

# Climate Change:

## Uncertainty and Economic Policy

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# Confronting Policy Uncertainty

## Tension:

- ▷ **Limited understanding** of the mechanism by which policy influences economic outcomes
- ▷ **Demand for precise answers** by the public and/or governmental policy makers

## Examples:

- ▷ Monetary Policy
- ▷ Financial Market Oversight
- ▷ **Climate Change**

# Haunted by Hayek's Forewarning



“Even if true scientists should recognize the limits of studying human behaviour, as long as the public has expectations, there will be people who *pretend* or *believe* that they can do more to meet popular demand than what is really in their power.”  
(From Hayek’s Nobel address, 1974)

For quantitative policy analysis, we should not “throw in the towel,” but should acknowledge the *limits to their understanding*.

# Quantitative Storytelling

Use **mathematical models** with numerical inputs to further our **understanding** and support **policy analysis**.

Ingredients:

- ▷ substantive knowledge
- ▷ formal models
- ▷ empirical evidence

# Where does Uncertainty emerge?

## Quantitative storytelling with multiple stories

- ▷ **multiple models** give rise to multiple “stories” with **different implications**
- ▷ each model has **random impulses** and requires numerical inputs
- ▷ each model is an **abstraction**: stories not intended to be detailed recordings of actual histories or complete descriptions of reality

# Dangers of Being Naive



*The Cheat*, Georges de La Tour

# Conceptual Tools

- ▷ decision theory under uncertainty
  - statistics
  - control theory
  - economics

*How do we make “sensible” or “rational” decisions?*

- ▷ asset valuation under uncertainty
  - “assets” include financial, physical, human, organizational and environmental “capital”
  - associated with each asset is a prospective sequence of net payoffs to investments

*How do we assess the investment opportunities in the face of uncertain future net payoffs?*

decision-making and valuation are symbiotically linked

# Navigating Uncertainty

Probability models we use in practice are **misspecified**, and there is **ambiguity** as to which among multiple models is the best one.

- Aim of **robust** approaches:
  - ▷ use models in **sensible ways** rather than discard them
  - ▷ use probability and statistics to provide tools for limiting the type and amount of uncertainty that is entertained
- aversion - **dislike** of uncertainty about probabilities over future events
- implementation - **target** the uncertainty components with the **most adverse consequences** for the decision maker

# Uncertainty, climate change and economic valuation

- ▷ **market valuation fails** to account for the **full social impact** of human inputs on the climate
- ▷ **uncertainty** can have a **big impact** on the measurement of the **social cost of carbon** - an idealized target defined formally as a socially efficient (Pigouvian) tax
- ▷ **two interacting sources** of uncertainty
  - impact of CO2 emissions on temperature changes - **geophysics**
  - impact of temperature changes on well being - **economics**

# Climate Science and Uncertainty

*... the eventual equilibrium global mean temperature associated with a given stabilization level of atmospheric greenhouse gas concentrations remains **uncertain**, **complicating** the setting of stabilization targets to avoid potentially dangerous levels of global warming.*

Citation: Allen *et al.*: 2009

# Climate Impacts

Climate literature suggests an approximation that simplifies discussions of uncertainty and its impact.

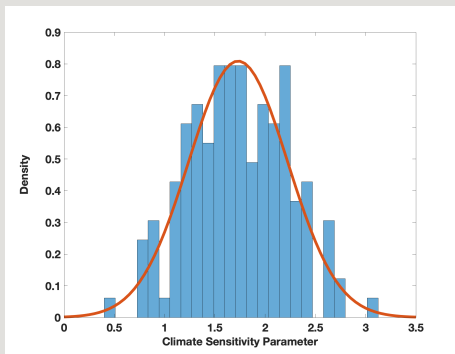
- ▷ Matthews *et al* and others have purposefully constructed a simple “**approximate**” climate model:

$$T_t - T_0 \approx \beta \int_0^t E_\tau d\tau.$$

- ▷ Abstract from transient changes in temperature.

Emissions today have a **permanent impact** on temperature in the future where  $\beta$  is a **climate sensitivity parameter**.

