The social cost of carbon, or: what has climate economics ever done for us?

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This talk only represents my personal views and not necessarily those of any institution. All views are my own.

Nobel for climate economics in 2018...

Why has climate economics failed us?

Economists could have helped in the fight against climate change. So far, they haven't.

Noah Smith
Apr 13 ♡ 66 ○ 94 ⌲

"Wildfire in the Pacific Northwest" by BLM Oregon & Washington, CC BY 2.0

Ezra Klein has an excellent post at the *New York Times* on the politics of Bidenomics. This part really caught my eye:

> Biden has less trust in economists, and so does everyone else...

Part 1: The beginning, or: what is the social cost of carbon

Externality: the key concept in environmental economics

Arthur Cecil Pigou (1920, *The Economics of Welfare*)

- ▶ Key insight: the private costs of an activity differ often differs from its social costs.
- ▶ In these cases, there will too much or too little of an activity compared to the social optimum.

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It is true of resources devoted to the prevention of smoke from factory chimneys:[3] for this smoke in large towns inflicts a heavy uncharged loss on the community, in injury to buildings and vegetables, expenses for washing clothes and cleaning rooms, expenses for the provision of extra artificial light, and in many other ways.[4]
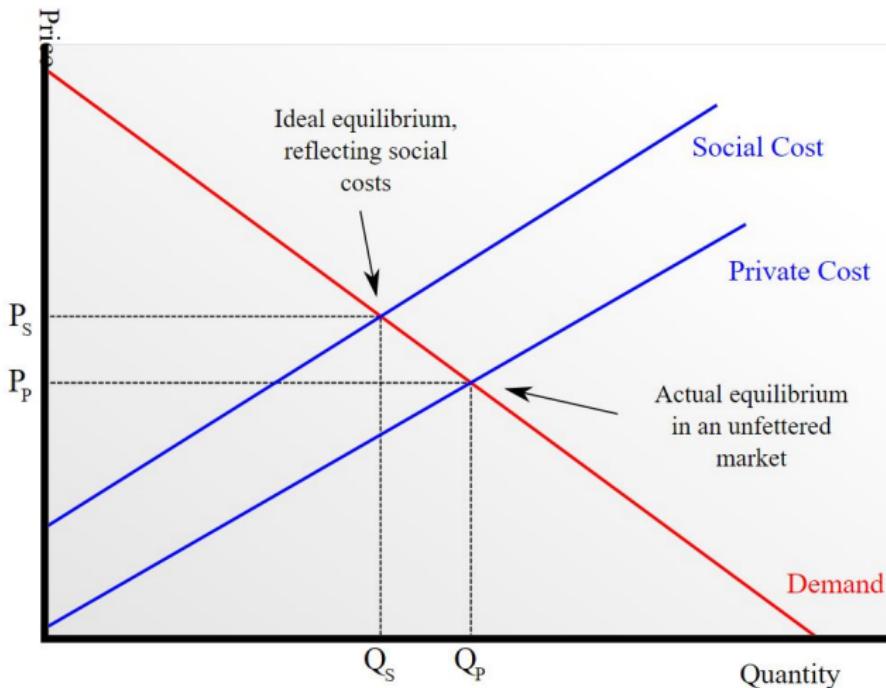
Source: Wikipedia

Externality: the key concept in environmental economics

What does Pigou teach us?

- ► In a market economy, there will inefficiently many GHG emissions unless companies have to pay to emit GHGs.
- ► The price they should pay equals the additional marginal cost for society: the social cost of carbon (SCC).
  - ► SCC = the economic damages from one additional ton of carbon dioxide over its lifespan

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Collateral: if we knew the social cost of carbon, we could derive the optimal amount of emissions (T&Cs apply)

- ▶ "Optimal pollution" can be hard to digest for environmental policy-makers

Part 2: IAMs, or: how to estimate the social cost of carbon

Why is estimation of the social cost of carbon difficult?

