Economics 134, Lecture 1

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UCLA

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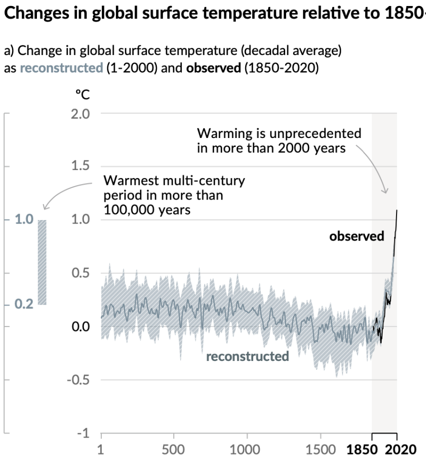
Welcome

What is environmental economics?

- economics: the study of the allocation of scarce resources
- environmental: how economic forces shape the natural world, and vice versa

Much of economics assumes that markets are mostly perfect. **We will not**.

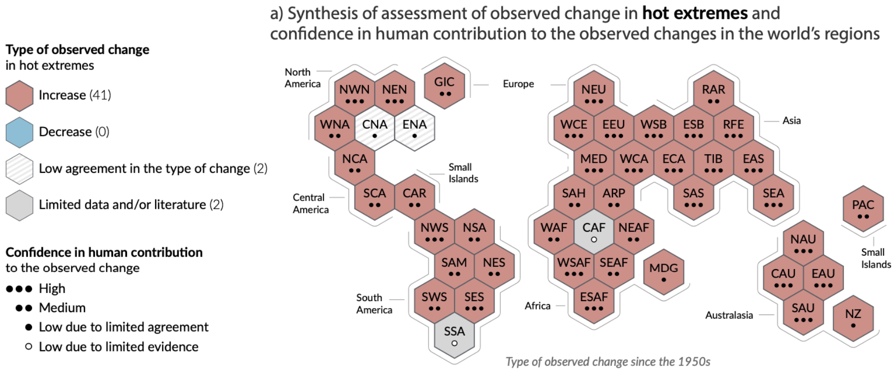
1. Unprecedented rise in global temperature



Source. IPCC August 2021, p. 8

1. Unprecedented rise in global temperature

Heat waves



Source. IPCC August 2021, p. 13

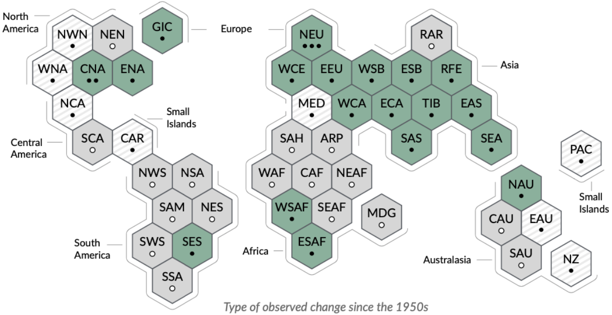
Type of observed change in heavy precipitation

- Increase (19)
- Decrease (0)
- Low agreement in the type of change (8)
- Limited data and/or literature (18)

Confidence in human contribution to the observed change

- ●●● High
- ●● Medium
- ● Low due to limited agreement
- ○ Low due to limited evidence

b) Synthesis of assessment of observed change in **heavy precipitation** and confidence in human contribution to the observed changes in the world's regions



Source. IPCC August 2021, p. 13

1. Unprecedented rise in global temperature

Droughts

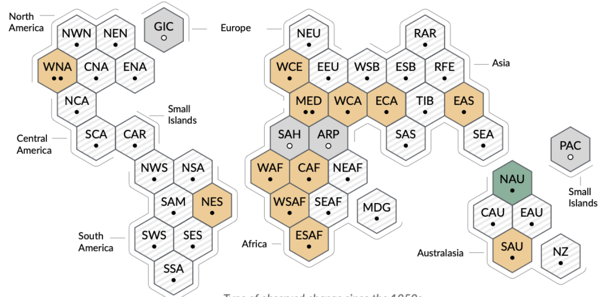
Type of observed change
in agricultural and ecological drought

- Increase (12)
- Decrease (1)
- Low agreement in the type of change (28)
- Limited data and/or literature (4)

Confidence in human contribution
to the observed change

- ●●● High
- ●● Medium
- ● Low due to limited agreement
- ○ Low due to limited evidence

c) Synthesis of assessment of observed change in **agricultural and ecological drought** and confidence in human contribution to the observed changes in the world's regions



Type of observed change since the 1950s

Source. IPCC August 2021

(. . .)

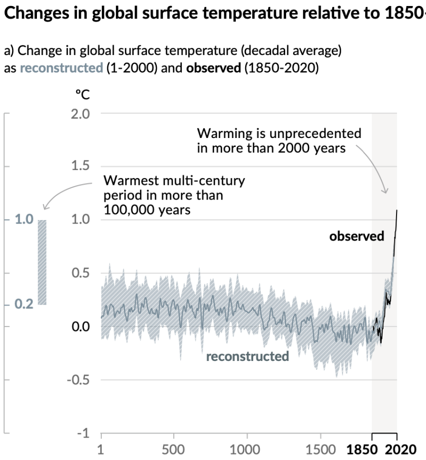
Each hexagon corresponds to one of the IPCC AR6 WGI reference regions