# Climate Sensitivity Uncertainty



Histograms and density for the climate sensitivity parameter across models. Evidence is from MacDougall-Swart-Knutti (2017).

# Carbon Budgeting

Many in the climate concerns community and policy community argue for a **carbon budgeting approach** as a simplified way to frame the discussion of environmental damages.

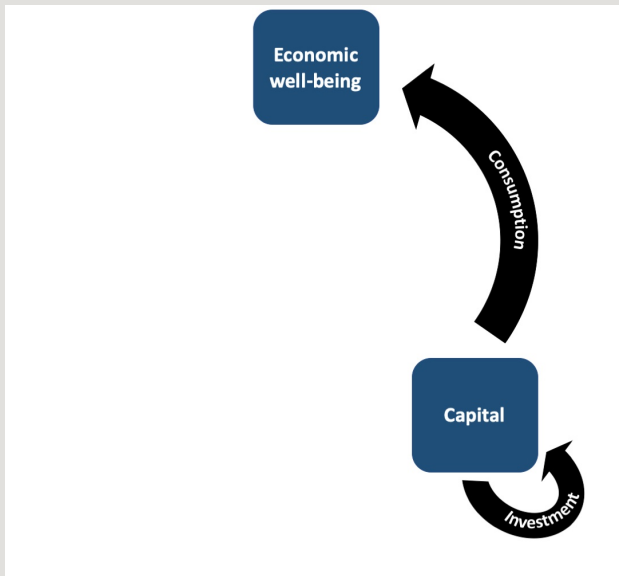
- ▷ exploit the Matthews approximation linking emissions to temperature
- ▷ design policy to enforce a Hotelling-like restriction on cumulative carbon emissions because of climate impact

Still must **confront uncertainty**: constraint depends on the **unknown** climate sensitivity parameter.

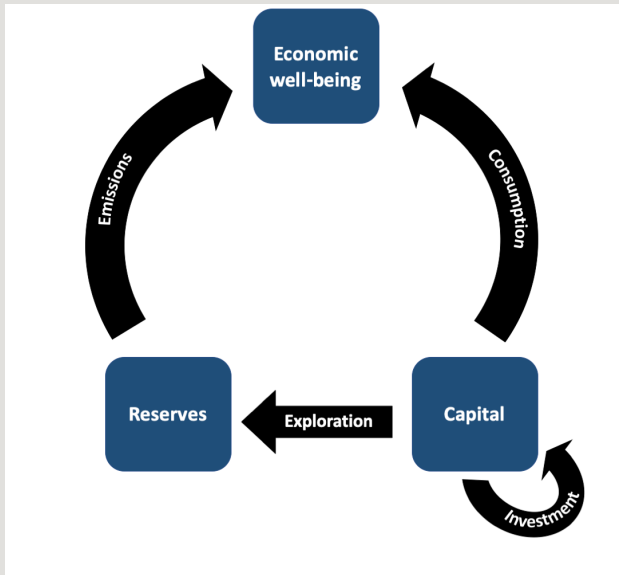
# Beyond Carbon Budgeting

- ▷ explicitly model **economic dynamics**
- ▷ incorporate economic “**damages**” to measure the social cost climate change on the economic environment
- ▷ treat formally **uncertainty** and its interconnected components