Economists use integrated assessment models (IAMs) to estimate the social cost of carbon

First climate economic IAM in 1975 by William Nordhaus

- ▶ Later evolved into DICE, which is one of the three leading IAMs (PAGE and FUND are the other two)
- ▶ Key input for decision makers

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3. Damage channels are hard to estimate empirically →need to extrapolate based on limited past experience

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Typical IAM building blocks
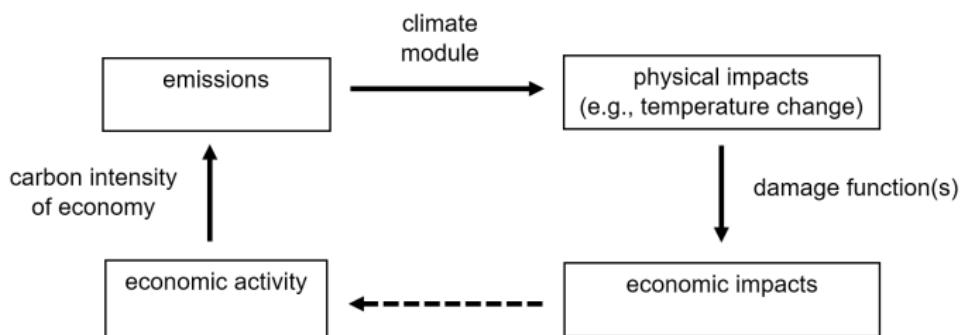
Source: Own elaboration.

GHGs are long-lived →need to consider very long timescales

Economic modelling is difficult

- ▶ Many uncertain economic parameters: population, innovation, cost of mitigation, ...
- ▶ Economic IAM components can perform poorly even in hindsight (Millner and McDermott, 2016)
- ▶ Partly avoid this problem by using scenarios (SSP-RCP)

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Ethical judgements about future generations matter as much as the economic analysis itself

- ▶ IAMs try to find the climate policy target that leads to the largest human welfare (jargon: utility, happiness, ...)
- ▶ Do so by summing current and future welfare. Different weights on future vs. present: the discount factor

$$Welfare = \sum_{t=0}^{T} \frac{1}{(1+\rho)^t} u_t \tag{1}$$

Complex impacts →need to model full climate system

IAMs need reduced-form models for all components of the climate system

- ▶ Carbon cycle, warming models, changes in geophysical outcomes
- ▶ Incorrect geophysical representations can lead to incorrect policy conclusions from climate economists (Dietz, van der Ploeg, Rezai and Venmans, 2021)
- ▶ Missing climate system components such as tipping points can lead to underestimates in the social cost of carbon (Dietz, Rising, Stoerk, and Wagner, 2021)

Damage channels are hard to estimate empirically

Key problem: lack of past experience with rapid climate change

- ► Lack of both data and tools meant early IAMs had to pull damage functions out of a hat
- ► Empirical advances in the last 10 years now help improve damage functions for temperature damages (Hsiang, 2016)...
  - ► ...but it is unclear whether past relationships can be extrapolated into the future
- ► Modelling of sea-level rise damages only partially based on empirical foundations
- ► Damages channels for key impacts such as precipitation changes or ocean acidification still absent from IAMs

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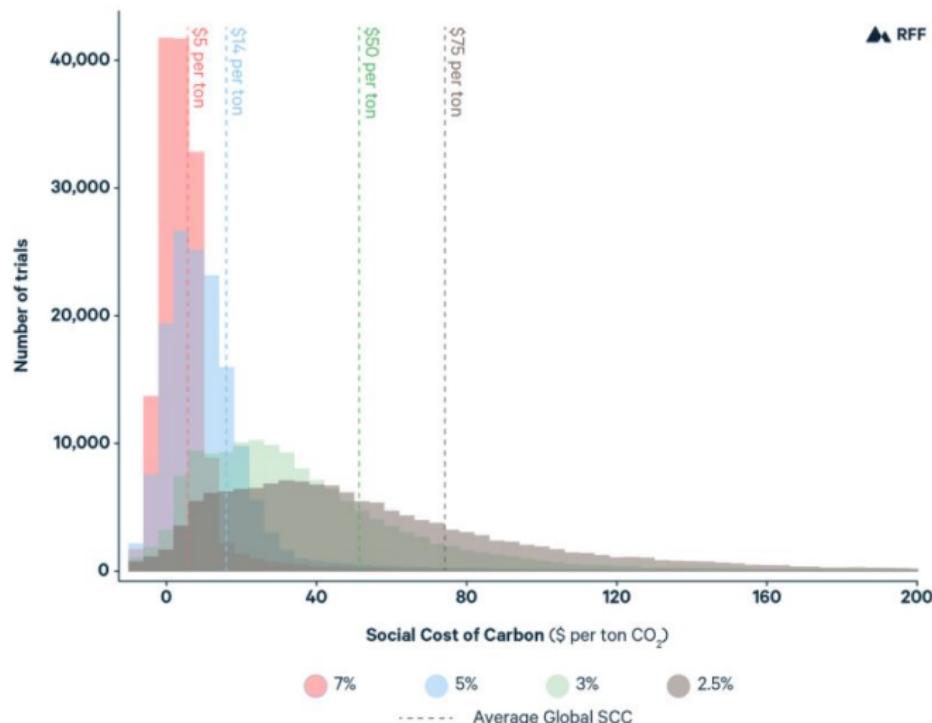
Role of adaptation

