EC569 Economic Growth
Climate Change
Lecture 13

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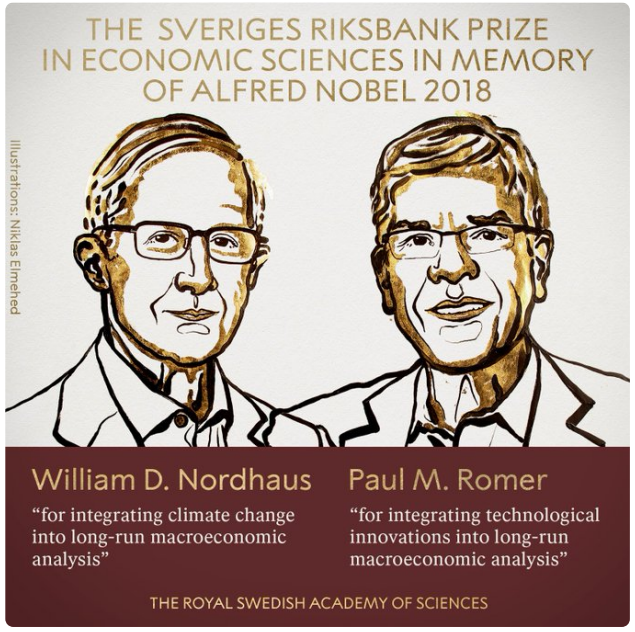
2020-03-29

The Nobel Prize
@NobelPrize

BREAKING NEWS: The Royal Swedish Academy of Sciences has decided to award the Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel 2018 to William D. Nordhaus and Paul M. Romer. #NobelPrize



4,457 10:51 AM - Oct 8, 2018

4,096 people are talking about this

Justin Wolfers @JustinWolfers · Oct 8, 2018
Replying to @JustinWolfers
At one level, this prize doesn't seem like an obvious combination -- both are somewhat related to modern growth theory, but not in any particularly coordinated or similar fashion.

Justin Wolfers
@JustinWolfers

But the Nordhaus-Romer pairing makes sense, because they each point to contradictions at the heart of capitalism. It's all about market failure. Left alone, markets will generate too much pollution (Nordhaus) and too few ideas (Romer).

