# Why is the Economics of Climate Change so Difficult and Controversial?

Martin L. Weitzman, Max Weber Lecture.

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*A Black Swan is a highly improbable event with three principal characteristics: it is unpredictable; it carries a massive impact; and, after the fact, we concoct an explanation that makes it appear less random, and more predictable than it was* – Nassim Taleb

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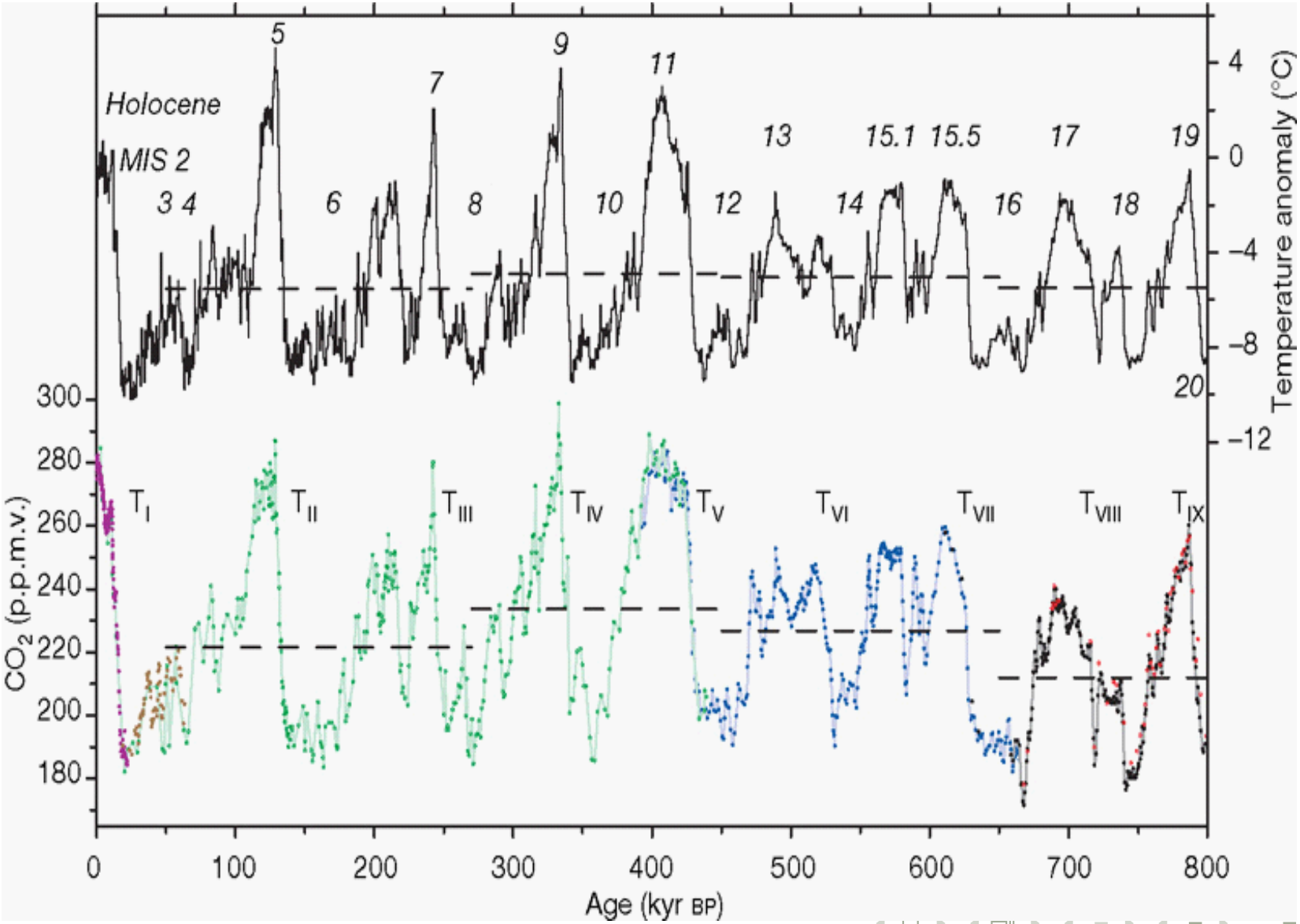
*The climate system is an angry beast and we are poking it with sticks* – Wally Broecker

