Components of the Social Cost of Carbon Under Uncertainty

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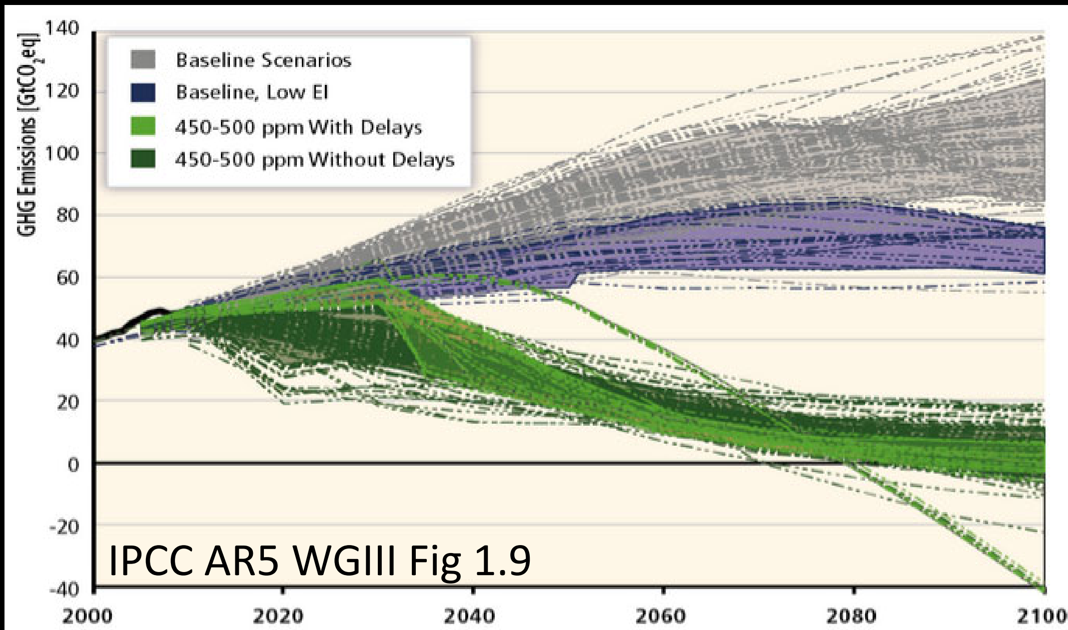
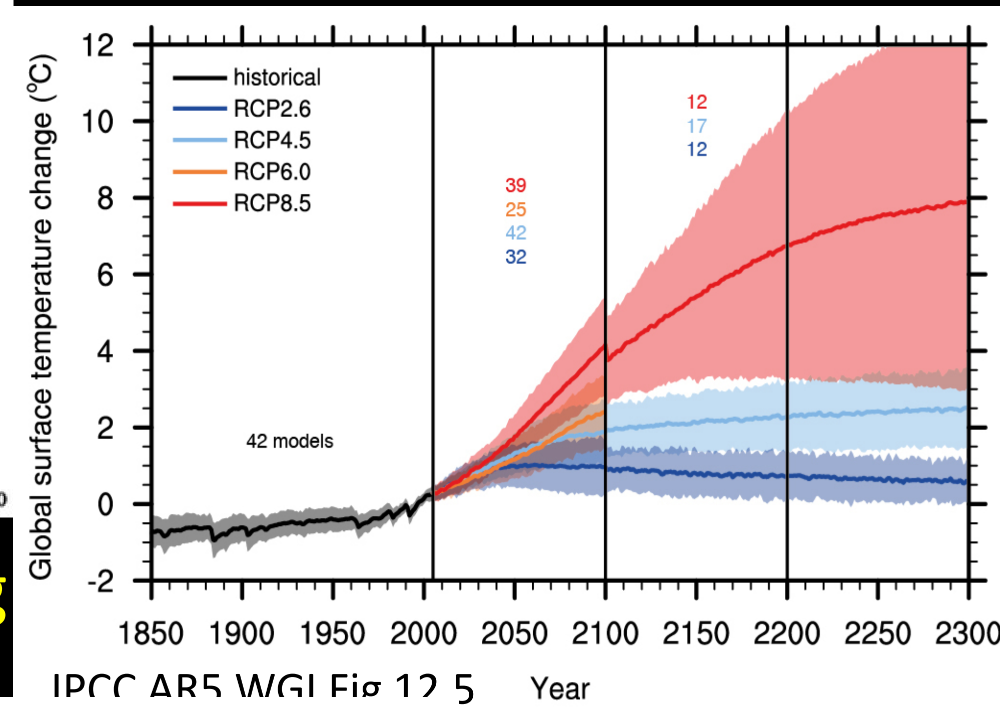
Climate change is rife with uncertainty, including about



Emissions



Warming

> The bottom line here is that the damage functions used in most IAMs are completely made up, with no theoretical or empir[ical] foundation.