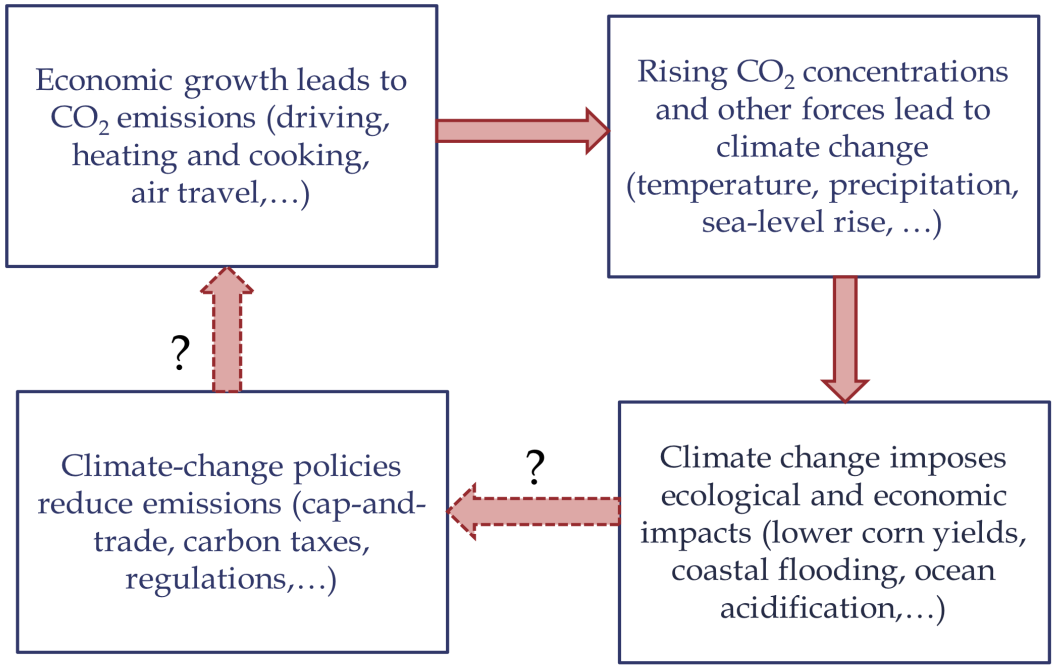
690 10:57 AM - Oct 8, 2018

396 people are talking about this

Nordhaus' Nobel Lecture

Watch it on YouTube, Slides here

The circular flow of global warming science, impacts, and policy



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Source: William Nordhaus

DICE model

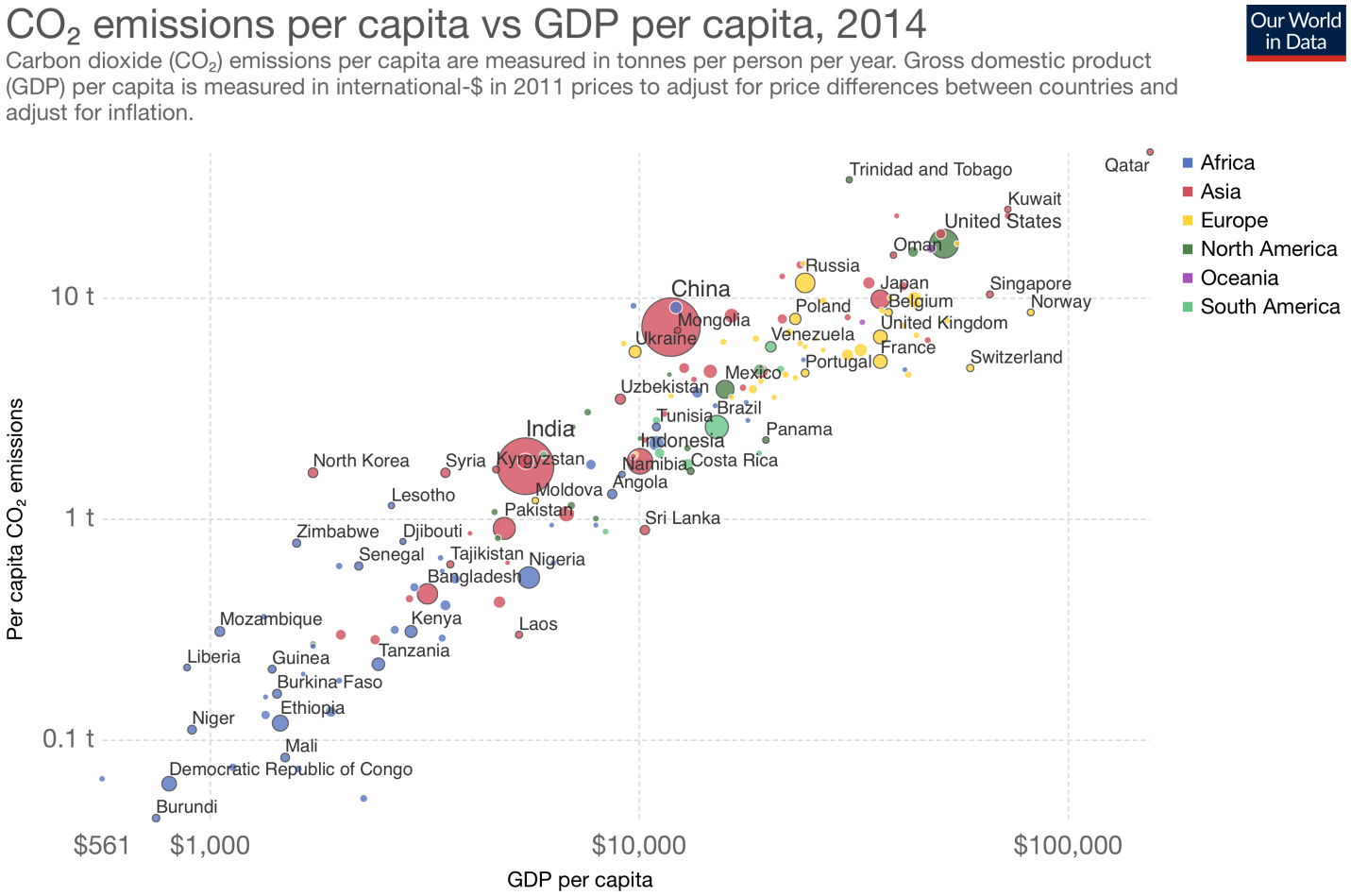
ECONOMIC GROWTH, TECHNOLOGICAL CHANGE, AND CLIMATE CHANGE

by The Committee for the Prize in Economic Sciences in Memory of Alfred Nobel:

> 1. a carbon-circulation model that maps emissions of fossil carbon to a path for atmospheric carbon-dioxide (CO2) concentration
>
> 2. a climate model that describes the evolution of the climate over time depending on the path of CO2 concentration
>
> 3. an economic model that describes how the economy and the society is affected by climate change over time, and – closing the loop – how the path of economic activity leads to emissions of fossil carbon.

