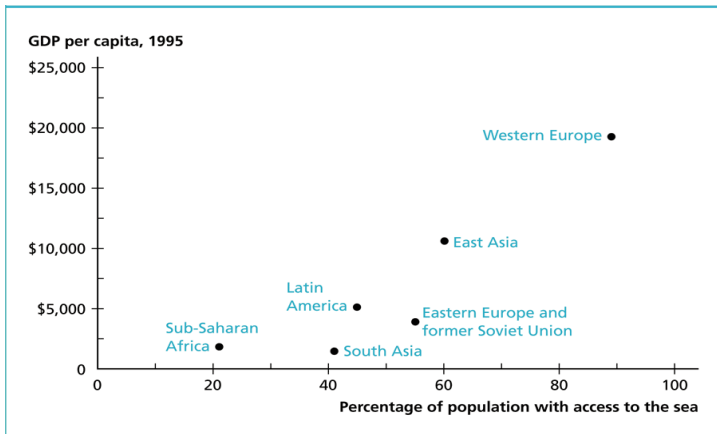
Correlation - Geographic Position



Source: Gallup, Sachs, and Mellinger (1998).

Explaining Differences in Income: Fundamental Determinants

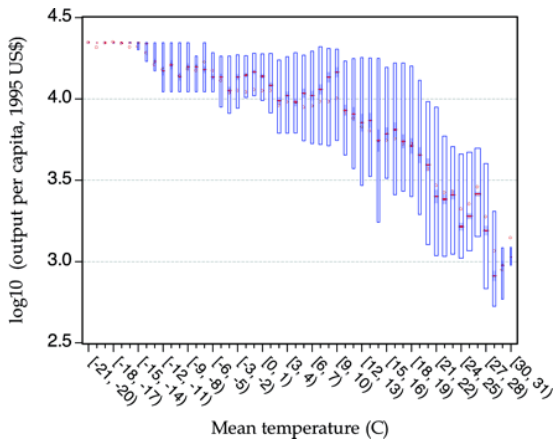
Correlation - Geographic Position



Source: Gallup, Sachs, and Mellinger (1998).

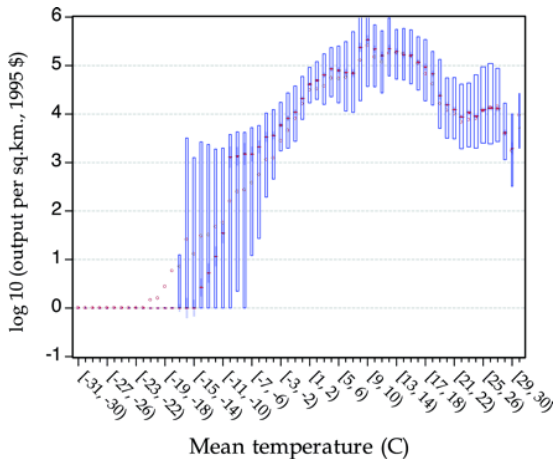
Explaining Differences in Income: Fundamental Determinants

Temperature and GDP per capita - Nordhaus



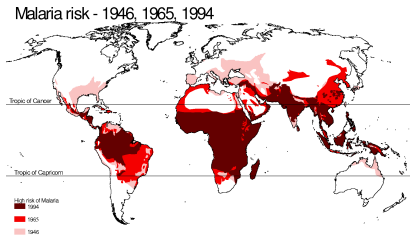
Explaining Differences in Income: Fundamental Determinants

Temperature and Output Density - Nordhaus



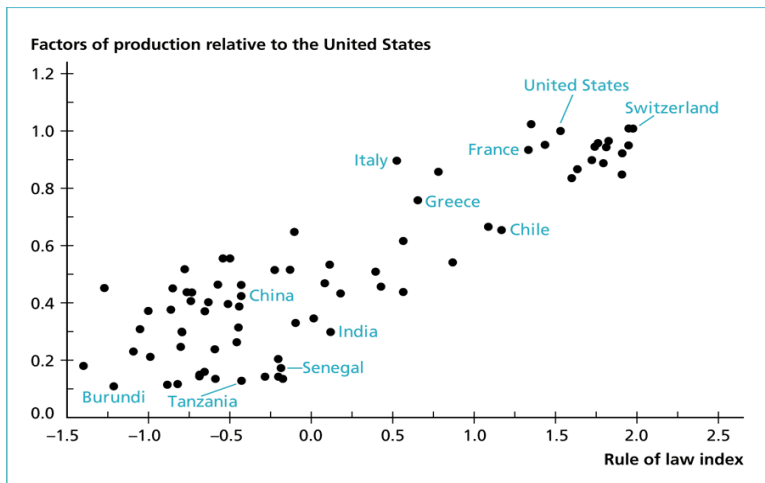
Explaining Differences in Income: Fundamental Determinants

Temperature and Malaria - Sachs



Explaining Differences in Income: Fundamental Determinants

Correlation - Role of Institutions



Source: Kaufmann, Kray, and Mastruzzi (2007). Data are scaled to have a standard deviation of 1.