# 800-K-Year Antarctic Ice Record of CO2 and Temps



# Preliminary Probing and Basic Issues

- Go over 800K-yr Antarctic Ice Core Record. Quality of data. Meaning. Causality. Uncertainty. Currently at 400 ppm of $CO_2$ (like 3 mya), [and 450 ppm of $CO_2e$], growing at 2ppm per year.
- Based on IPCC AR5 description of climate sensitivity probabilities:

| ppm $CO_2e$ | **450** | **500** | **550** | **600** | **650** | **700** | **750** | **800** |
|---|---|---|---|---|---|---|---|---|
| Median $\Delta T$ | 1.8° | 2.2° | 2.5° | 2.7° | 3.2° | 3.4° | 3.7° | 3.9° |
| Pr[$\Delta T \geq 6°C$] | .3% | 1.2% | 3% | 5% | 8% | 11% | 14% | 17% |

- Caveats about what this table means.
- Climate change has deep structural uncertainties and an inability to exclude catastrophes. Potentially unlimited downside liability.
- Climate change as "mother of all externalities." Carbon-free solution seems expensive. GHG mitigation is a big international public good without international governance. A serious free riding problem.
- Climate change appears to public as relatively remote distant-future problem. Not felt at grassroots level.

# Climate Change Economics: Difficult and Controversial

- Why is analysis of what to do about climate change an economist's nightmare? Why is it more problematic than other applications?
- Some attempts at partial answers about what makes economics of climate change "special" and "specially difficult" follow below.
- **Time.** Immense time scales of centuries and millenia. Difficult for people to conceptualize. Tendency to put off action until emergency. Are climate change catastrophes "endogenous"?
- **Discounting.** How should distant-future events be discounted? At what rate? What difference does it make?
- **Uncertainty.** Huge structural uncertainties everywhere. Ambiguous fuzzy probabilities. Difference between frequentist and subjective probabilities. Why does this make everything more difficult?
- **Global Public Good.** Biggest ever. Free rider problem. International agreement? Verification? Enforcement? Penalties?

# Climate Change Economics: Difficult and Controversial

- **What are costs**? How to project or predict? Acute problem here of predicting technological change when go outside familiar range of known isoquants.
- **What are damages**? How to estimate? Functional form? How to include nature, biodiversity? What are high-temperature damages? Can we do better than mere extrapolation?
- **What is welfare**? Do we trust modified Pareto criterion? How to combine different effects on different regions and countries?
- **Irreversibilities**. Strong irreversible elements including $CO_2$ atmospheric concentrations, ocean heat, etc. Once underway, climate change very difficult to reverse by subsequent mitigation. Tremendous inertia of long-lived atmospheric $CO_2$ stock. Not sufficient to stabilize emissions flow – must cut back to near zero. Bathtub stock-flow analogy. Can we learn enough about impending catastrophes in time to act? Are catastrophes endogenous?

# Catastrophic Climate Change

- Potentially unlimited liability. Great uncertainty. Tipping points. Black Swans. How to analyze (EU theory?)? What to do?
- Let $X$ be climate-change "damages" with probability $P(X)$. *How fast* does $P(X) \longrightarrow 0$ as $X \longrightarrow \infty$?
- Distinction between thin-tailed distributions like normal (exponential decline) and fat-tailed distributions like Pareto (polynomial decline).
- Seeming sensitivity to fatness of bad tails, especially for CRRA utility.
- Should we do more research about fatness of extreme tails of PDFs relative to more research about central tendencies? Is this "science"?
- Beware of fighting fat-tailed problems with fat-tailed solutions.
- Should we hope for the best but prepare for the worst by contingency planning for bad outcomes? Is there a possibly important niche role for last-resort options like geoengineering?

# The Spectre of Geoengineering

- What is geoengineering? What is solar radiation management? Here simplistically equate the two.
- Mount Pinatubo eruption of 1991 as prototype "natural experiment." What about *artificial* experiment of seeding the stratosphere with $SO_2$ (or other reflective particles)?
- The incredible economics of geoengineering. The downsides of geoengineering. The need for more research.
- Does geoengineering have a constructive role in a balanced portfolio of climate-change-response options?
- What happens in future if a country feeling imminent threat of a climate change catastrophe unilaterally undertakes geoengineering?
- Contrast "free driver" problem of geoengineering with "free rider" problem of GHG mitigation. These two "mother-father" externalities have diametrically opposite properties.
- Climate change on the horns of a *double externality* dilemma.

# What is to be done?

- Put a price on carbon. If only the rest of the world agreed with us economists...
- How can/should it be done. Pigouvian tax vs. tradeable permits.
- Is carbon price enough? (With right price, usually content to let market take care of innovation. Is $CO_2$ "different"?)
- What to do in a world without a price on carbon?
- Do standards help?
- Does "Pledge and Review" much help? Should we build in incentives to coordinate price of carbon? How?