Trends in climate change

Economic growth ⇒ CO_2 Emissions

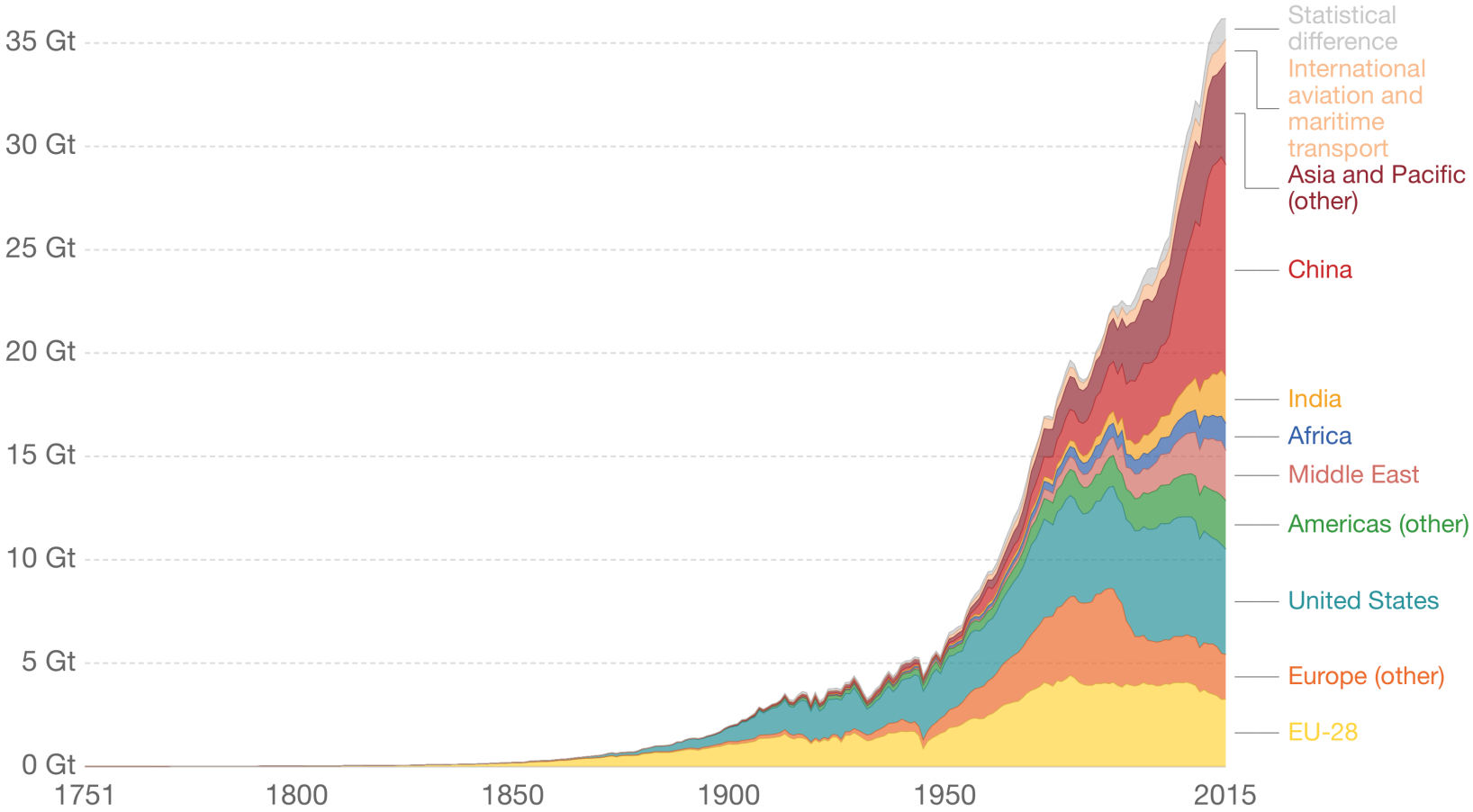


Source: Global Carbon Project, Maddison (2017)

OurWorldInData.org/co2-and-other-greenhouse-gas-emissions/ • CC BY

Annual CO_2 emissions by world region

Annual carbon dioxide (CO_2) emissions measured in billion tonnes (Gt) per year



Source: Carbon Dioxide Information Analysis Center (CDIAC)

Note: Emissions data have been converted from units of carbon to carbon dioxide (CO2) using a conversion factor of 3.67. Regions denoted "other" are given as regional totals minus emissions from the EU-28, USA, China and India. Here, we have rephrased the general term "bunker (fuels)" as "international aviation and maritime transport" for clarity.

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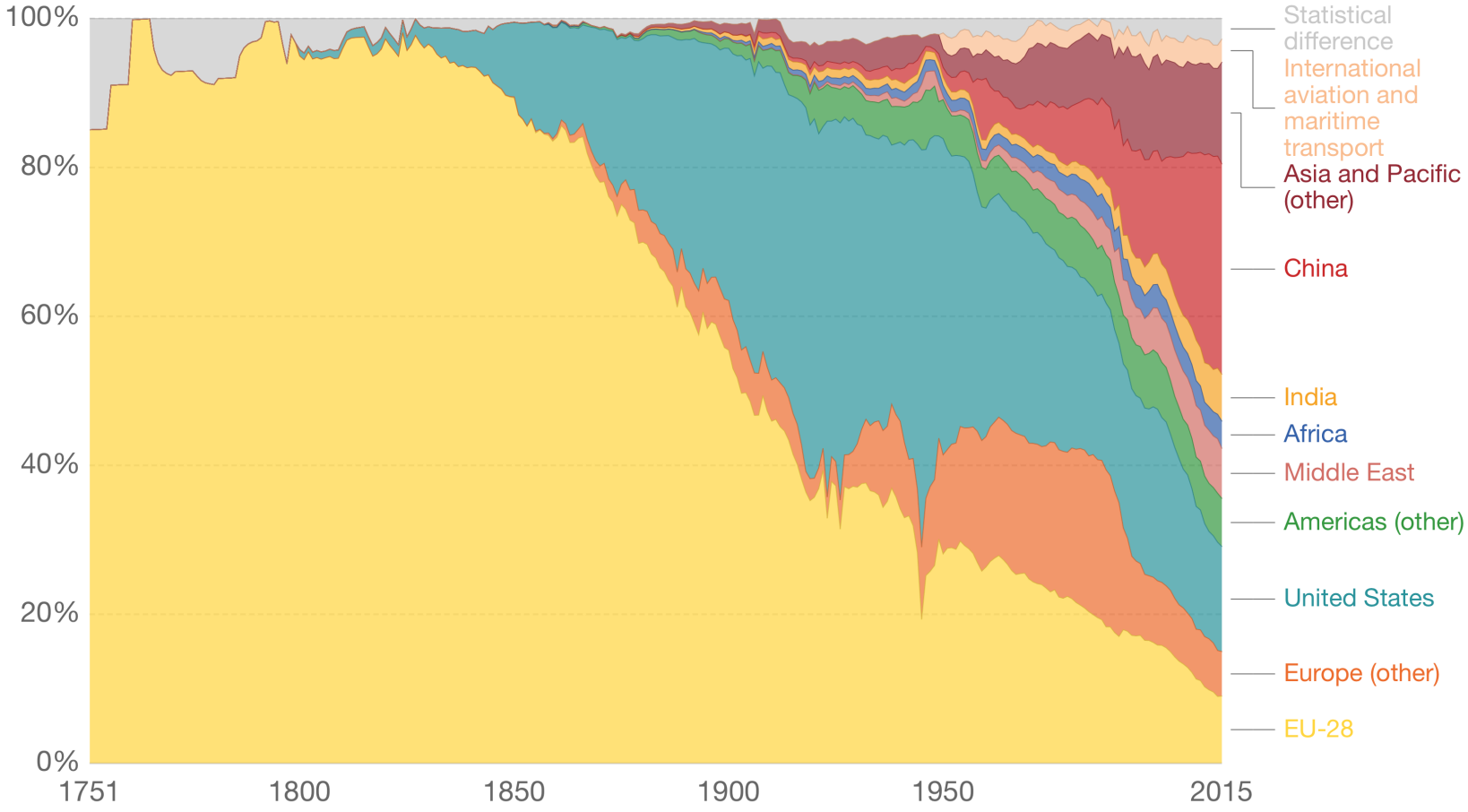
Annual carbon dioxide (CO_2) emissions measured in billion tonnes (Gt) per year



