

# The Social Cost of Carbon – An Overview

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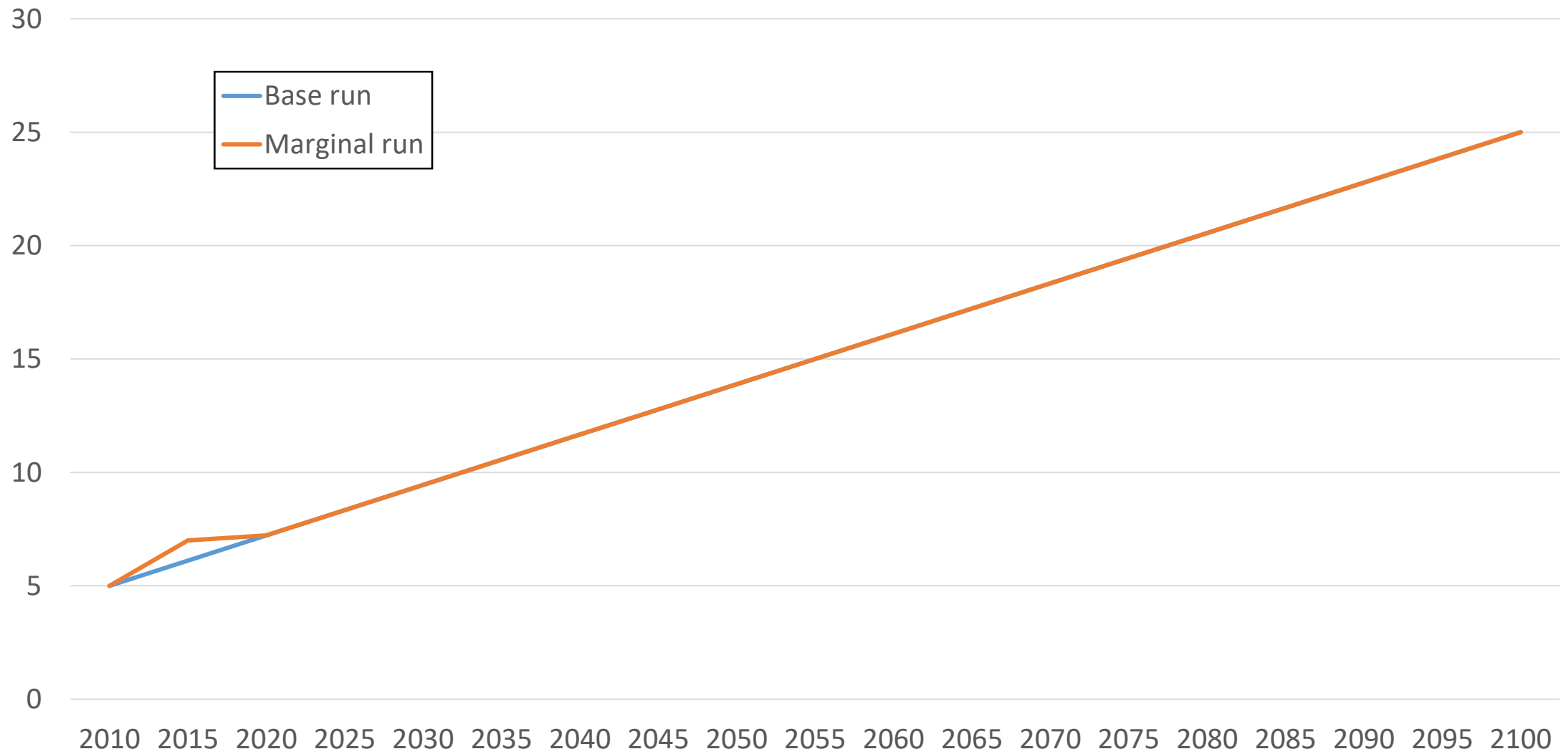
# Outline

- **What is the SCC?**
- How is it used?
- Current research efforts
- Some important issues in policy use

# Definition

An economic measure of the harm caused by emitting one extra ton of CO<sub>2</sub>.