- ▶ Adaptation can lower climate damages. Treatment of adaptation is therefore a first-order concern.
- ▶ However: treatment of adaptation in its infancy (for temperature damages) and somewhat simplistic (for sea-level rise damages)
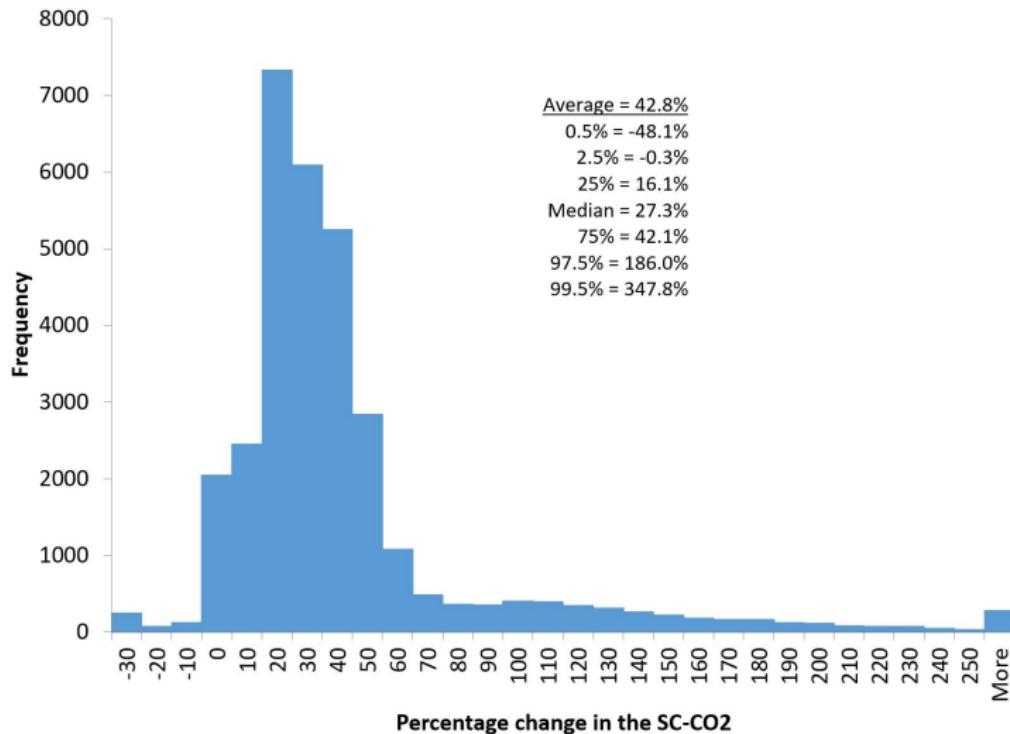
Part 3: Let's look at the numbers

Baseline social cost of carbon estimates (DICE, PAGE, and FUND)

Source: Resources for the Future.