Kaldor Facts - Building Block of Neoclassical Growth

Can we organize ideas systematically?

- ▶ We want a theory that is capable of replicating some stylized facts of economic growth.
- ▶ Economist Nicholas Kaldor summarized these facts in a 1950 paper:
 1. That GDP per capita grows at a constant rate
 2. That capital per worker grows over time
 3. That the capital/output ratio is constant
 4. That GDP share of capital and labor is constant over time
 5. That the return on capital is constant
 6. That real wage grows over time

These facts hold well in developed economies. However, recent research suggests that these facts may not be as robust as we once thought. In particular, there are some signs that growth is slowing down in developed economies —item 1. Also, there's evidence that the return on capital is falling and that share of GDP that goes to workers is falling. I will discuss this in more detail later.

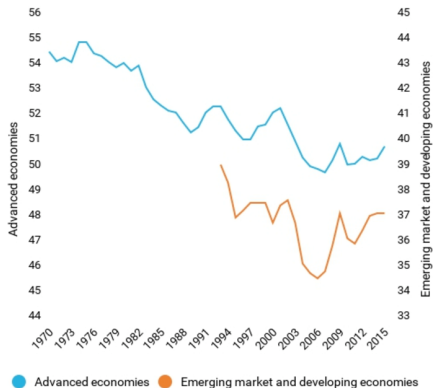
Kaldor Facts - Building Block of Neoclassical Growth

One Caveat - Labor Share has been in decline

Labor is losing out

The share of national income paid to workers has been declining in many countries.

(evolution of the labor share of income, percent)



Source: IMF, *World Economic Outlook*, April 2017.

New Kaldor Facts - Jones and Romer

More modern insights

▶ New Facts

1. Increases in the extent of the market
2. Accelerating growth.
3. Variation in modern growth rates.
4. Large income and TFP differences.
5. Increases in human capital per worker
6. Long-run stability of relative wages

Summary of First Block

- ▶ Economic Growth Theory: origin of differences in living standards across countries

Summary of First Block

- ▶ Economic Growth Theory: origin of differences in living standards across countries
 - ▶ To measure differences in living standard, focus on income per capita

Summary of First Block

- ▶ Economic Growth Theory: origin of differences in living standards across countries
 - ▶ To measure differences in living standard, focus on income per capita
- ▶ Reviewed some of the main facts about differences in level of income per capita

Summary of First Block

- ▶ Economic Growth Theory: origin of differences in living standards across countries
 - ▶ To measure differences in living standard, focus on income per capita
- ▶ Reviewed some of the main facts about differences in level of income per capita
 - ▶ Differences in income across countries are large (more than 40 times between richest and poorest countries!)

Summary of First Block

- ▶ Economic Growth Theory: origin of differences in living standards across countries
 - ▶ To measure differences in living standard, focus on income per capita
- ▶ Reviewed some of the main facts about differences in level of income per capita
 - ▶ Differences in income across countries are large (more than 40 times between richest and poorest countries!)
 - ▶ Current differences originate in a long growth process

Summary (Cont'd)

- ▶ Reviewed some facts about differences in growth rates income per capita

Summary (Cont'd)

- ▶ Reviewed some facts about **differences in growth rates income per capita**
 - ▶ Exponential growth by more and more countries since 1800s

Summary (Cont'd)

- ▶ Reviewed some facts about **differences in growth rates income per capita**
 - ▶ Exponential growth by more and more countries since 1800s
 - ▶ Divergence in income across countries since 1960s

Summary (Cont'd)

- ▶ Reviewed some facts about **differences in growth rates income per capita**
 - ▶ Exponential growth by more and more countries since 1800s
 - ▶ Divergence in income across countries since 1960s
 - ▶ Convergence within groups of countries with similar characteristics

Summary (Cont'd)

- ▶ Reviewed some facts about **differences in growth rates income per capita**
 - ▶ Exponential growth by more and more countries since 1800s
 - ▶ Divergence in income across countries since 1960s
 - ▶ Convergence within groups of countries with similar characteristics

- ▶ Many reasons, need to sort them out

Final Bit of Class

- ▶ Let's do the rule of seventy

Final Bit of Class

- ▶ Let's do the rule of seventy
- ▶ Talk about a book: Guns Germs and Steel

Next 2 Class

- ▶ Mathematical Review I

Next 2 Class

- ▶ Mathematical Review I

Next 2 Class

- ▶ Mathematical Review I
- ▶ Laws of Exponential Growth