NWN *North-Western North America*

IPCC AR6 WGI reference regions: **North America:** ***NWN*** *(North-Western North America,* ***NEN*** *(North-Eastern North America),* ***WNA*** *(Western North America),* ***CNA*** *(Central North America),* ***ENA*** *(Eastern North America),* **Central America:** ***NCA*** *(Northern Central America),* ***SCA*** *(Southern Central America),* ***CAR*** *(Caribbean),* **South America:** ***NWS*** *(North-Western South America),* ***NSA*** *(Northern South America),* ***NES*** *(North-Eastern South America),* ***SAM*** *(South American Monsoon),* ***SWS*** *(South-Western South America),* ***SES*** *(South-Eastern South America),* ***SSA*** *(Southern South America),* **Europe:** ***GIC*** *(Greenland/Iceland),* ***NEU*** *(Northern Europe),* ***WCE*** *(Western and Central Europe),* ***EEU*** *(Eastern Europe),* ***MED*** *(Mediterranean),* **Africa:** ***MED*** *(Mediterranean),* ***SAH*** *(Sahara),* ***WAF*** *(Western Africa),* ***CAF*** *(Central Africa),* ***NEAF*** *(North Eastern Africa),* ***SEAF*** *(South Eastern Africa),* ***WSAF*** *(West Southern Africa),* ***ESAF*** *(East Southern Africa),* ***MDG*** *(Madagascar),* **Asia:** ***RAR*** *(Russian Arctic),* ***WSB*** *(West Siberia),* ***ESB*** *(East Siberia),* ***RFE*** *(Russian Far East),* ***WCA*** *(West Central Asia),* ***ECA*** *(East Central Asia),* ***TIB*** *(Tibetan Plateau),* ***EAS*** *(East Asia),* ***ARP*** *(Arabian Peninsula),* ***SAS*** *(South Asia),* ***SEA*** *(South East Asia),* **Australasia:** ***NAU*** *(Northern Australia),* ***CAU*** *(Central Australia),* ***EAU*** *(Eastern Australia),* ***SAU*** *(Southern Australia),* ***NZ*** *(New Zealand),* **Small Islands:** ***CAR*** *(Caribbean),* ***PAC*** *(Pacific Small Islands)*

Source. IPCC August 2021, p. 13

2. Effect of carbon dioxide (CO_2) on temperature



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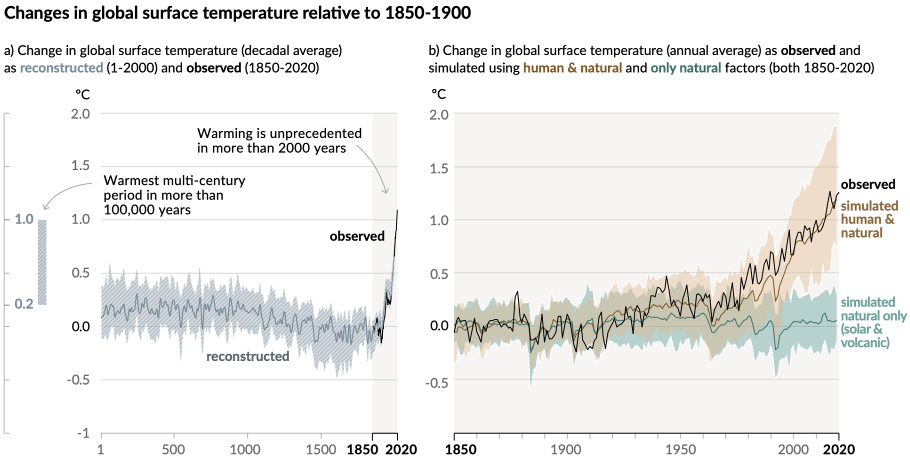

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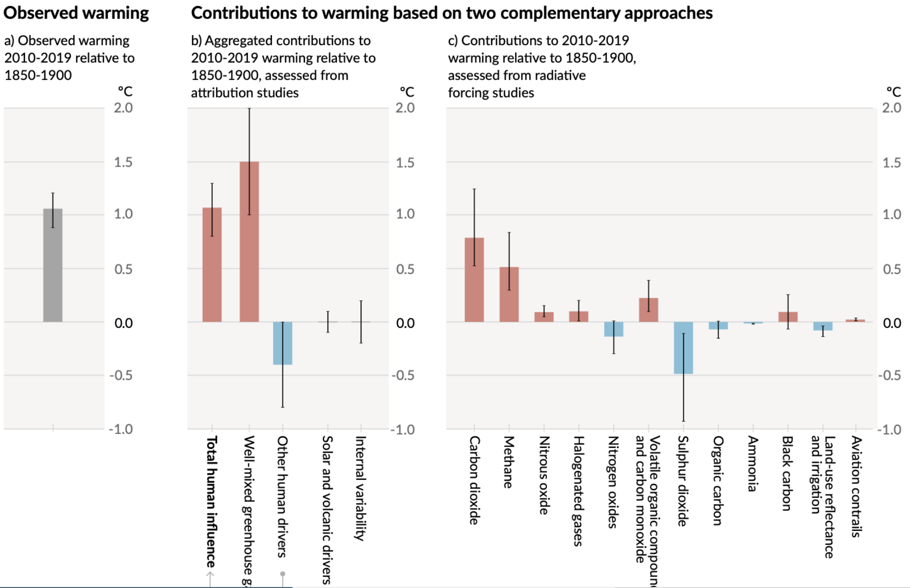
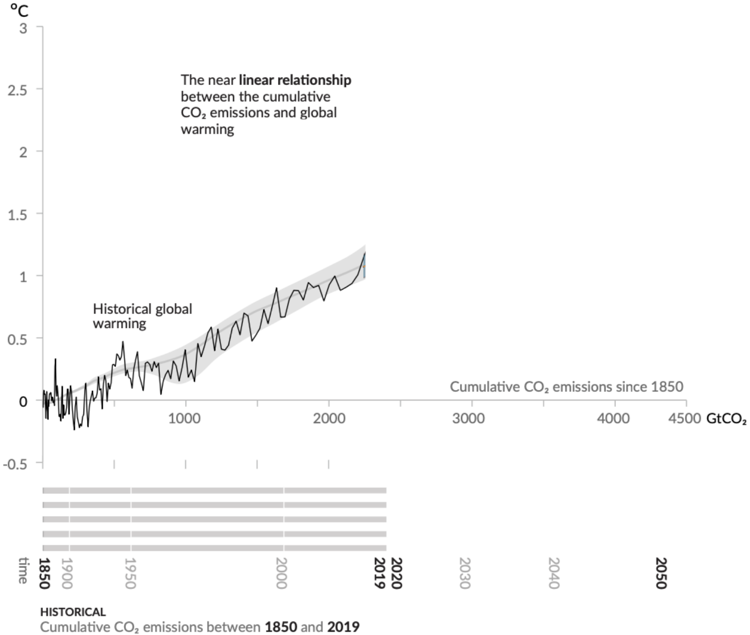