Social cost of carbon estimates span orders of magnitude

Percentage increase due to tipping points

Figure data:
- Average = 42.8%
- 0.5% = -48.1%
- 2.5% = -0.3%
- 25% = 16.1%
- Median 27.3%
- 75% = 42.1%
- 97.5% = 186.0%
- 99.5% = 347.8%

X-axis: Percentage change in the SC-CO2
Y-axis: Frequency

Source: Dietz, Rising, Stoerk, and Wagner (2021).

Part 4: How the social cost of carbon enters policy

How do social cost of carbon numbers get used in practice?

Three main uses

1. Optimal policy, a.k.a. economists wanting to determine ambition
2. Learn about economic impacts of climate change
3. Cost-benefit and cost-effectiveness analysis of investments and policies

Optimal policy

Findings based on DICE (Nordhaus, 2018)

- ▶ Social cost of carbon estimate: 33.6\$/tCO2 in baseline scenario
- ▶ Optimal warming by end of century: 3.5°C

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Cameron Hepburn @camjhep · Oct 8, 2018 · · ·
Would closer engagement with scientists change the conclusion of our new Nobel Laureate that optimal warming is 3.5°C (and rising) in 2100? See nber.org/reporter/2017n.... Perhaps not, but difficult not to juxtapose this with @IPCC_CH report on #GlobalWarming of 1.5°C.

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One key exception to dominant economic paradigm: the Stern Review (Stern, 2007)

- ▶ UK government-sponsored review of climate economics led by Lord Nicholas Stern
- ▶ "The scientific evidence is now overwhelming: climate change presents very serious global risks, and it demands an urgent global response."
- ▶ "The benefits of strong, early action on climate change outweigh the costs"

Optimal policy

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- ► Social cost of carbon estimate: 33.6\$/tCO2 in baseline scenario
- ► Optimal warming by end of century: 3.5°C

Since then: climate economists have shown that Paris Agreement can be seen as optimal

- ► Hänsel et el. (2020): "the benefits of limiting global warming to (well) below 2°C outweigh the costs of doing so"

Concerns

- ► Conclusions sensitive to ethical and arbitrary assumptions
- ► Economic estimates never fully comprehensive (Rising et al., 2022)
- ► Runs counter to the European model of democratically elected politicians choosing ambition based on the science

Learn about economic impacts of climate change

E.g., to study the distribution of climate impacts around the globe
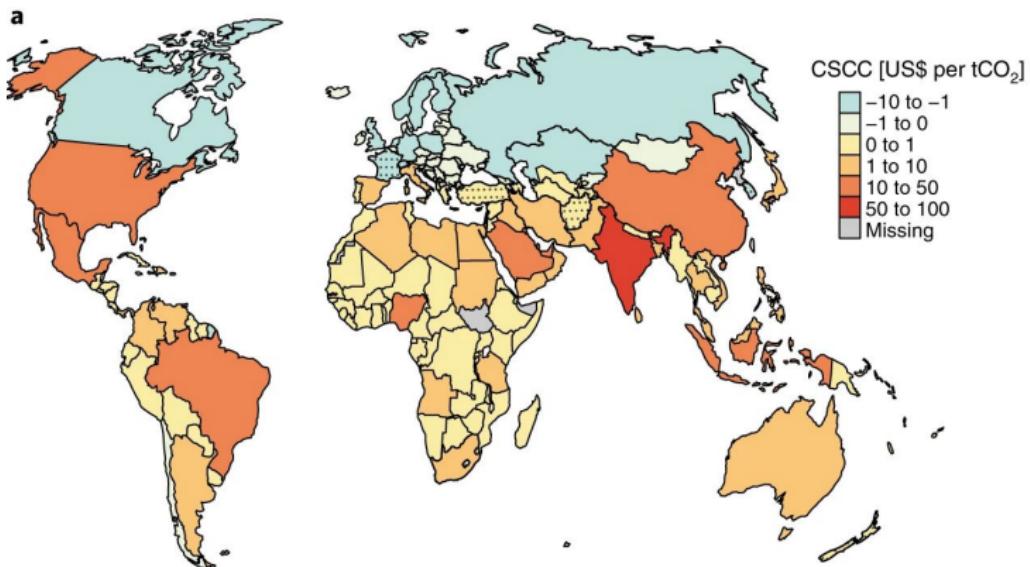
Source: Ricke, Drouet, Caldeira, and Tavoni (2018).