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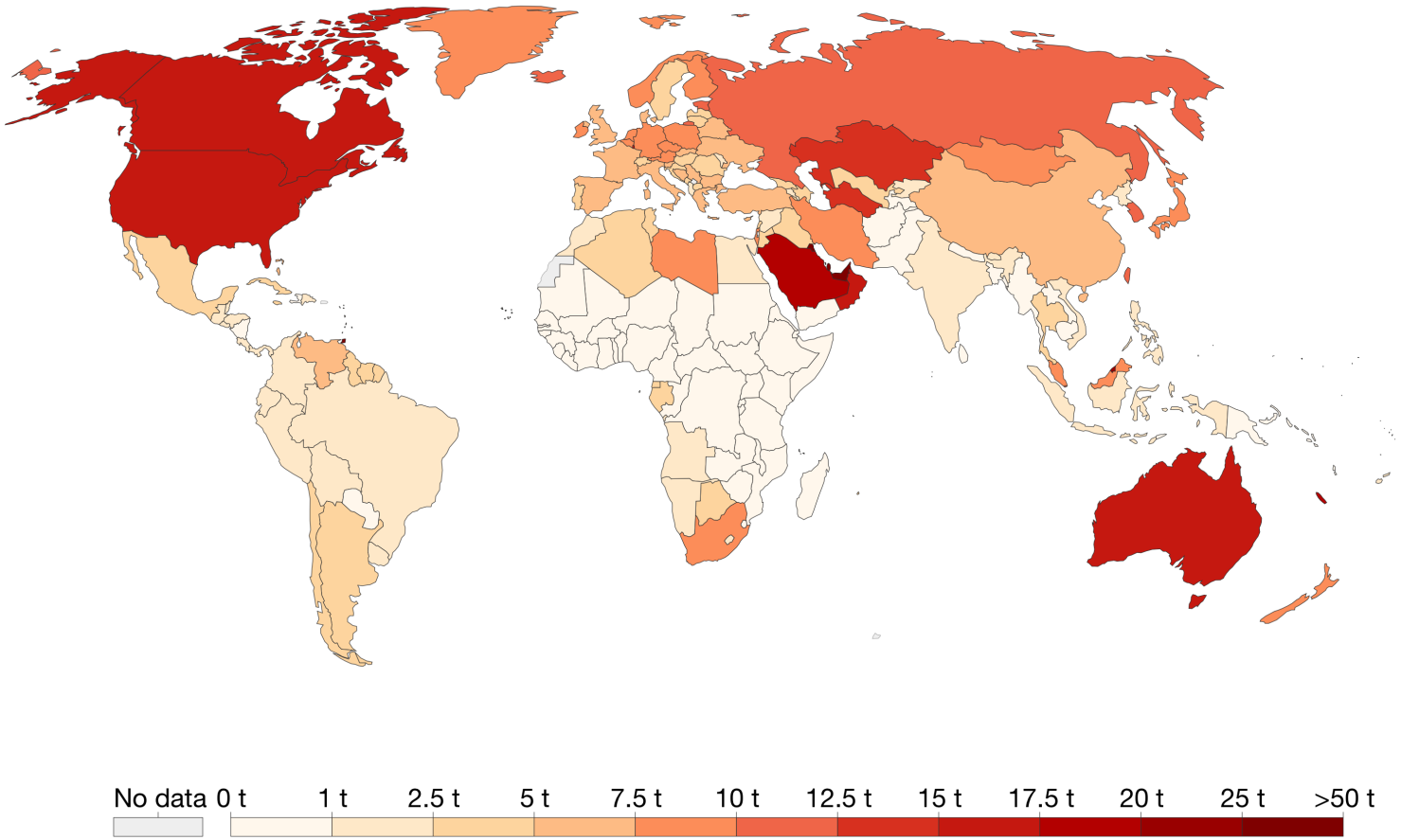
CO_2 emissions per capita, 2016

Average carbon dioxide (CO_2) emissions per capita measured in tonnes per year.