Global surface temperature increase since 1850-1900 (°C) as a function of cumulative CO_2 emissions ($GtCO_2$)



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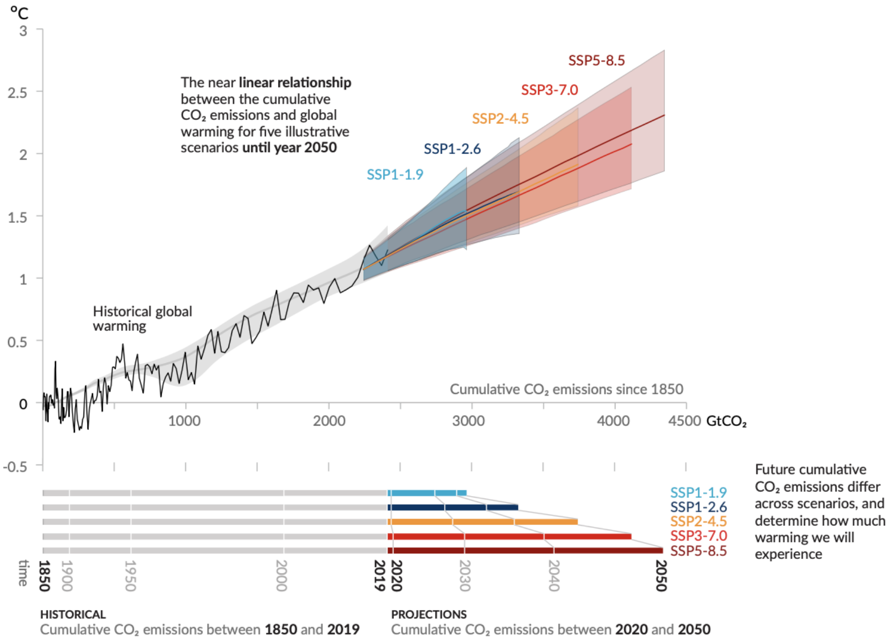

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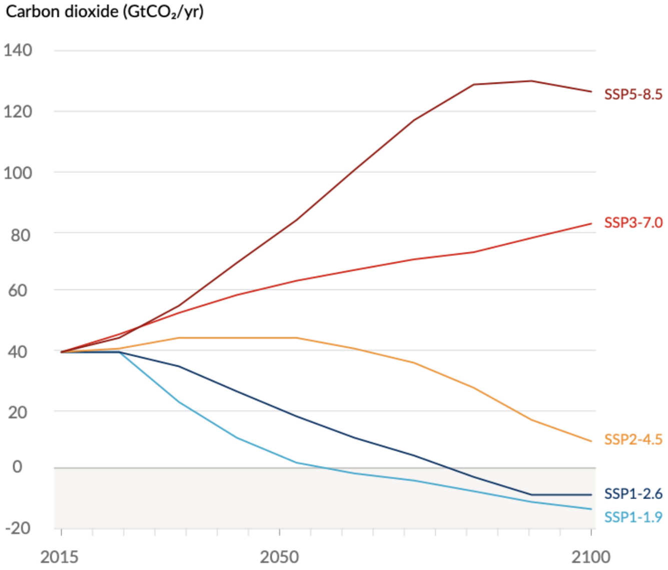

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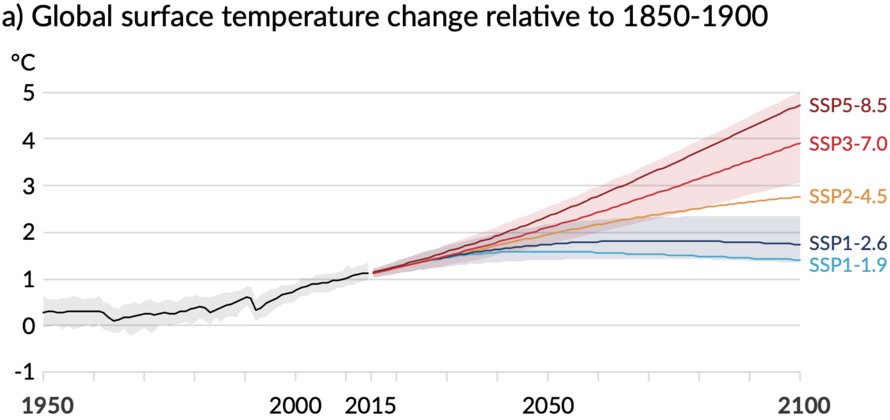

Source. IPCC August 2021, p. 30

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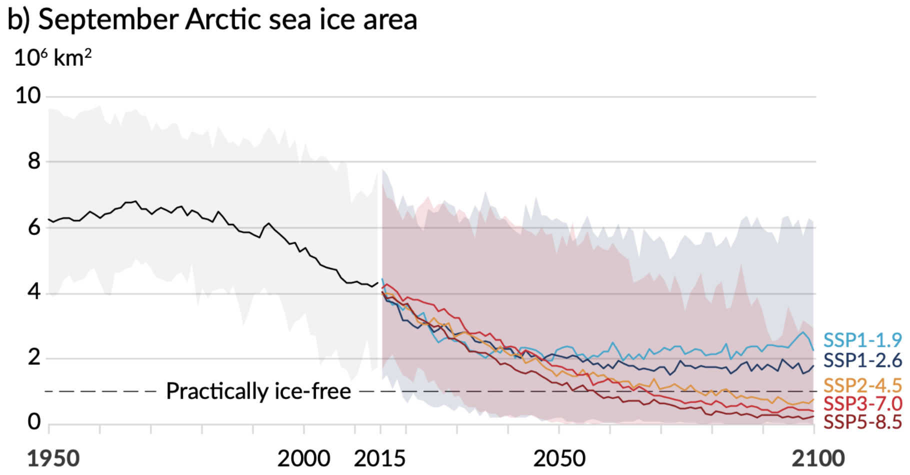