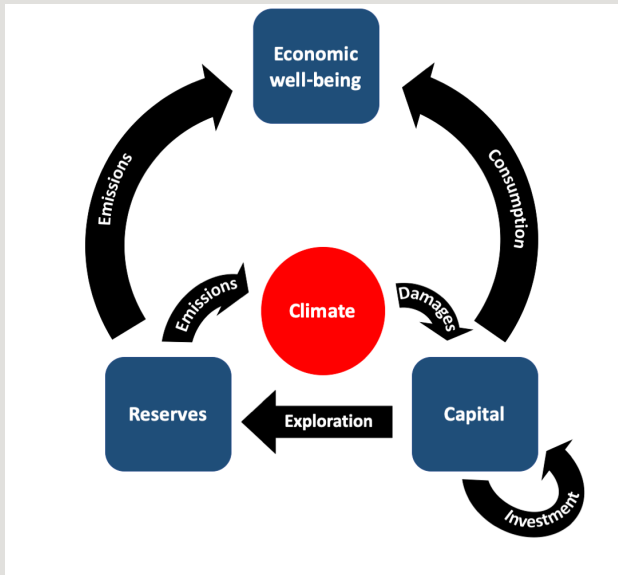
# Modeling Framework



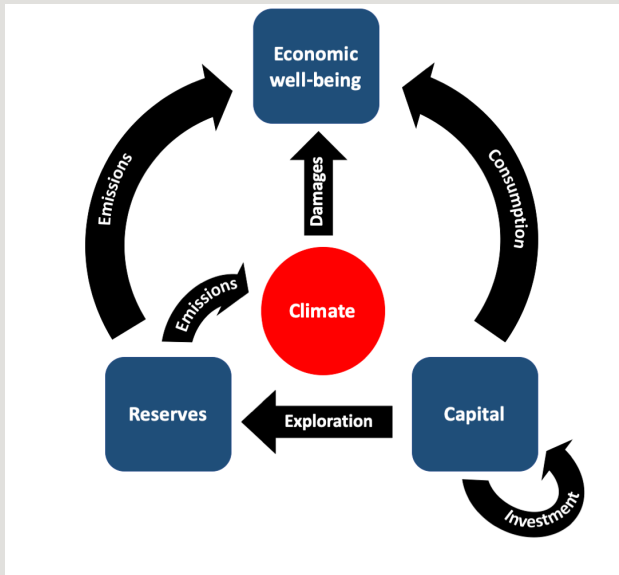
# Modeling Framework



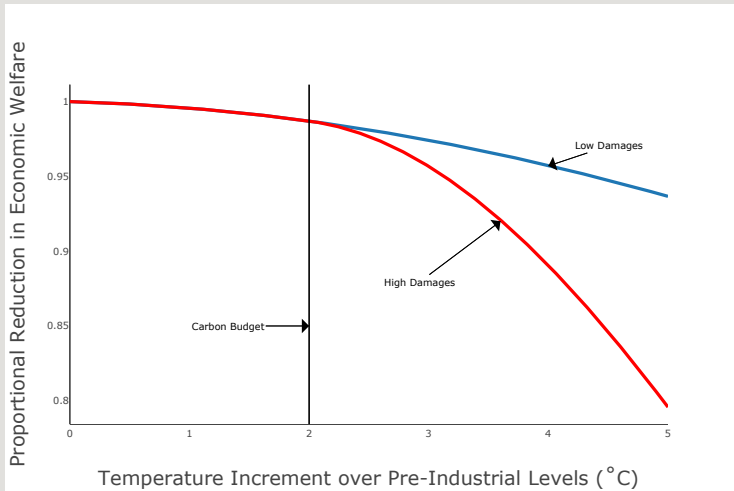
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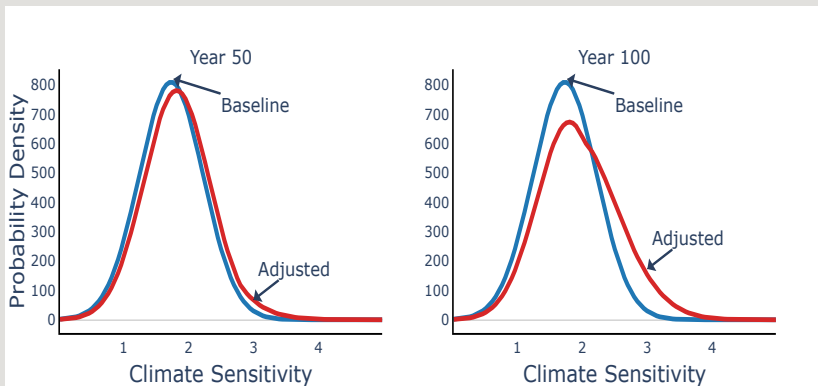
# Modeling Framework