Our World in Data



Source: OWID based on Global Carbon Project; Gapminder & UN

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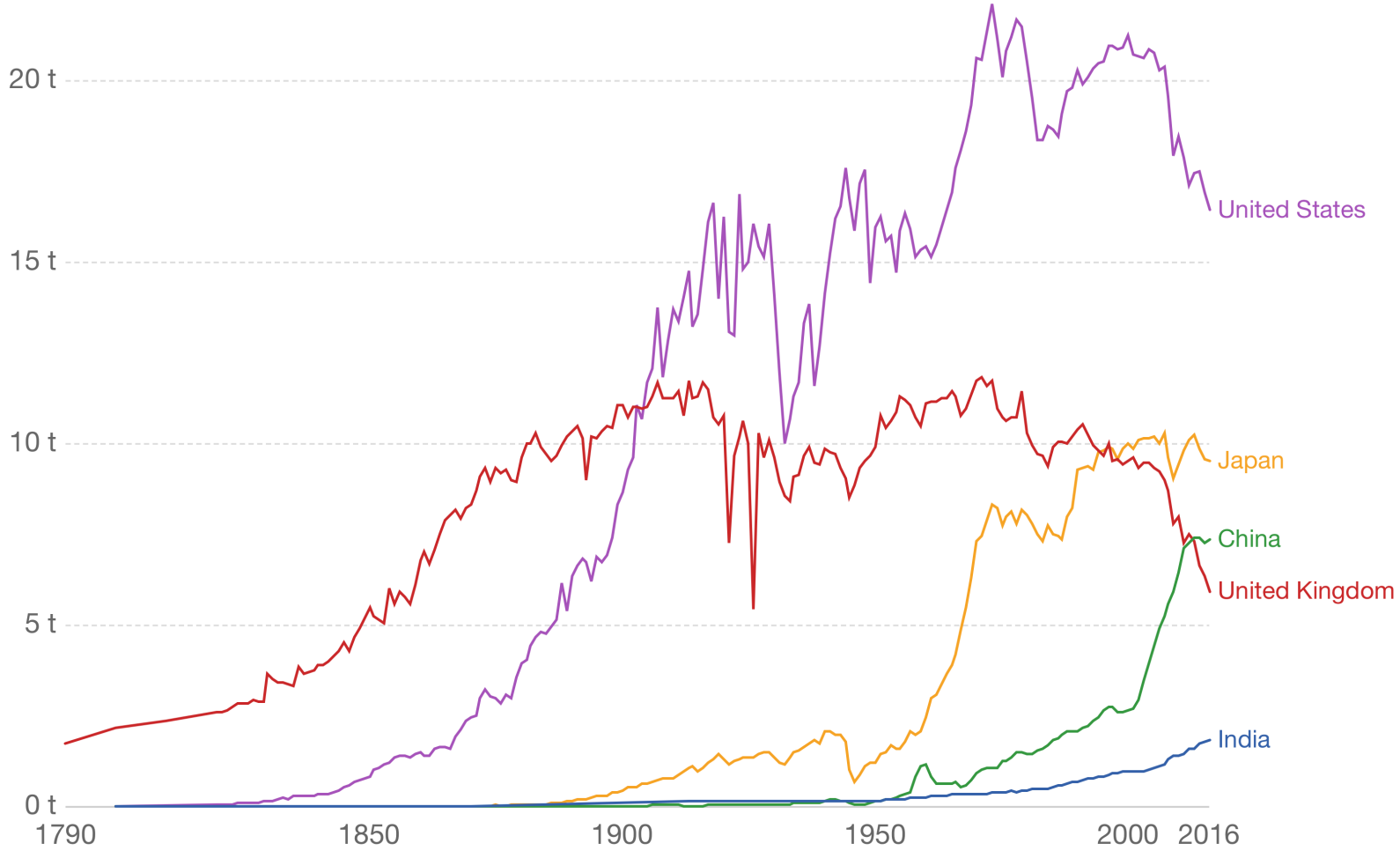
CO_2 emissions per capita

Average carbon dioxide (CO_2) emissions per capita measured in tonnes per year.