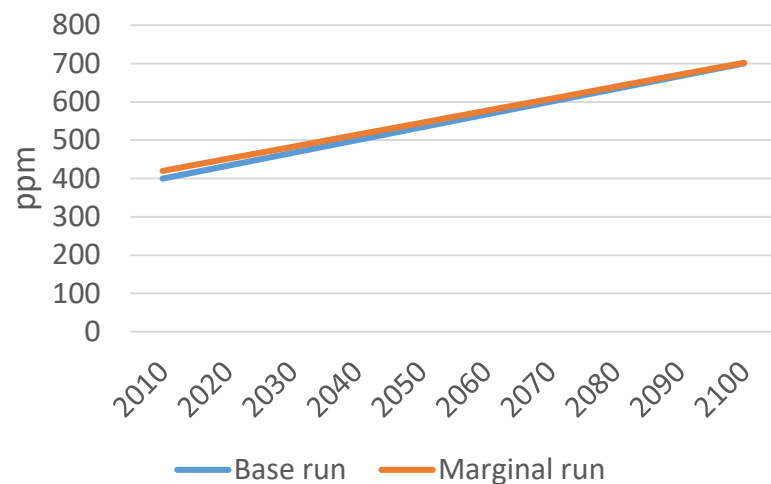
## CO2 emissions



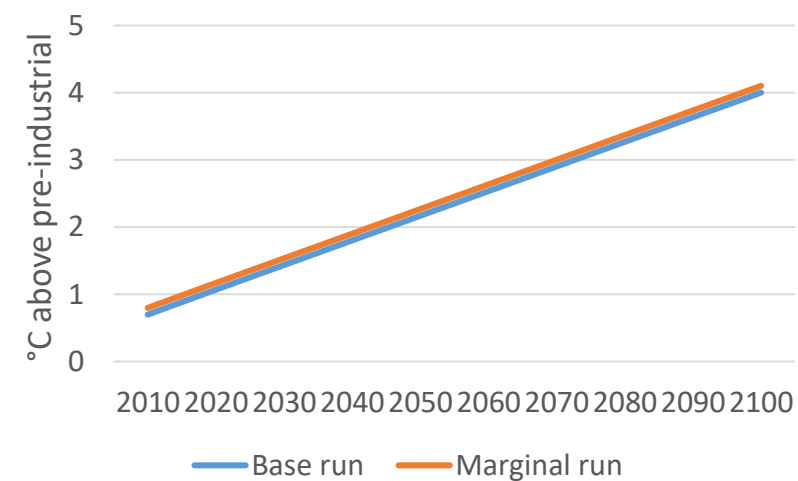
CO2 emissions



CO2 concentrations



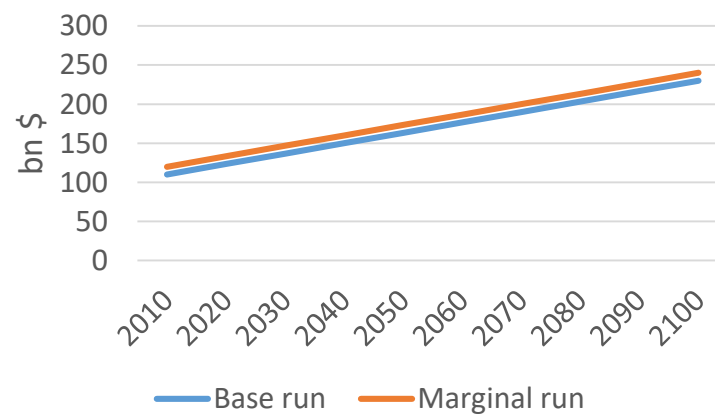
Temperature



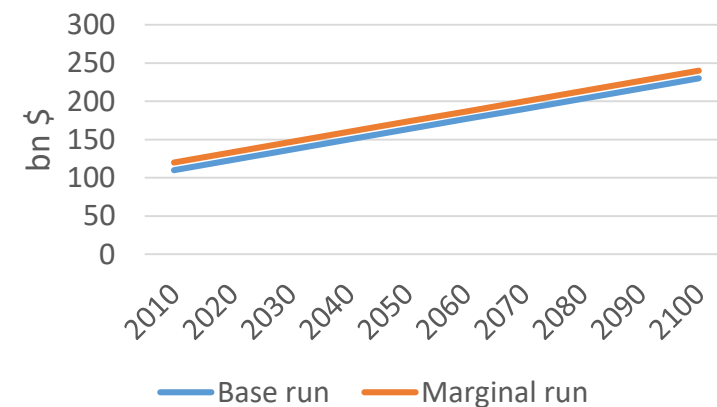
Climate damage US



Climate damage Europe

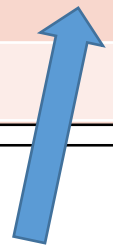
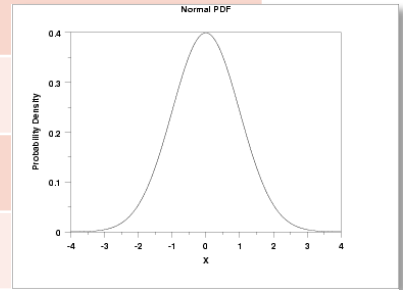