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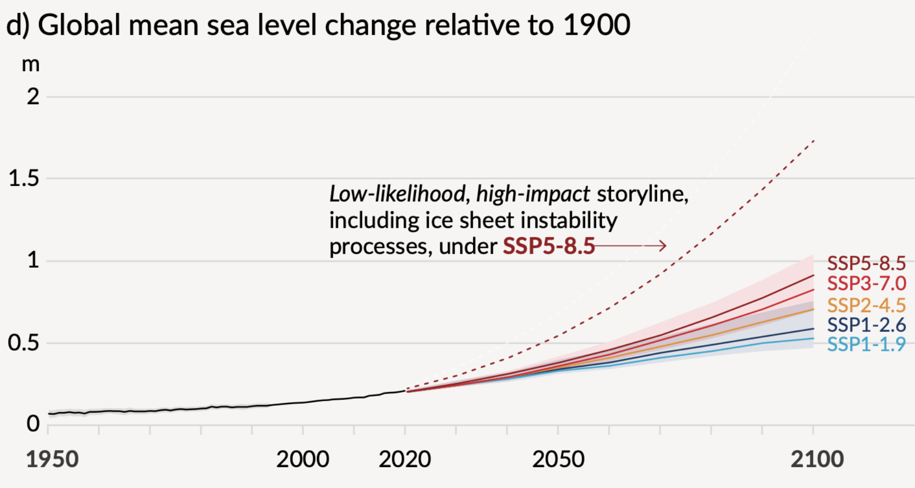

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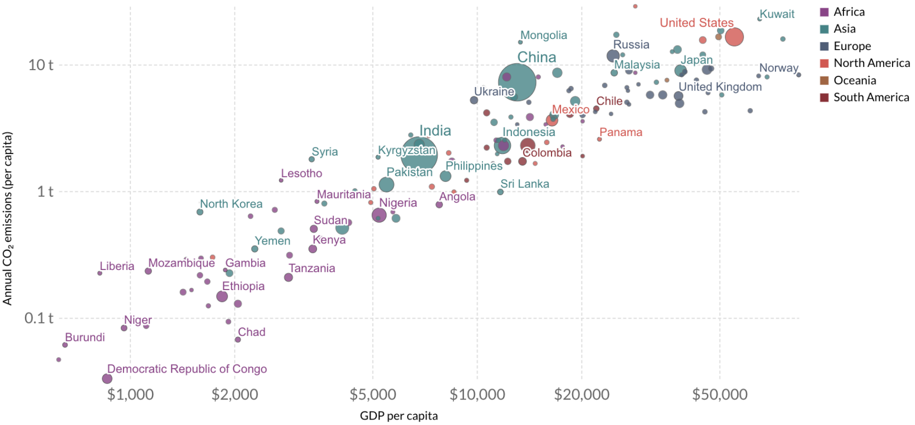
3. CO_2 per dollar economic output

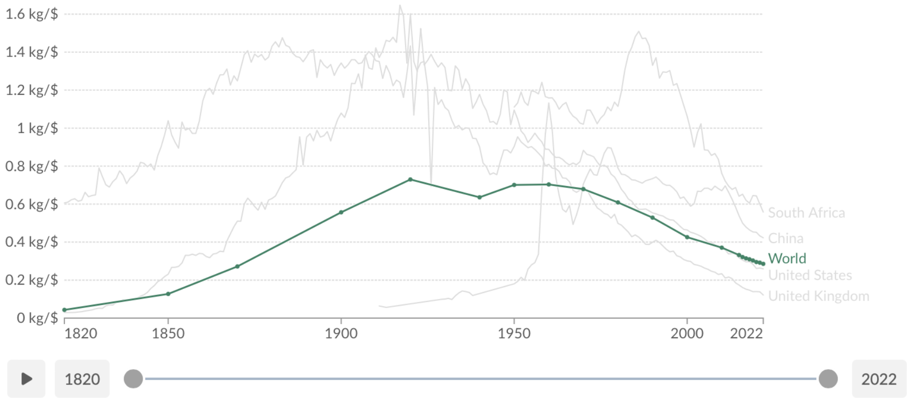
Across countries



Source: Our World in Data based on the Global Carbon Project, Maddison Project Database 2020 (Bolt and van Zanden (2020))

3. CO_2 per dollar economic output

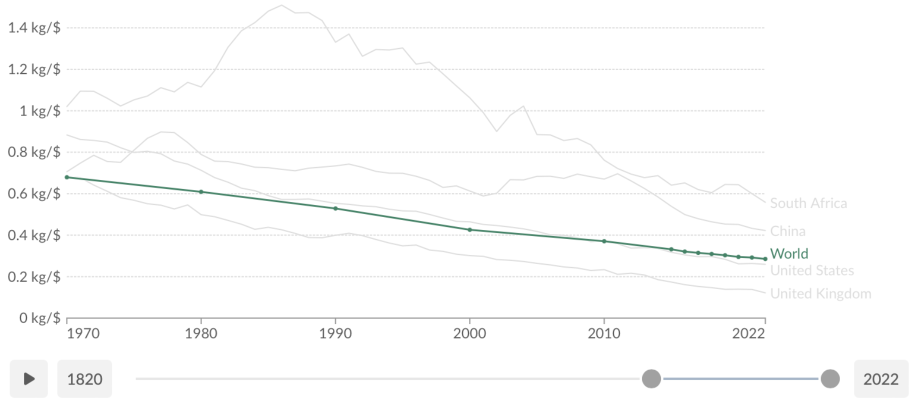
1820–2022



Source. Global Carbon Budget (2023); Bolt and van Zanden - Maddison Project Database 2023 – Note: GDP data in 2011 prices.
`OurWorldinData.org/co2-and-greenhouse-gas-emissions`

3. CO_2 per dollar economic output

1970–2022



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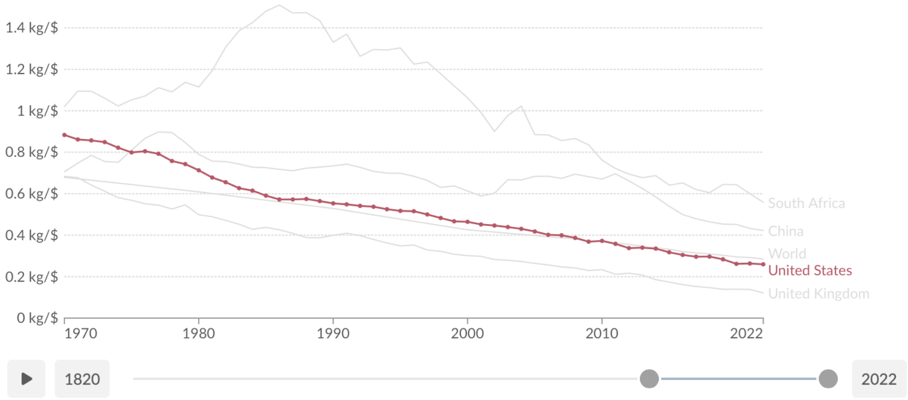
3. CO_2/GDP, United States