Source: OWID based on Global Carbon Project; Gapminder & UN

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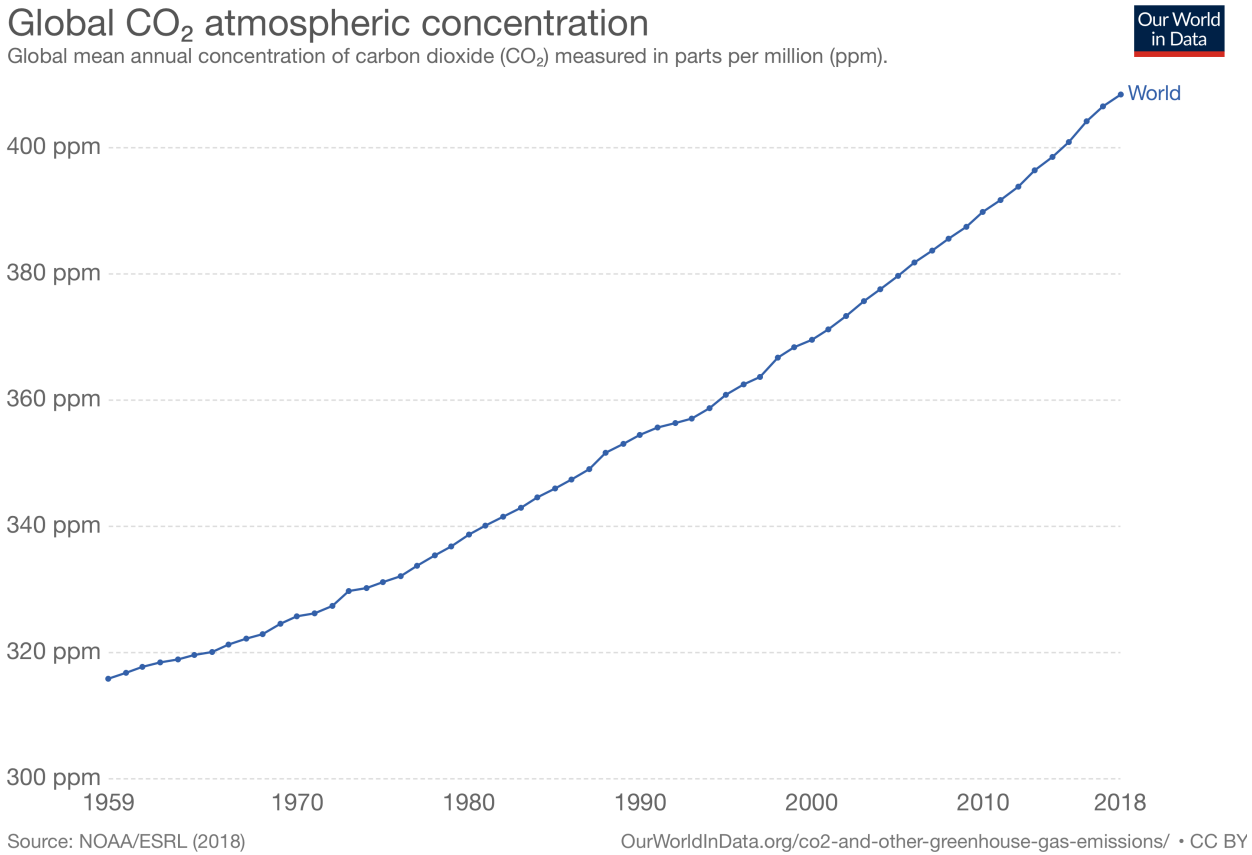
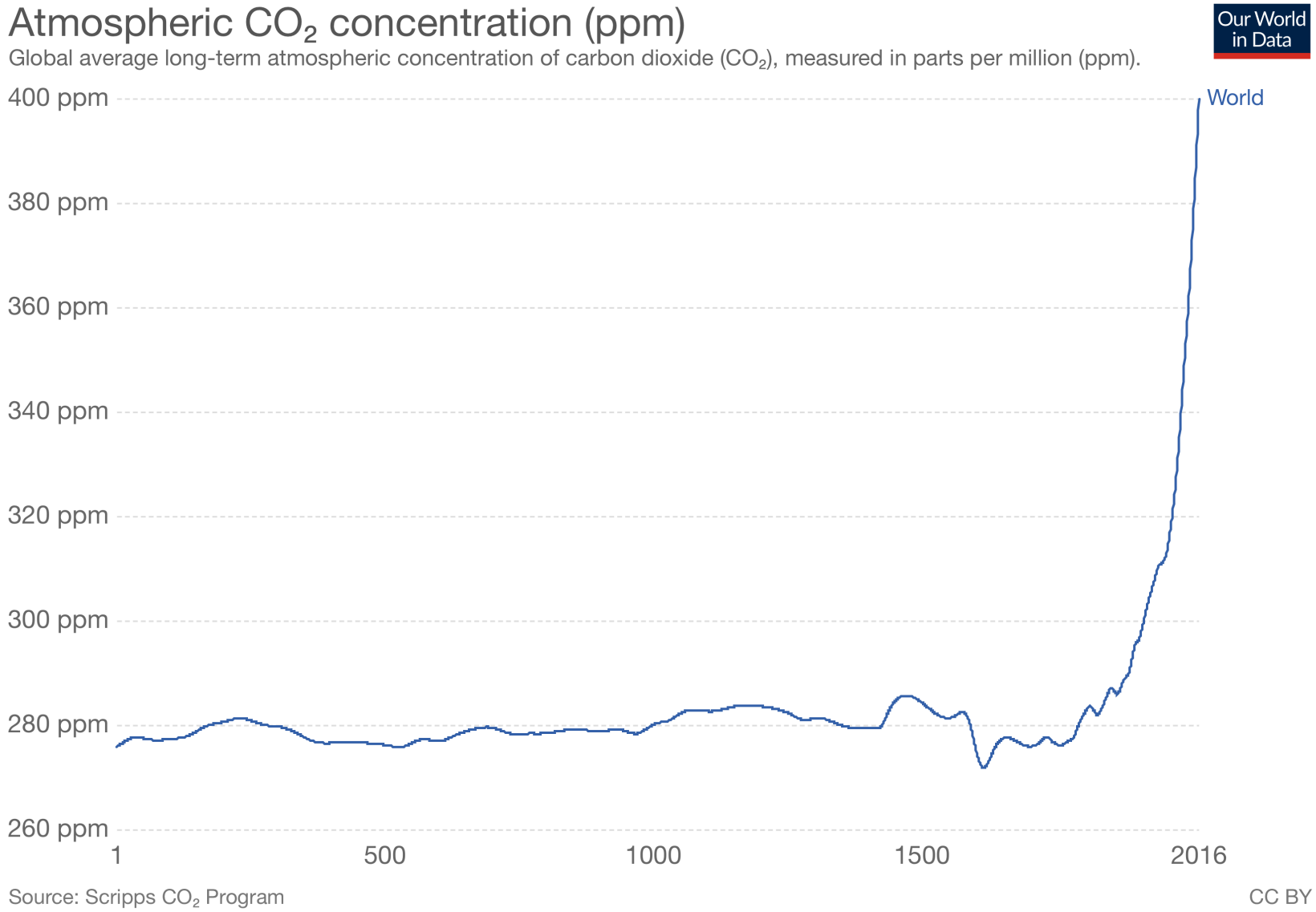
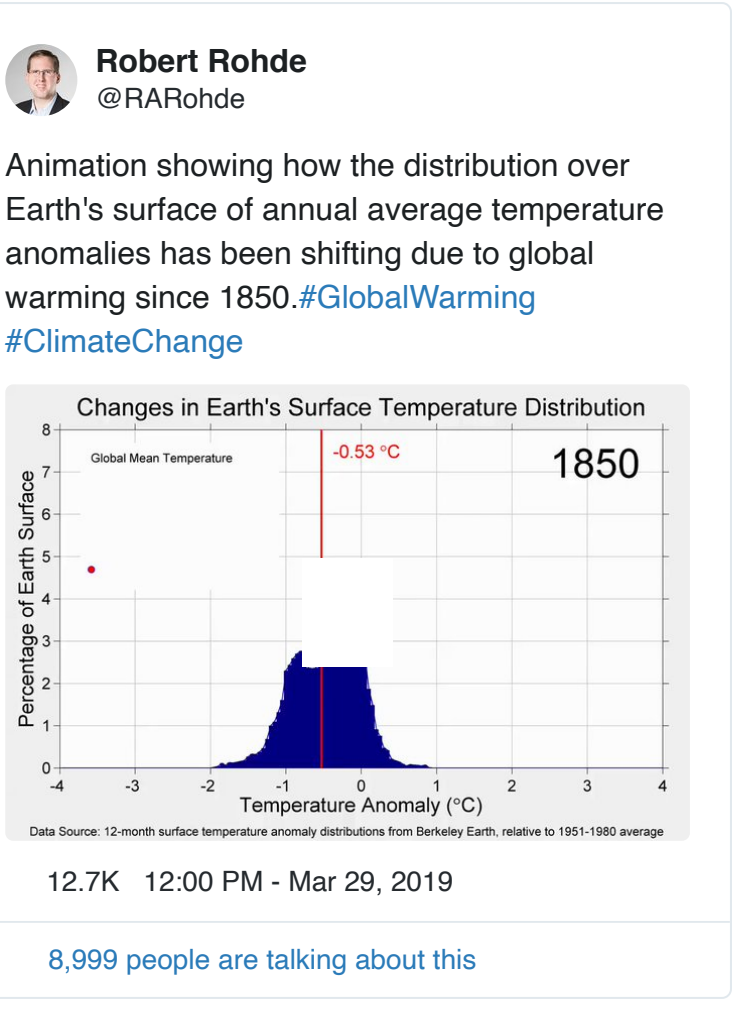
CO_2 Emissions ⇒ CO_2 Concentrations