Climate damage China

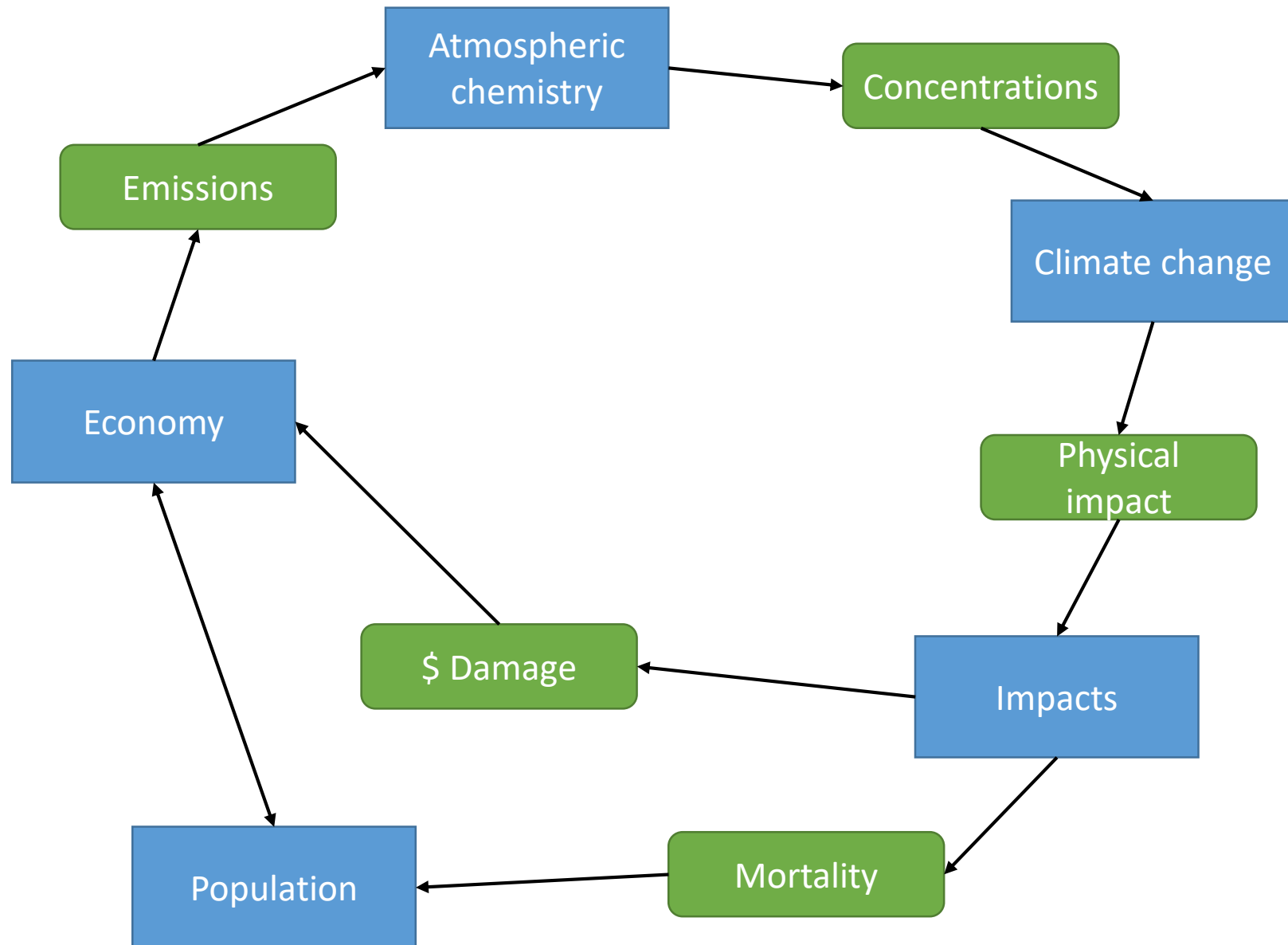


# Marginal damage

	USA	Europe	China	...
2010	\$0.20	\$0.03	\$0.12	...
2011	\$0.20	\$0.04	\$0.12	...
2012	\$0.30	\$0.05	\$0.13	...
2013	\$0.40	\$0.05	\$0.14	...
2014	\$0.50	\$0.06	\$0.15	...
2015	\$0.60	\$0.07	\$0.16	...
2016	<div data-bbox="611 928 2497 1370" data-label="Equation-Block"> <math display="block">SCC = \sum_t \sum_r w_{tr} \times MD_{tr}</math> </div>			
2017				
....				



# Integrated assessment models





# Sources of published SCC estimates

- DICE/RICE



- PAGE



- FUND



Bill Nordhaus

Chris Hope

Richard Tol & me

Surveys, “meta-studies”

Parametric variations

Simplified versions

# Outline

- What is the SCC?
- **How is it used?**
- Current research efforts
- Some important issues in policy use

# Academic use

- Estimates have been published since the mid-1990s
- A Nobel Prize has been won for this kind of work (Nordhaus)
- A large variety of different papers
  - New SCC estimates
  - Investigations into discounting, equity or risk preferences
  - Used as an input into policy evaluations
  - IAMs used to find optimal policies (or robust policies, or strategies)