1970–2022



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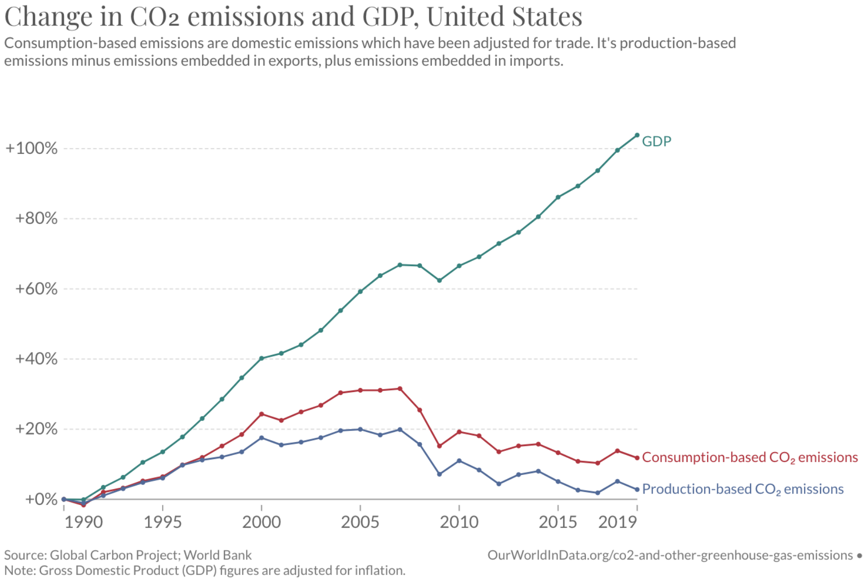
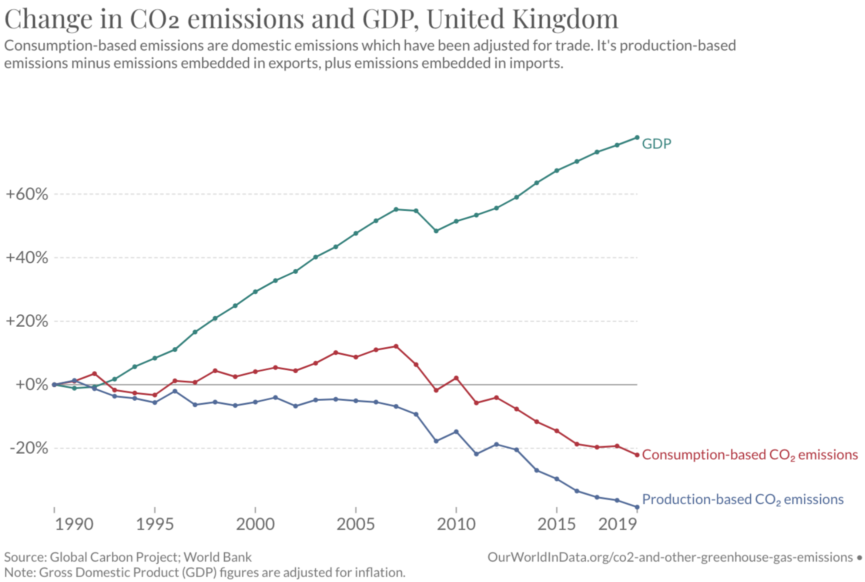
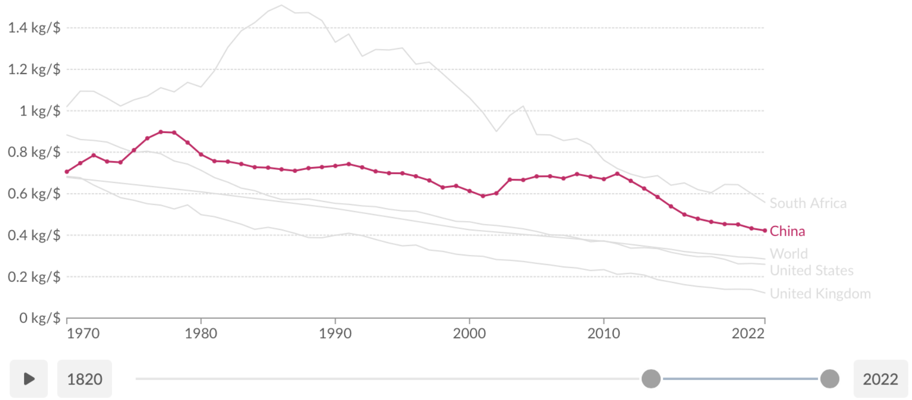


3. CO_2/GDP, UK


Change in CO2 emissions and GDP, United Kingdom
Consumption-based emissions are domestic emissions which have been adjusted for trade. It's production-based emissions minus emissions embedded in exports, plus emissions embedded in imports.
GDP
Consumption-based CO2 emissions
Production-based CO2 emissions
+60%
+40%
+20%
+0%
-20%
1990
1995
2000
2005
2010
2015
2019
Source: Global Carbon Project; World Bank
OurWorldInData.org/co2-and-other-greenhouse-gas-emissions
Note: Gross Domestic Product (GDP) figures are adjusted for inflation.