Cost-benefit and cost-effectiveness analysis

US: No federal GHG emissions target

- ▶ Cost-benefit analysis required for any significant policy proposal (since 1936 Flood Control Act)
- ▶ Impacts must be quantified based on best available science. Not using the SCC would value climate benefits at 0\$/tCO2

EU: Net-zero GHG by 2050

- ▶ European Climate Law sets climate neutrality (=net-zero GHG emissions) as 2050 quantity target
- ▶ Mitigation cost of carbon numbers consistent with this emissions reduction target conceptually different from social cost of carbon

Conclusions

Key take-aways

In the past, climate economists used the social cost of carbon to argue against serious climate policy ambition based on questionable premises.

Current use of the social cost of carbon in climate economics is mainly to measure climate impacts.

Policy-making only requires social cost of carbon numbers in the absence of a quantity target on GHG emissions (e.g., US). With a binding emissions target, mitigation cost of carbon numbers become relevant.

"Sorry, Harold, but I'm reducing our carbon footprint."

Bonus slides: redeeming climate economists

Design of climate policy instruments

- ▶ International collaboration
- ▶ Carbon pricing
- ▶ Cost-effective distribution of effort
- ▶ Cost-effective adaptation
- ▶ Support for innovation
- ▶ Prevention of leakage

Ex-post evaluation of the effects of climate policy

- ▶ Huge literature on the effects of the EU ETS on carbon leakage, innovation, emissions, firm competitiveness, etc.

Bonus slides: international collaboration

Nordhaus (2015, AER): From ASSA presidential address…

Climate Clubs: Overcoming Free-riding in International Climate Policy[†]

By WILLIAM NORDHAUS*

Notwithstanding great progress in scientific and economic understanding of climate change, it has proven difficult to forge international agreements because of free-riding, as seen in the defunct Kyoto Protocol. This study examines the club as a model for international climate policy. Based on economic theory and empirical modeling, it finds that without sanctions against non-participants there are no stable coalitions other than those with minimal abatement. By contrast, a regime with small trade penalties on non-participants, a Climate Club, can induce a large stable coalition with high levels of abatement. (JEL Q54, Q58, K32, K33)

Nordhaus (2015, AER): From ASSA presidential address...to 2022 EU agreement

● Council of the EU   Press release   15 March 2022   16:45

Council agrees on the Carbon Border Adjustment Mechanism (CBAM)

Today, the Council reached agreement (general approach) on the Carbon Border Adjustment Mechanism (CBAM) regulation, which is one of the key elements of the European Union's 'Fit for 55' package.

The main objective of this environmental measure is to **avoid carbon leakage**. It will also **encourage partner countries to establish carbon pricing policies to fight climate change**.

Two other issues will continue to be followed:

- the proposals by the Commission for **own resources**, based, inter alia, on revenues from the sale of CBAM certificates, which are under consideration for deliberation by 1 July 2022, in accordance with the inter-institutional agreement of 16 December 2020;
- the Council noted the importance of **greater international cooperation** with third countries, including through the establishment, in parallel to the CBAM, of a **climate club** where carbon pricing policies can be discussed and encouraged.

Dechezleprêtre, Gennaioli, Martin, Muûls and Stoerk (2022, JEEM)

- ▶ Does unilateral carbon pricing cause companies to shift the location of production, thereby creating carbon leakage?
  - ▶ Carbon leakage: reallocation of GHG-emitting economic activity from regulated to unregulated jurisdictions
- ▶ Most evidence is from ex ante modelling studies
- ▶ Use firm-location-year observations of GHG emissions within multinationals to track possible carbon leakage
- ▶ Descriptive paper: useful to reverse burden or proof in policy debates

Thank you!

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Further reading

Carbonbrief explainer

- https://www.rff.org/publications/explainers/social-cost-carbon-101/
- In particular, the section entitled "How else can we price CO_2 emissions?"

Resources for the Future explainer (US focus)

- https://www.rff.org/publications/explainers/social-cost-carbon-101/

Wider background on Pigouvian taxation

- https://en.wikipedia.org/wiki/Pigovian_tax

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