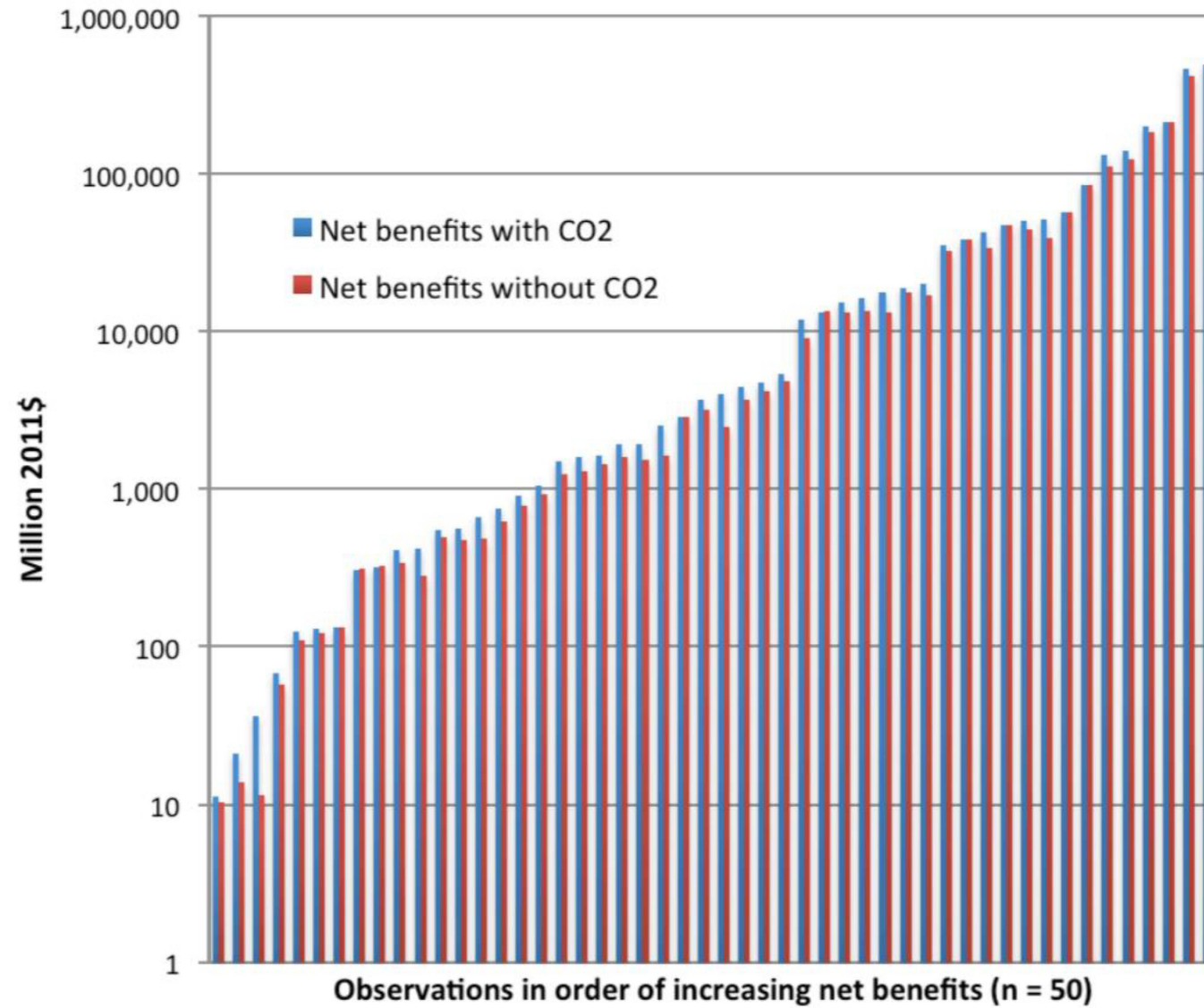
# Policy use

- United Kingdom: 2000s
  - CBA of individual projects/regulations
  - Later ex-post analysis of major national climate policy
- United States: 2010-present
  - Regulatory impact analysis
- German: 2007 (?) – present

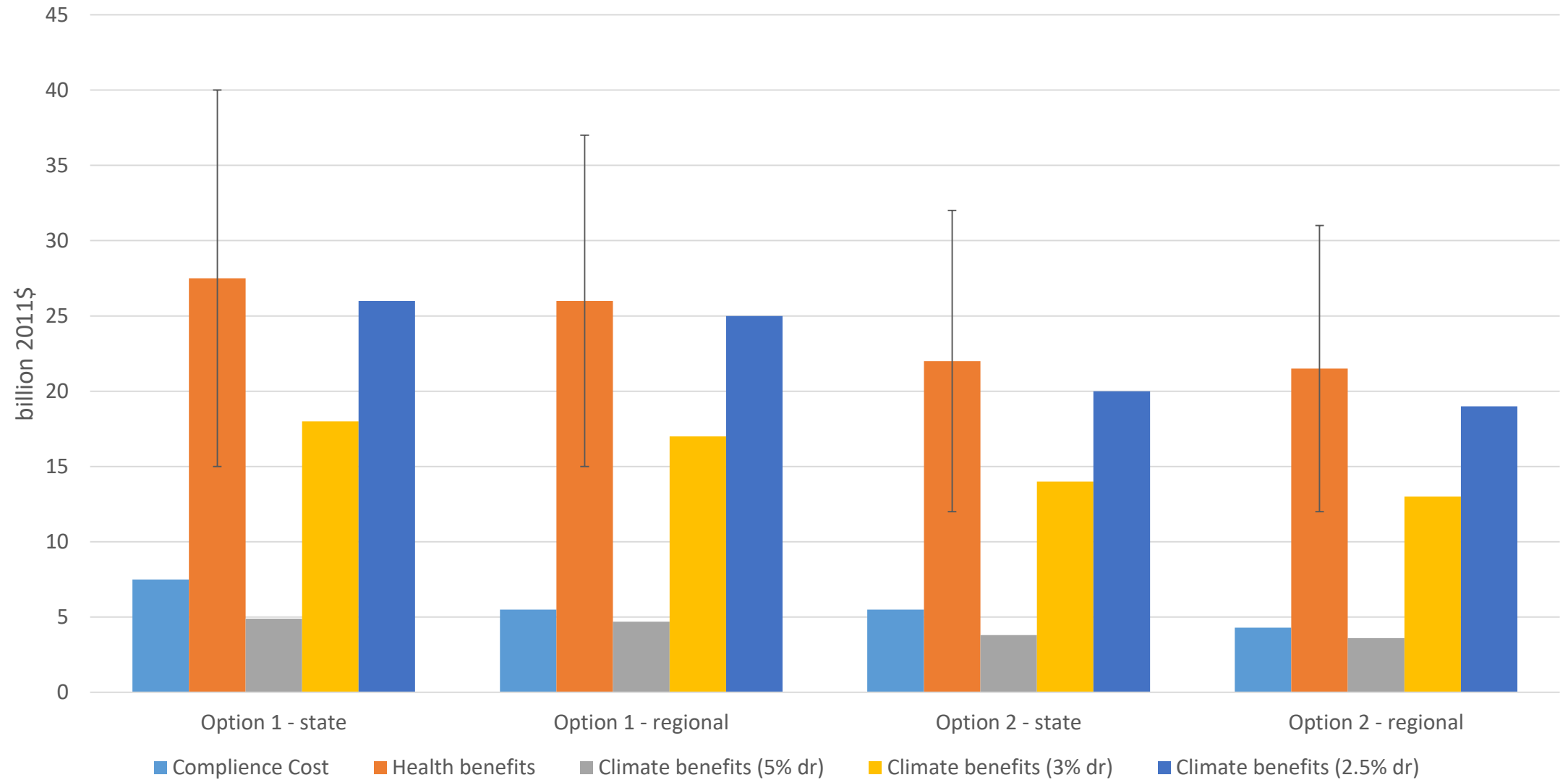
# A short history of the SCC in the US – Part 1

- Everything happening within existing regulatory framework (Clean Air Act, 2007 Supreme Court pollutant ruling, 2009 endangerment finding, EO 12866)
- Obama administration convenes Interagency Working Group on the SCC → 2010 official SCC estimate
  - Three IAMs: DICE, PAGE and FUND
  - Five standardized socio-economic and emissions scenarios
  - Standardized climate sensitivity
  - 2.5%, 3% and 5% discount rate
- 2013 update (uses newer model versions)
- ~2015 White House commissions NAS report

**Figure 2: Net benefits with and without valuing CO<sub>2</sub>**



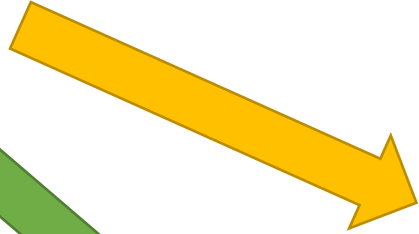
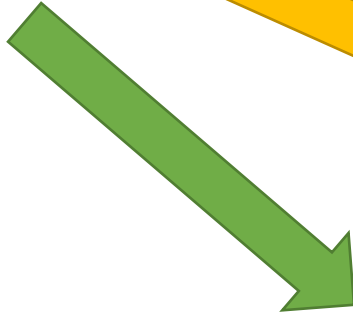
## Proposed rule for existing power plants - benefits and cost in 2020



Federal  
SCC



Various court cases.