3. CO_2/GDP, China

1970–2022



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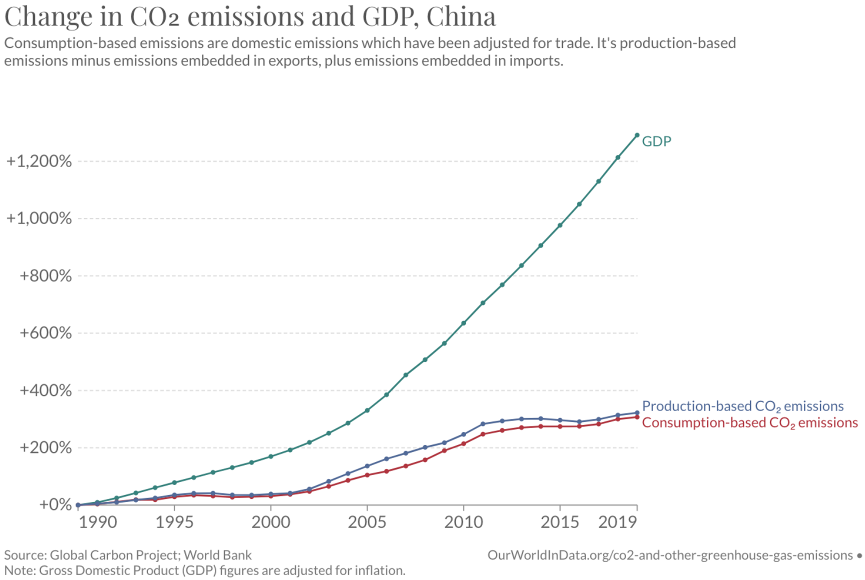
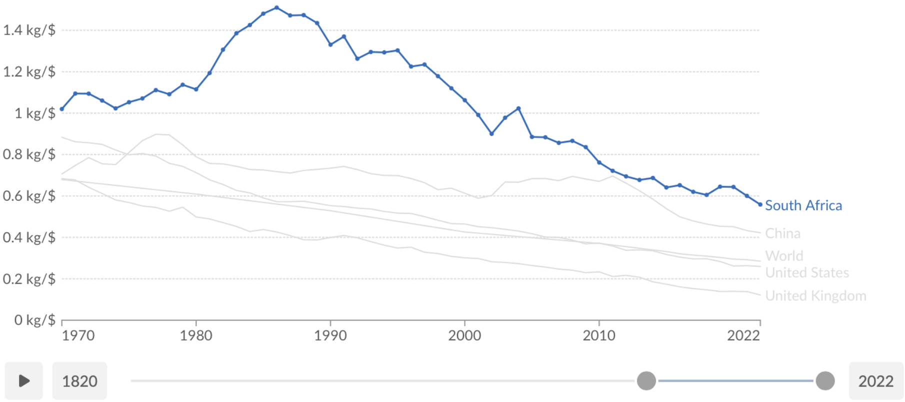


3. CO_2/GDP, South Africa

1970–2022



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3. CO_2/GDP, South Africa

Change in CO2 emissions and GDP, South Africa

Consumption-based emissions are domestic emissions which have been adjusted for trade. It's production-based emissions minus emissions embedded in exports, plus emissions embedded in imports.

Source: Global Carbon Project; World Bank
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OurWorldInData.org/co2-and-other-greenhouse-gas-emissions •

Key themes

In this course, we will treat environmental economics as a **useful framework** to evaluate environmental problems and their solutions

Three aims:

1. **Describe** how economic behavior gives rise to environmental destruction and/or protection
2. **Evaluate** outcomes using normative criteria such as efficiency and welfare
3. Propose **policies** designed to improve (2) given (1)

Key themes

We will try to combine theory and data.

1. **Describe** how economic behavior gives rise to environmental destruction and/or protection
   - theory
     - the market does not solve all problems
   - guided by data
     - environmental and economic systems are complex
     - but we will try to disentangle **correlation** from **causation**
2. **Evaluate** outcomes using criteria such as efficiency and welfare
   - theory guides our evaluation (e.g., when and how to use cost-benefit analysis)
   - data indicates what we should prioritize
3. Propose **policies** to improve (2) given (1)
   - theory suggests various solutions
   - learn from the myriad approaches taken in the world today

Course outline

L1–L6: **market failures**

- externalities
- estimating costs and benefits
- common-pool problems
- public goods

L7–L10: **climate change**

- optimal climate policy
- risk, uncertainty, and long timeframes
- equity and international political economy

L11–L16: new topics in environmental economics

- **environmental markets**: air pollution, carbon trading, offsets
- **natural resources**: water, oil, conservation, forests
- **innovation**: renewable energy, electric vehicles

Prerequisites

- Microeconomic theory (Econ 101); calculus
- Introductory econometrics (Econ 41 or Statistics 12 or 13)

Requirements and grading

- Three problem sets (10%)
- Two midterms (35%), in-class, October 20 and November 12
- Final exam (55%), December 6

I. Introduction and overview

II. Theory of externalities

I. Introduction and overview

II. Theory of externalities

Externalities

Most important concept in environmental economics:

Definition (Externality)

An **externality** is any (external) effect of an action not internalized by the actor.

That is, an activity generates externalities "if its costs or benefits spill outside the market and are not captured in market prices" (Nordhaus, 2018 Nobel Prize lecture).

Often useful to distinguish between **positive** and **negative** externalities.

$\hookrightarrow$ "positive" $\equiv$ beneficial effect

$\hookrightarrow$ "negative" $\equiv$ detrimental effect

Some examples of externalities:

- A loud end-of-summer party may compromise a neighbor's sleep
- A fun end-of-summer party may lead to spontaneous acts of goodwill
- Driving at the wrong time may worsen traffic
- Driving carefully may inspire others to do the same
- You not paying attention today may have an externality on your future self

The key to all of these examples is that we have assumed these external effects **are not** internalized by the actor.