# Proportional Damage Uncertainty: Reconsidered

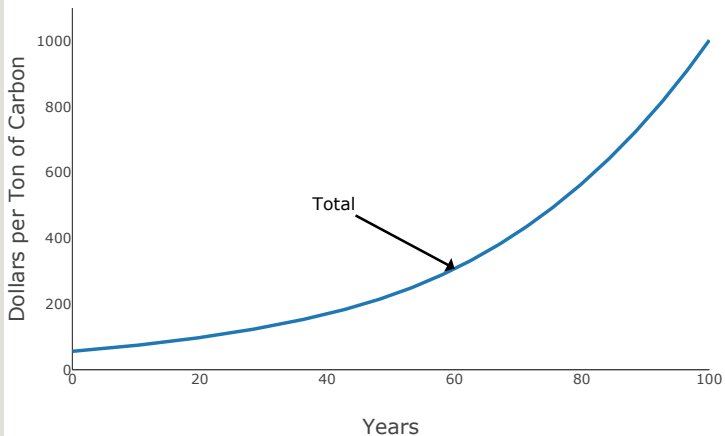


# Ambiguity-Adjusted Probabilities

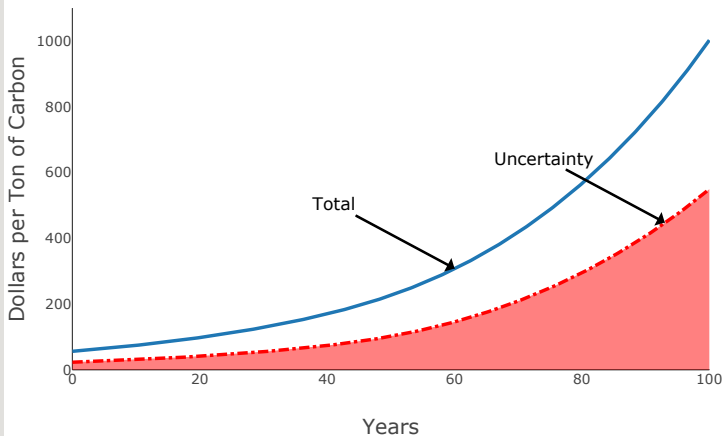


The initial weighting is the same for both the low- and high-damage specifications. The ambiguity-adjusted probabilities remain very close to this at year 50, but are tilted towards the high damage specification (probability .59) at year 100.

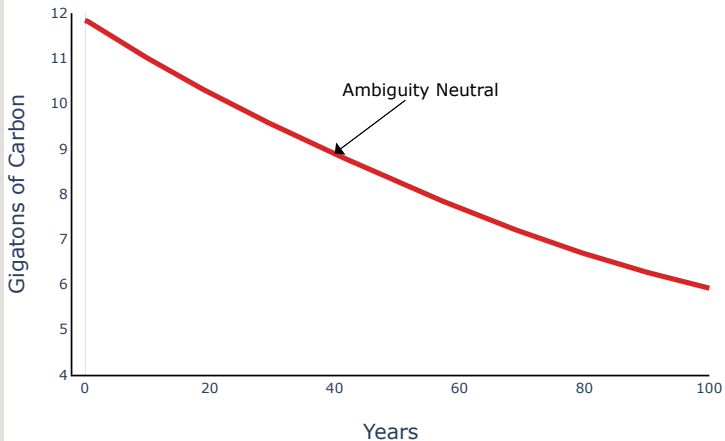
## Social Cost of Carbon Decomposition



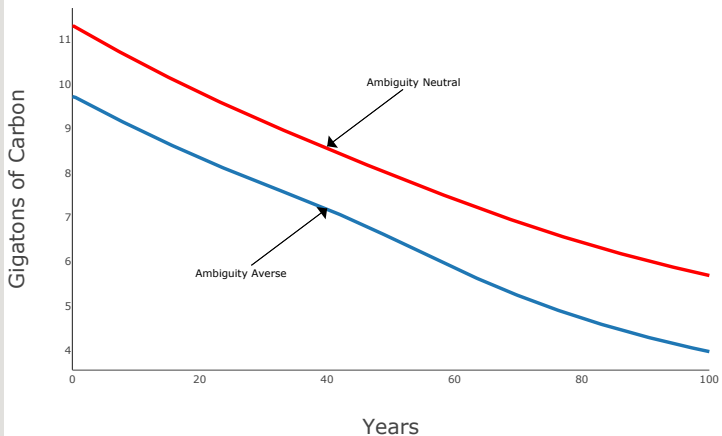
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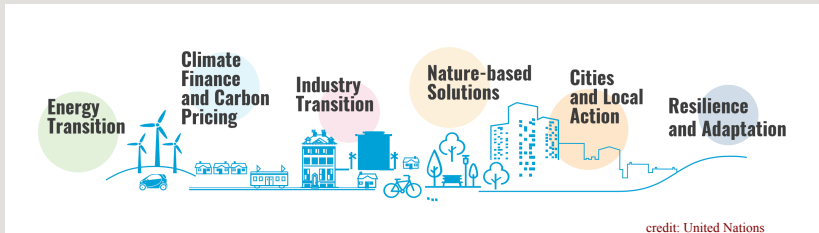
## Emissions Comparison