International:  
• Canada  
• ...

States:

- Minnesota
- Colorado
- Maine
- Nevada
- Illinois
- New York
- California

Used in dozens of federal regulatory impact assessments (including Clean Power Plan rule)

CLIMATE  
LEADERSHIP  
COUNCIL

## THE CONSERVATIVE CASE FOR CARBON DIVIDENDS

How a new climate strategy can strengthen our economy, reduce regulation, help working-class Americans, shrink government & promote national security

James A. Baker, III

Martin Feldstein

Ted Halstead

N. Gregory Mankiw

Henry M. Paulson, Jr.

George P. Shultz

Thomas Stephenson

Rob Walton



# A short history of the SCC in the US – Part 2

- Trump issues EO that rescinds IAW SCC estimates during first months in office
- “Regulatory Impact Analysis for the Review of the Clean Power Plan: Proposal”
- Still uses the Social Cost of Carbon concept
- Two key changes:
  - Discount rate (3% and 7% replace 2.5%, 3% and 5%)
  - Domestic SCC
- New SCC estimates: \$6/tCO<sub>2</sub> and \$1/tCO<sub>2</sub>
- Nothing else as changed on the SCC side

# Outline

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- **Current research efforts**
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# Two large scale efforts underway

- Climate Impact Lab (Houser, Greenstone, Hsiang, Kopp et al.)
  - Develop new damage estimates of climate impacts using modern econometrics
- RFF Social Cost of Carbon Initiative (network of partners, RFF, UC Berkeley, Harvard, Princeton, U Washington, PennState and others)
  - Implement the National Academies recommendations

# RFF SCC Initiative I

- Provide a modular computational platform for integrated assessment models (Mimi.jl)
- Develop probabilistic projections for relevant socio-economic variables, like GDP, population, emissions intensity
  - Statistical approach spearheaded by Stock, Muller and Watson
  - Expert elicitation spearheaded by Cooke
- Create state-of-the-art natural science components (Berkeley, Penn State and Oxford collaboration)
- Integrate existing damage estimates from the literature (and hopefully Impact Lab results once they are out)
- Develop a discounting module compatible with the NAS recommendations (Pizer, Newell & Prest)

# RFF SCC Initiative II

- We see our initiative very much as providing a platform for collaboration
- We want other groups to create modules on the Mimi.jl platform
- We can provide support and help to other groups
- We want to provide results and tools for policy makers

# Mimi.jl

- Modular platform for integrated assessment models
- Some goals:
  - Open source and free
  - Fast
  - Easy to use
  - Decentralized workflow
  - Transparency in research
- Some non-goals:
  - We don't aim to be the best platform for every type of IAM

# Existing models on Mimi.jl

- MimiFUND.jl
- MimiDICE2010.jl
- MimiDICE2013.jl
- MimiRICE2010.jl
- MimiPAGE2009.jl
- Mimi-SNEASY.jl
- Mimi-FAIR.jl
- Mimi-MAGICC.jl (CH4 parts)
- Mimi-HECTOR.jl (CH4 parts)
- Mimi-CIAM.jl
- Mimi-BRICK.jl
- AWASH
- PAGE-ICE
- Local air pollution
- NICE
- NICER

# Groups using/collaborating

- UC Berkeley (my lab)
- RFF
- Penn State (Klaus Keller's lab)
- Princeton University (Marc Fleurbaey and Rob Socolow's group)
- RFF Europe (formerly known as FEEM) (planned)
- A proposal out of Duke (planned)
- LSE (James Rising)
- RAND Corporation



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# Equity

## **Count US damages “Domestic SCC”**

Only the harm experienced within US borders is accounted for.

Trump administration

## **Count world damages “Global SCC”**

Harm anywhere in the world is accounted for. A dollar loss in the US receives the same weight as a dollar loss in the poorest region in the world.

Obama administration

## **Count equity adjusted world damages “Equity weighted SCC”**

Harm anywhere in the world is accounted for. A dollar loss to someone poor is weighted more than a dollar loss to someone richer.

UK (but incorrectly), Germany

# Robustness

- Deep (structural) uncertainty is pervasive and (in my opinion) won't go away
  - If someone tells you anything else, I would get VERY suspicious
- There will be multiple damage functions, multiple scenarios, multiple models, and there won't be agreement which of these is the “correct” one
- Being transparent about these uncertainties is really important → use multiple models, show differences, show how policies fare under different ones

# SCC in a world of existing climate targets

- In purist world, you use the SCC (or IAMs) to find an optimal target
- We don't live in a purist world, and to my knowledge economic climate analysis has never been used in that way in real world policy design
- Even if you have a political or scientific target, you can use the SCC to quantify the benefits of individual policies
- (and you can use marginal abatement cost estimates to check whether you are implementing cost-effective policies)

# Funding

- The SCC is one of the most important numbers to estimate in climate policy
- As far as I know, none of the primary policy users has ever provided any research funding for SCC work
  - Right now foundations like the Sloan Foundation are stepping in
- These are early days for the SCC and we need a massive research effort to improve it

# Conclusion

- SCC is now deeply embedded in the policy fabric in the US and other countries
- While there are two major efforts underway to improve the SCC, the research field is tiny compared to the natural science side of things → does not reflect the importance of this work