In Econ 134, we will focus primarily on **environmental** externalities, where the external effect alters some aspect of the natural environment

Some examples:

- A beekeeper's bees may pollinate the trees of a nearby apple orchard
- Burning coal to generate electricity puts carbon dioxide into the atmosphere
- Driving may create smog
- Sparks from an electric transmission line may risk wildfires

Building blocks

Introductory microeconomics and econometrics:

1. supply and demand for bumblebees
2. supply and demand for coal
3. supply and demand for cars and roads
4. supply and demand for electricity

We will study how the above interact with problems such as

1. growing apples
2. climate change
3. air pollution
4. wildfires

Example

A firm produces some $q \geq 0$ to maximize its net output,

$$\pi(q) = p \cdot q - c(q)$$

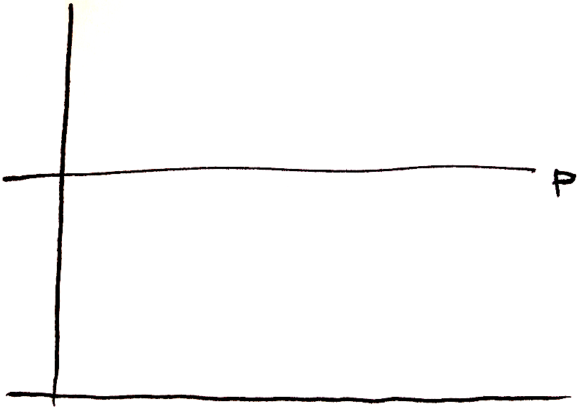
where p is the firm's output price and $c(\cdot)$ is a cost function with $c', c'' > 0$.

I. Free market outcome. To maximize π, the firm chooses

$$\pi'(q^*) = p - c'(q^*) = 0,$$

i.e., the firm equates price with marginal cost.

Free market equilibrium



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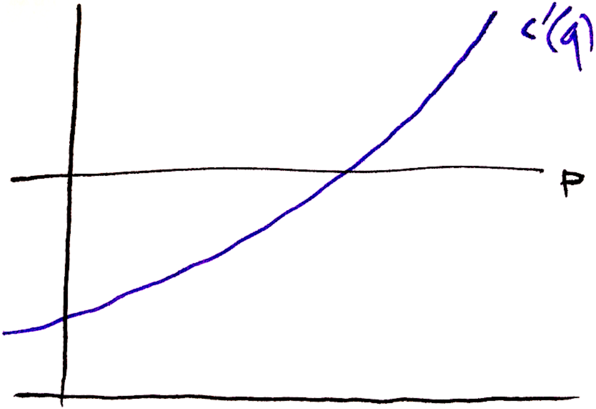

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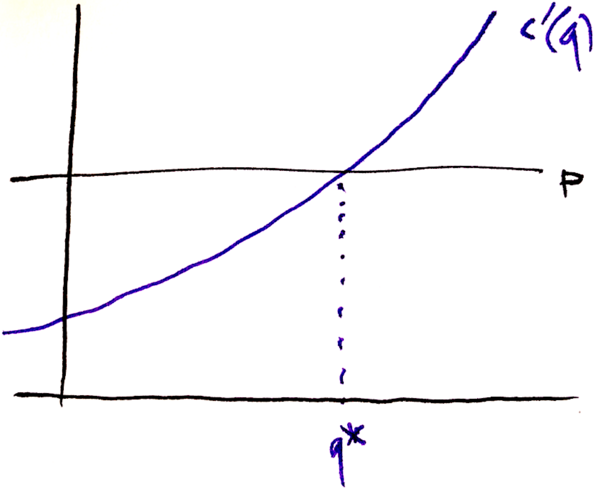
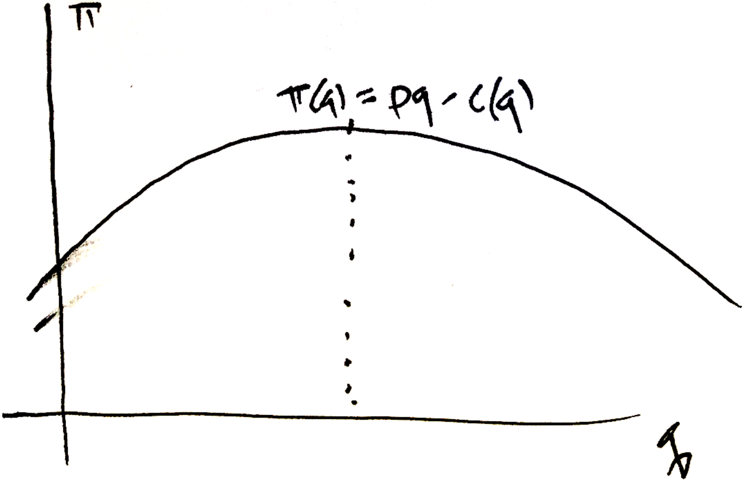


Profit space



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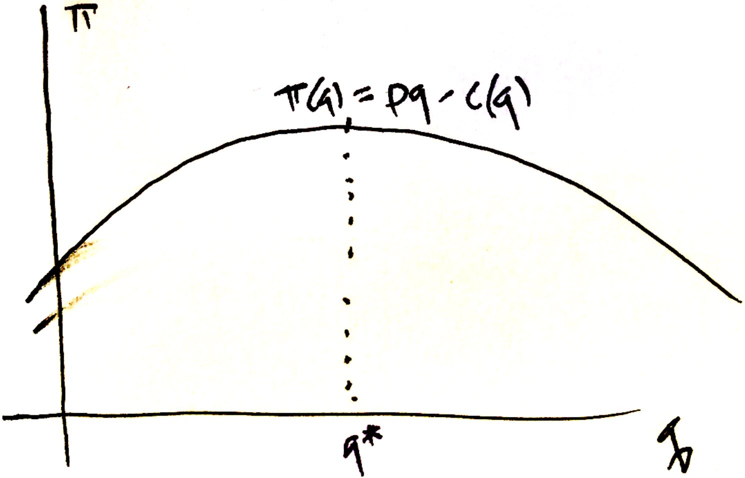


Example, cont'd

A firm produces some $q \geq 0$ to maximize its net output,

$$\pi(q) = p \cdot q - c(q)$$

where p is the firm's output price and $c(\cdot)$ is a cost function with $c', c'' > 0$.