Pindyck (2013)

Damages

Technology and Consumption

Yet integrated assessment models have struggled to incorporate uncertainty.

Conventional integrated assessment models (IAMs) are deterministic.

Monte Carlo analyses of a deterministic model can tell you about the spread of outcomes but may not tell you how policy choices should account for uncertainty.

Recursive IAMs are computationally demanding and can be black boxes (but can fully account for learning).

Today:

- How does uncertainty matter?
- How can we calculate that effect?

Uncertainty affects the social cost of carbon through several channels (following Lemoine 2021, JAERE):

1) Precautionary savings channel

2) Insurance channel

   2a) Damage scaling channel

   2b) Growth insurance channel

(1) Precautionary savings channel increases the social cost of carbon.

Uncertainty about future consumption increases desire to save today so that are moving consumption from the safer to the riskier period (assuming "prudent" agents).

Reducing emissions is a form of saving for the future.

Climatic and economic uncertainties make future consumption (or its equivalent) uncertain.

So climatic and economic uncertainties increase desired emission reductions and increase the social cost of carbon.

Discount rate interpretation:
Climatic and economic uncertainties reduce the risk-free discount rate to be applied to any future payoff.

(2) Insurance channel has ambiguous effects on the social cost of carbon.

Increases value of emission reductions (i.e., social cost of carbon) if and only if reducing emissions hedges future uncertainties.

->Will today's emission reductions benefit the future more in cases in which the future turns out to be relatively poor or relatively rich?

Relatively poor: Good hedge! Increases scc

Relatively rich: Bad hedge! Decreases scc

Discount rate interpretation:

Risk-adjusted discount rate for climate damages is below risk-free rate if and only if emission reductions a good hedge (i.e., "climate beta" is negative).

(2) Conflicting elements of insurance channel:

(2a) Damage scaling channel reduces social cost of carbon:

If warming reduces consumption multiplicatively, then losses greatest when already rich

->Emission reductions a bad hedge

(2b) Growth insurance channel increases social cost of carbon:

Additional emission reductions increase the growth rate of consumption by more when relatively poor

e.g., Are poor because climate change was bad
e.g., Atmospheric CO_2 is low because are poor

->Emission reductions a good hedge
(under conventional preference specifications)

What matters is the net effect

In my JAERE paper, I cannot sign the insurance channel (i.e., climate beta) in general:

Unclear sign of (2a)+(2b)

But I do show that the precautionary savings channel dominates the negative damage scaling channel under conventional preferences:

(1)+(2a) increases the social cost of carbon

And because (2b) increases the social cost of carbon:

(1)+(2a)+(2b) increases social cost of carbon

Takeaway: It is critical that calculations include <u>both</u> the precautionary (i.e., risk-free rate) and insurance (i.e., climate beta) adjustments.

What matters is the net effect

Type of Uncertainty	Channel		Effect on Social Cost of Carbon Under Standard Preferences	
Consumption volatility, Warming uncertainty, Damage uncertainty	(1) Precautionary savings		+	+
	(2) Insurance	(2a) Damage scaling	-	
		(2b) Growth insurance	+	

What doesn't work as a calculation:

(A) Examining the correlation between climate damages and consumption as a way of signing effect of uncertainty

But: (a) We need marginal effect of emissions on damages

(b) We also need the precautionary savings channel

(B) Calculating certainty-equivalent losses from emissions, and aggregating using standard (Ramsey) discount rates

But: The precautionary channel reduces the discount rate should use to aggregate certainty equivalents.

And that adjustment depends on uncertain consumption outcomes, so should be determined within the same model.

What could work as a calculation:

(A) In each scenario, calculate climate damages and use that scenario's growth rate of consumption to determine the risk-free discount rate via Ramsey rule. Then aggregate over time within each scenario and across scenarios.

Critical that the discount rate vary by scenario, as that is how get precautionary savings effects

Note: Discount rate formula implies a utility function

(B) In each scenario, calculate the marginal utility loss from climate change and discount at pure rate of time preference. Then aggregate over time and scenarios.

Makes utility function explicit

Recommendations:

Damage uncertainty likely to be the most important.

->We need to converge on distributions for damages that account for full uncertainty, not just sampling (regression) uncertainty.

We also need to converge on best practices for social cost of carbon calculations:

Which uncertainties are critical to include?

What requirements must distributions meet?

Which numerical methods are acceptable?

How to report the components of the effect of uncertainty?