# Thank you!

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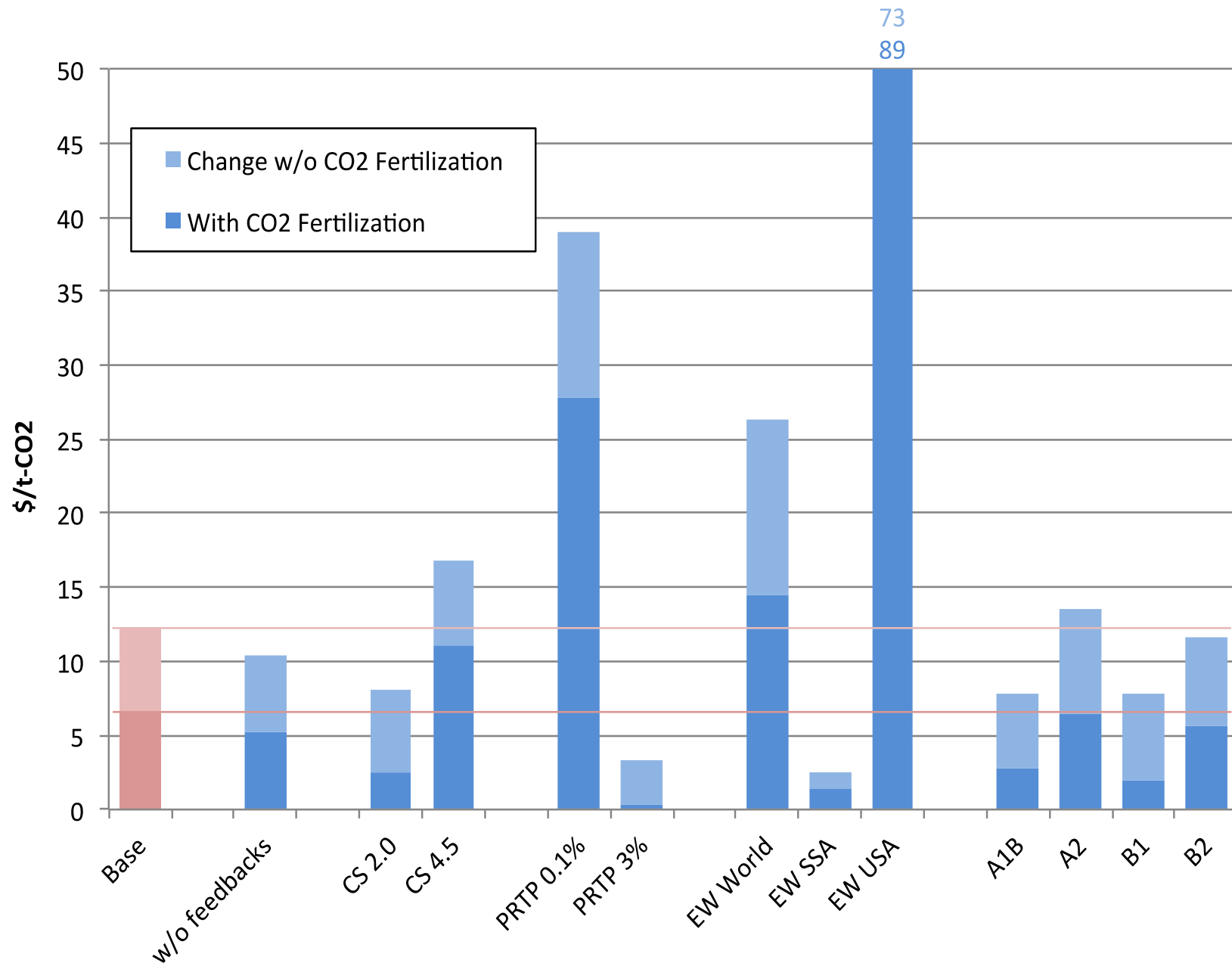
# Model choice & discount rate

& some other sensitivities



Table 3. Estimates of the Social Cost of Carbon for 2010 from US Interagency Working Group and Comparison with Alternative Model Estimates

Model and Scenario	Constant Discount Rate on Goods				
	5%	4.2%*	4%*	3%	2.5%
B. Estimates of 2015 SCC from US Working Group, 2013:					
DICE-2010	11.0			31.4	48.1
PAGE	20.2			58.6	85.3
FUND	2.7			17.3	30.4
Average	11.3			35.8	54.6



# Discounting

# Discounting & aggregation

- Opportunity cost approach: we don't want to waste resources, but try to stay out of distributional judgements (some variant of Kaldor Hicks)
- Social Welfare approach: we take an ethical stance, encoded as a particular Social Welfare Function

# Opportunity cost approach

- We should use the rate of return of other investments as our discount rate (what else could we have done?)
- 1) So we need a forecast of interest rates
- 2) And we need to figure out which interest rate is the relevant one
- For 1), we could in principle use many different methods, but in the IAM literature with a neo classical growth core, the interest rate is determined endogenously (using the Ramsey rule). Note that the Ramsey rule might appear normative, but it is NOT in this approach
- Question 2) has received a lot less attention, but there is a small literature on the climate beta

# Social Welfare approach

- You start with a Social Welfare Function, and derive your weights/discount factors from that
- A particular case of SWF that exhibits aversion to inequality between individuals runs under the term “equity weighting” in the climate literature
- Core idea is that of declining marginal welfare of consumption