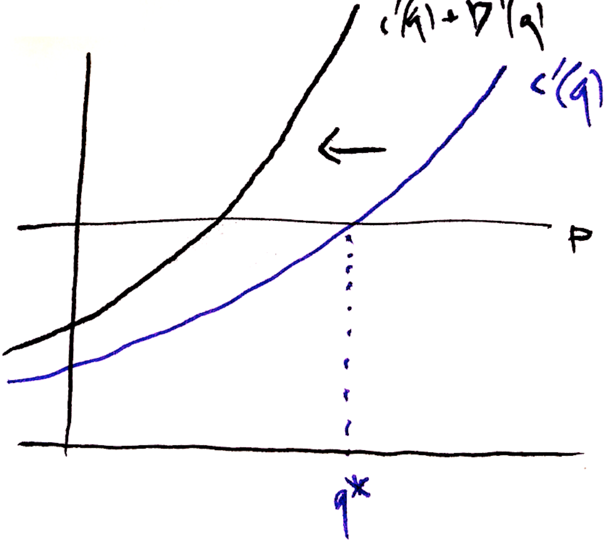
I. Free market outcome. To maximize π, the firm chooses

$$\pi'(q^*) = p - c'(q^*) = 0,$$

i.e., the firm equates price with marginal cost.

Now suppose there is a neighbor who incurs damages $D(q)$ from q (a **negative externality**). Suppose $D', D'' > 0$.

Marginal social cost vs. private cost



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Now suppose there is a neighbor who incurs damages $D(q)$ from q (a **negative externality**). Suppose $D', D'' > 0$.

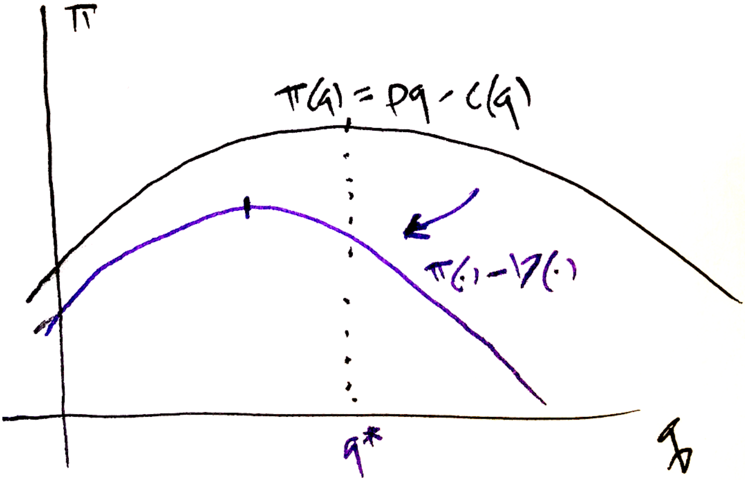
Then the aggregate or total surplus of producing some level q is

$$W(q) = \pi(q) - D(q).$$

In particular, total surplus under the free market is

$$W(q^*) = p \cdot q^* - c(q^*) - D(q^*).$$

Total surplus



Diagnosing market failure

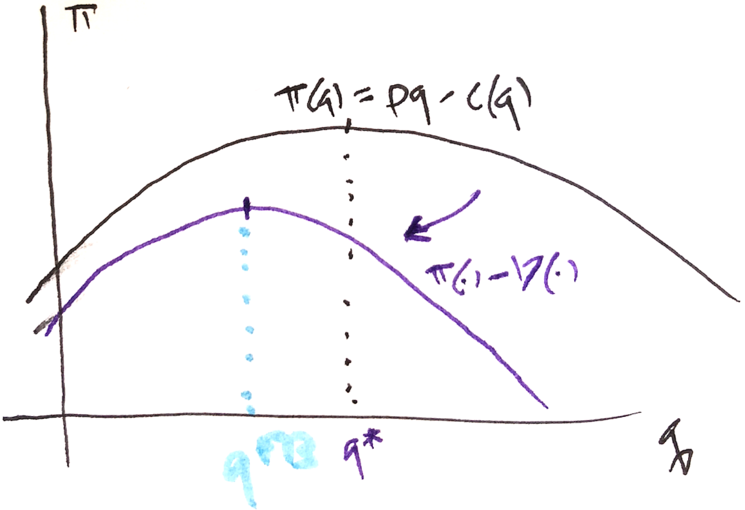
We will typically make the assumption that we care equally about the output of the firm and the wellbeing of the neighbor, so that $W(q)$ is **welfare**.

II. Efficient outcome. Let

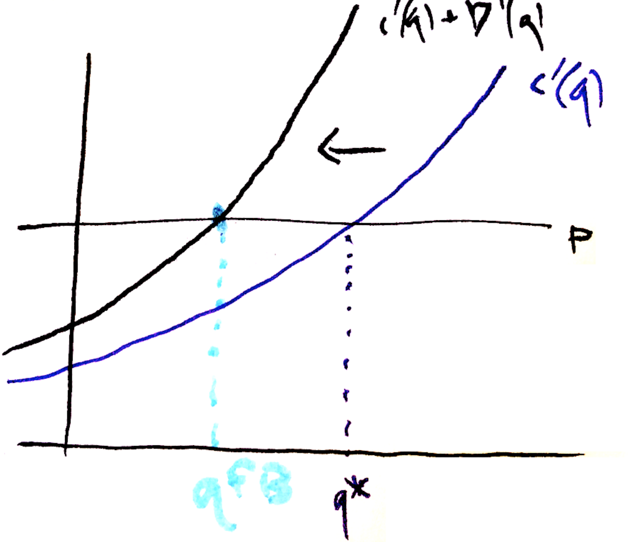
$$q^{\mathsf{FB}} = \arg\max_{q} W(q)$$

be the level of output that maximizes $W(\cdot)$. We sometimes call q^{FB} "first-best."

Efficient allocation



Marginal social cost



Diagnosing market failure

II. Efficient outcome. Let

$$q^{\mathrm{FB}} = \arg\max_q W(q)$$

be the level of output that maximizes $W(\cdot)$. We sometimes call q^{FB} "first-best."

Remark 1. Note that

$$W(q^*) < W(q^{\mathrm{FB}}).$$

In particular, $q^* > q^{\mathrm{FB}}$ (why?).

- i.e., there is overproduction of the good that has the negative externality

This implies the free market outcome is **inefficient**: lowering output from q^* to q^{FB} will help the neighbor more than it will hurt the firm.

Remark 2. Note that

$$\pi(q^*) > \pi(q^{\mathrm{FB}}),$$

because the firm does not internalize the neighbor's wellbeing.

Next time

- We will study policy solutions to the externality problem
- No readings or homework