Atmospheric CO_2 concentration (ppm)
Global average long-term atmospheric concentration of carbon dioxide (CO_2), measured in parts per million (ppm).
Our World in Data
400 ppm
380 ppm
360 ppm
340 ppm
320 ppm
300 ppm
280 ppm
260 ppm
World
1
500
1000
1500
2016
Source: Scripps CO_2 Program
CC BY

Climate Change ⇒ Economic and Ecological Impacts

- Lower corn yields
- Coastal flooding
- Extreme weather events
- Ocean acidification



Economic policy

Climate Change ⇒ ?? Climate-change policies ??

Because of market failures

- Climate change is a public bad
  - Non-rival (everyone will lose from it)
  - Non-excludable (one cannot exclude themselves from the negative effects)
  - Free-rider problem: if a country keeps producing CO_2 emissions, but the rest of world reduces the emissions, that country will be better off without paying any costs
- Negative externality
  - negative impact of CO_2 emissions on others
  - global: emissions by people in one country have negative impacts on residents of far away countries
  - long-run: emissions today have negative impact on future generations

Other factors

- Potential tipping point problem:
  - if the increase in global temperatures exceeds a point, it might be impossible to reverse the climate change
  - low probability but catastrophic event
  - necessitates prudential policies

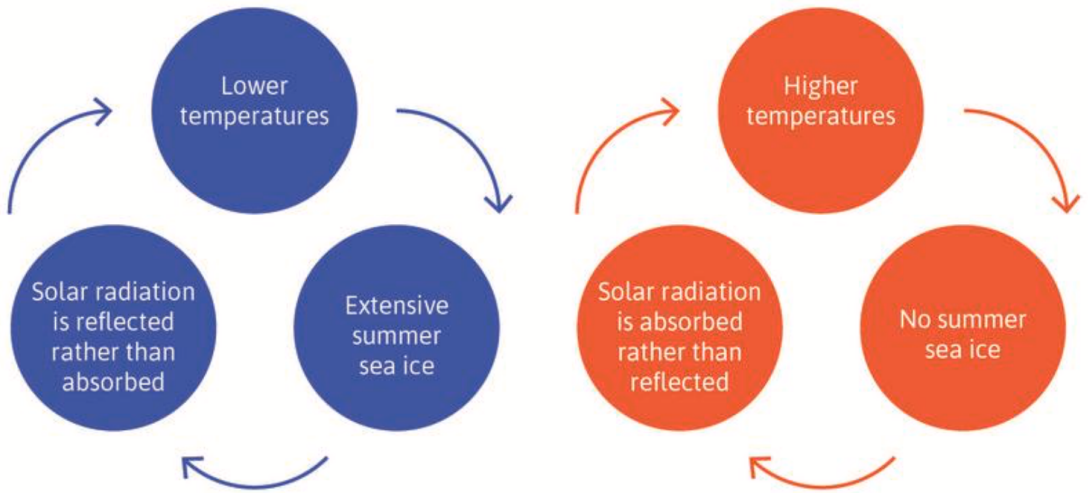


Figure from Core The Economy

Design of optimal policies

- People get utility from consumption
- They maximize discounted sum of utility from future consumption
  - subject to resource constraints: reductions CO_2 emissions require sacrifices from consumption
  - if CO_2 emissions is not reduced, the future consumption will be negatively affected.
- Question:
  - Models help us answer this question.