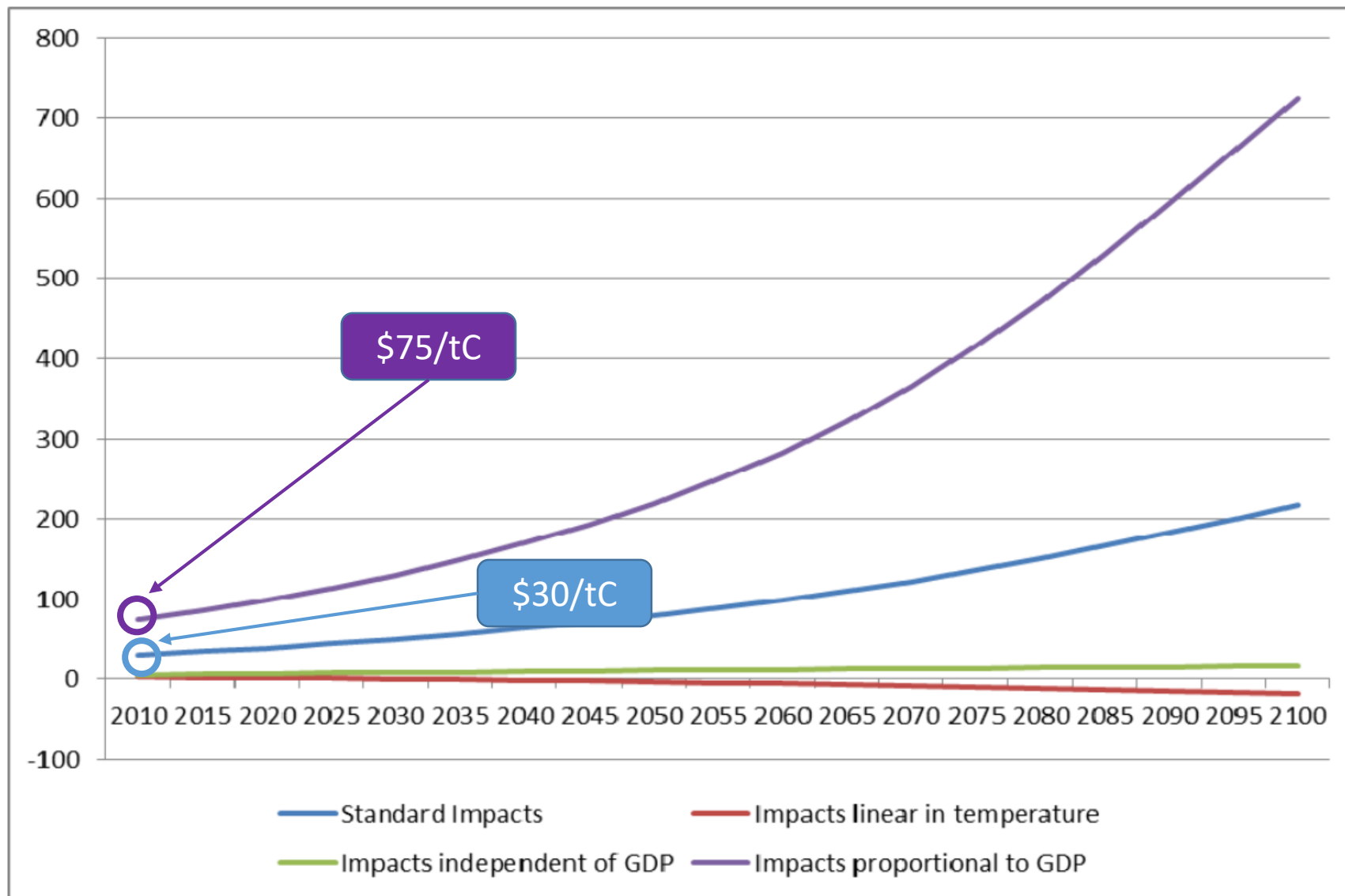
# Damage function

$$f(T) = \alpha T^2$$

$$D_{tr} = Y_{tr} \times f(T_{tr})$$

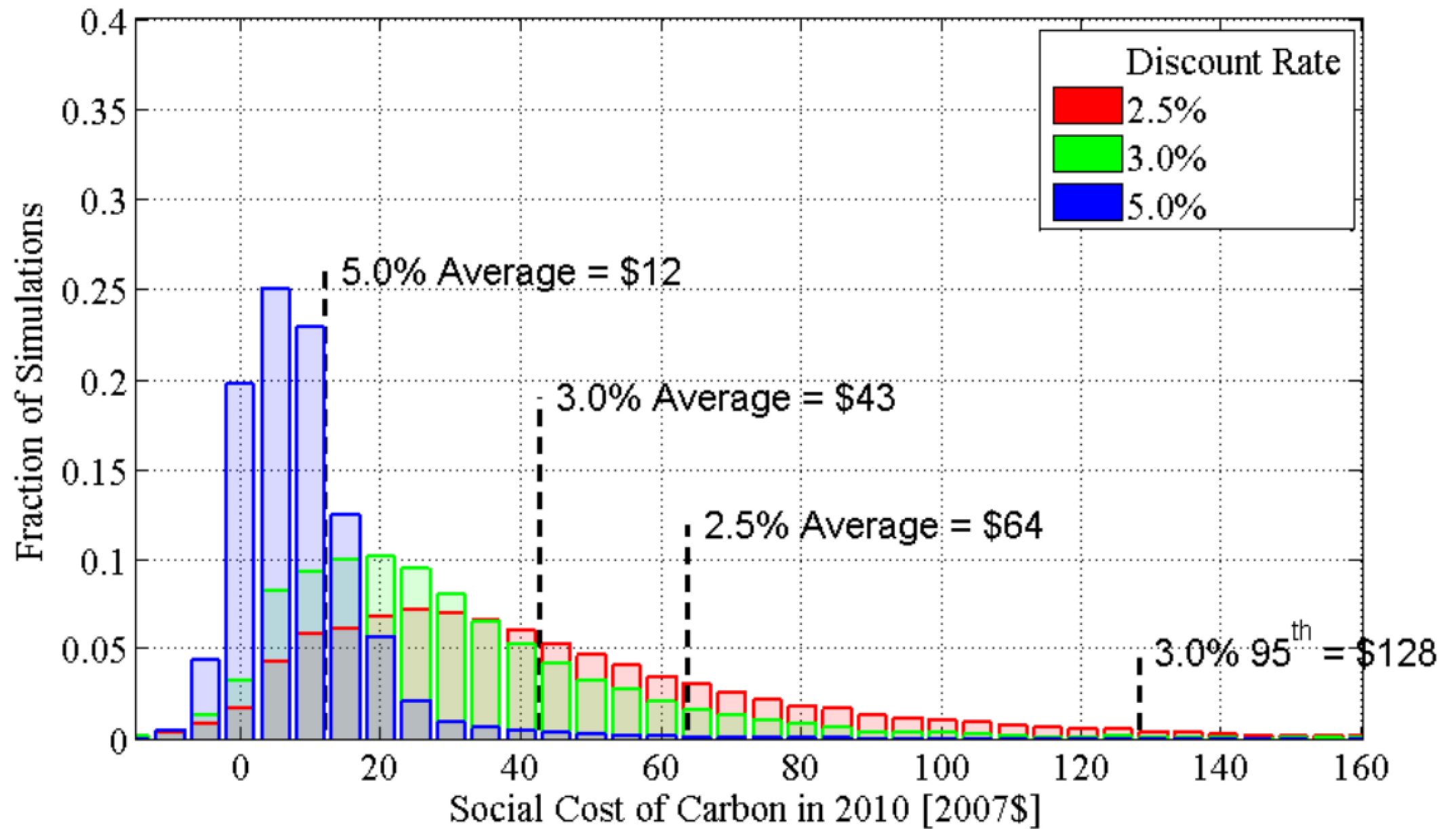
$$D_{tr} = \left( \frac{Y_{tr}}{Y_0} \right)^\epsilon \times Y_0 \times f(T_{tr})$$