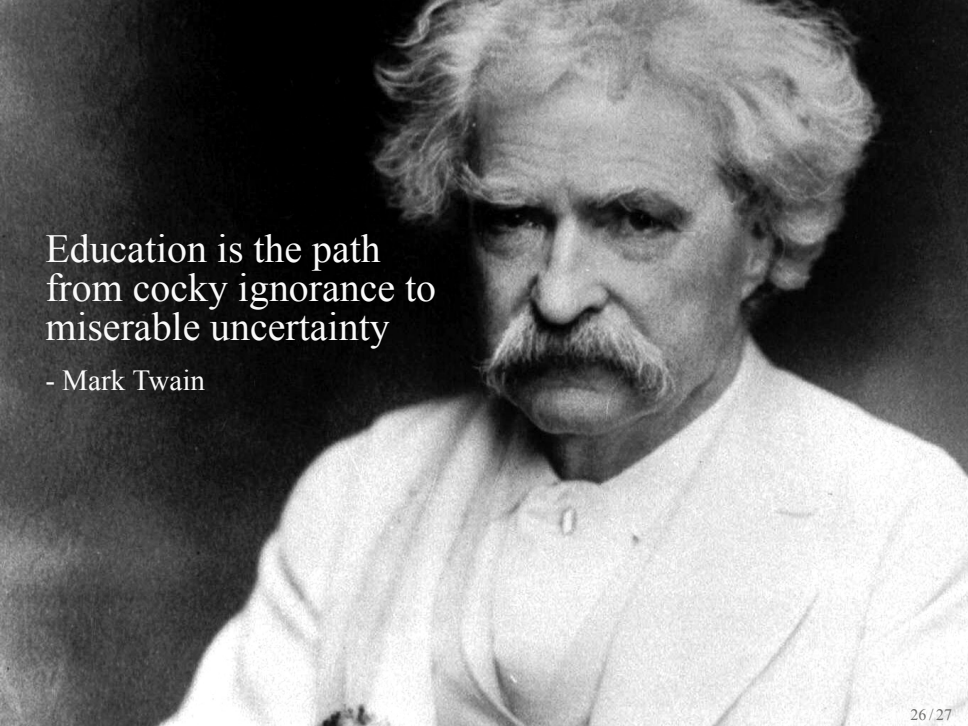
## Emissions Comparison



# Future Responses to Climate Change



Opens additional channels with uncertain consequences

A black and white portrait of Mark Twain, showing him from the chest up. He has white, wavy hair and a prominent white mustache. He is wearing a light-colored, high-collared shirt. The background is dark and out of focus.

Education is the path  
from cocky ignorance to  
miserable uncertainty

- Mark Twain

# Complementary References

- ▷ Cai, Judd, and Longzek (2017), *The Social Cost of Carbon with Climate Risk*
- ▷ Hambel, Kraft, and Schwartz (2018), *Optimal Carbon Abatement in a Stochastic Equilibrium Model with Climate Change*
- ▷ Lemoine and Traeger (2016), *Ambiguous Tipping Points*
- ▷ Millner, Dietz, and Heal (2013), *Scientific Ambiguity and Climate Policy*
- ▷ Nordhaus (2018), *Projections and Uncertainties About Climate Change in an Era of Minimal Climate Policies*
- ▷ Weitzman (2012), *GHG Targets as Insurance Against Catastrophic Climate Damages*