The mathematics of the DICE model

$$(1) \quad \max_{c(t)} W = \max_{c(t)} \left[\int_0^{\infty} U[c(t)] e^{-\rho t} dt \right]$$

subject to

$$(2) \quad c(t) = M[y(t); z(t); \alpha; \varepsilon(t)]$$

Source: William Nordhaus

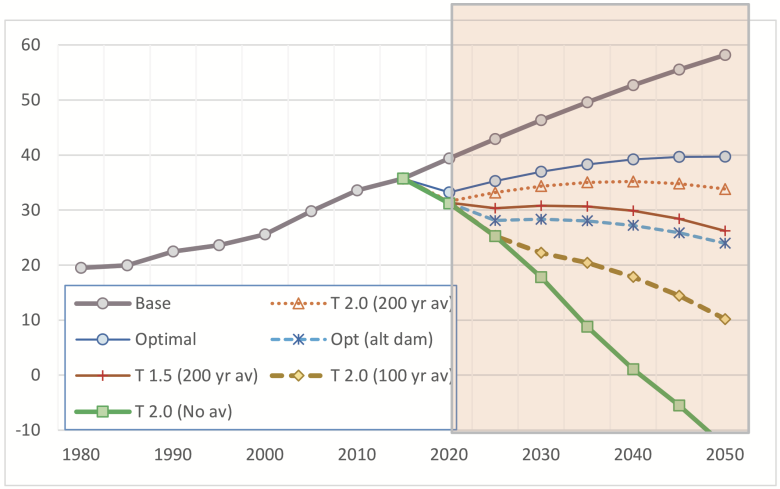
Modeling decisions

- Discount factor
- Weight on the welfare of future generations
  - Positive
  - Normative
- Households do not derive utility from the welfare of other households
  - How much weight should be put on the welfare of different regions?
- Policy implementation
  - carbon tax
  - tradable carbon emission permit

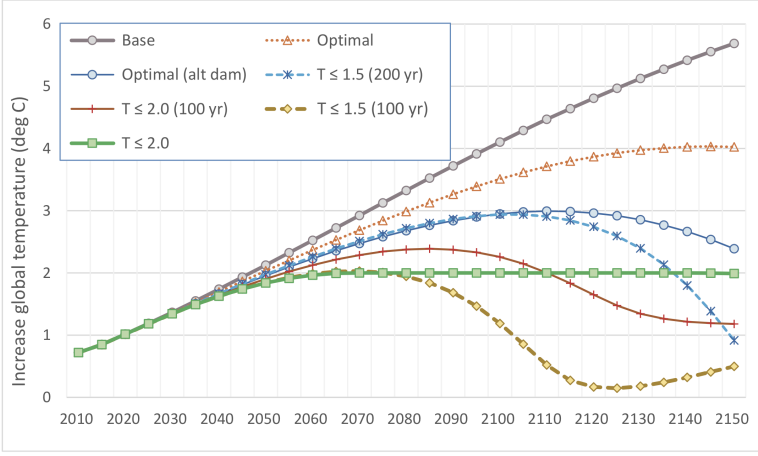
Alternative policies

- Business as usual (minimal policies)
- Cost-benefit optimum (two damage functions)
- Limit temperature increase (to 1.5 , 2, 2.5 °C) with hard cap
- Limit temperature increase (to 1.5 , 2, 2.5 °C) over 100-year or 200-year averaging period

Emissions trajectories in different policies



Temperature trajectories in different policies



Source: William Nordhaus

Social cost

Social cost: "the present value of the damage stream resulting from a marginal unit of fossil-fuel emissions"

Table 1 Carbon taxes 2010 US Dollars	**2015**	**2020**	**2025**	**2030**	**2050**
Optimal (Nordhaus's best parameter guess)	29.5	35.3	49.1	64.0	153.5
Optimal (Temperature Limit <2.5°C)	184.1	229.0	284.0	351.0	1008.4
Optimal (Stern discounting at 0.1%)	256.5	299.6	340.7	381.7	615.6

Source: Nobel Committee

- Carbon taxes disincentivize carbon-intensive production and consumption
- Carbon tax should be set equal to the social cost
- An increasing carbon tax is the most efficient way to coordinate economic activity
  - Needs coordination of economic activity by billions of people
- Carbon taxes incentivizes innovation in green technologies

Political economy

- Diverse group of countries/people with different incentives
- Pareto optimal allocation requires compensation of losers
- Free rider problem
- Proposal by Nordhaus
    - Form a climate club
    - Target carbon price, say $50 per ton CO2
    - Penalty tariff on non-participants, say 3% uniform
- Without cooperation, equilibrium tax would much lower than the optimal tax
- Incentives for innovation

Summary

We covered

- Surge in CO_2 emissions and atmospheric CO_2 concentration
- Market failures in carbon-intensive production/consumption
- Designing optimal policies

To review this lecture:

- Watch Bill Nordhaus' Nobel lecture
- Read the papers on Moodle (under essay)
- Read Unit 20 of Core the Economy