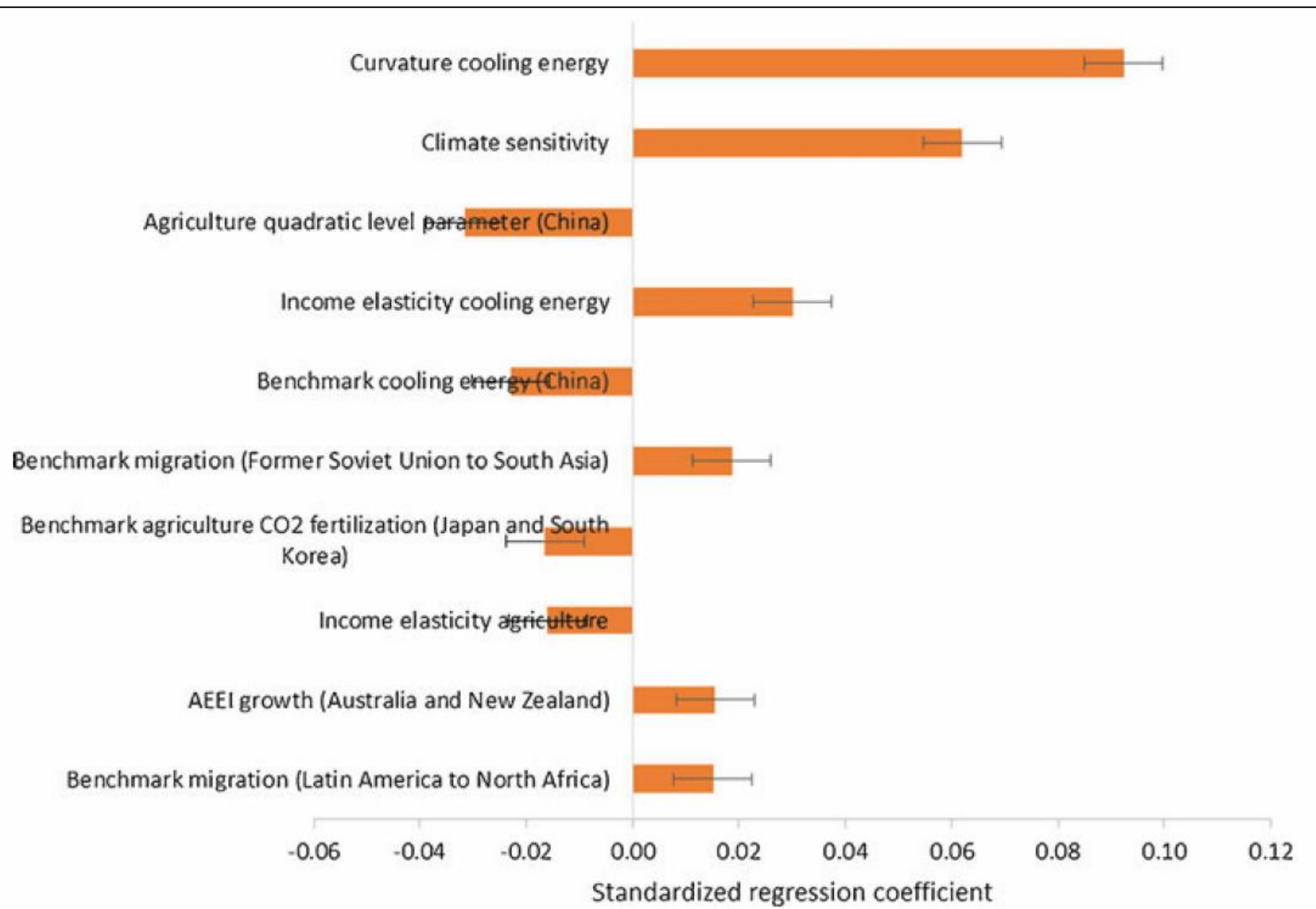




**Figure 6. The social cost of carbon as a function of the time of emission with the standard model, with impact functions linear in temperature, and with impacts independent and proportional to GDP.**

# Uncertainty





**Fig. 2** The ten most important parameters that determine the social cost of carbon and their standardised regression coefficient for a 1 % pure rate of time preference and a 1.5 rate of risk aversion. 90 % confidence intervals as error bars