Social Cost of Carbon and Risks of Climate Change Catastrophes

Mike Toman

World Bank Research Department *

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**Views are the author's alone*

Interest in the Topic

- Concern that "tipping points" may be closer in time and more serious than had been anticipated
  - calls for rapid and deep cuts in GHG emissions
- Concern for the uncertain fate of international negotiations
  - mitigation may fall short
  - adaptation may be under-financed

Challenges in Addressing Topic

- Deep scientific uncertainties about catastrophe risks
- Questions about efficacy of different strategies for mitigating CC risks
- Perception that standard rational choice methods are inadequate for assessing risks, identifying policy approaches

Outline

- Potential for Climate Catastrophes
- Decision Frameworks
- Analysis of Response Options
- Implications

Global CC Catastrophes

low probability events with large, global, irreversible impacts that dramatically reduce long-term human well-being

(probability rises with greater climate forcing)

Timely advance warning is uncertain

Types of Catastrophes

- "*Unfolding*" Catastrophes:
  - Sea level rise, ice sheet collapse
  - Major increase in natural hazard risks
  - Major ecosystem collapses (land, water)
  - Shifting ocean currents
- "*Cascading*" Catastrophes:
  - Relatively rapid succession of droughts, crop failures → widespread mitigation, conflicts
  - Remain poorly understood
- Methane feedbacks, interactions among types of catastrophes

“Unfolding” Catastrophes

- Some likely to unfold only over long time periods (many decades, centuries)
  - Even if ice sheets collapse, consequences only develop and intensify over time
- Ecosystem collapse could occur on much shorter time scales (decades)
  - Depends on unknown magnitude and speed of temperature responses, other climatic changes

"Unfolding" Catastrophes

- Physical tipping points uncertain and remain challenging to detect in advance
- Relationship of socio-economic tipping points to physical tipping points is even more uncertain
  - Depends on speed of consequences
  - Adaptation capacity

“Cascading” Catastrophes

- Cumulative effect of sequence of more localized CC-induced harms each reinforcing others
  - Series of regional crop disruptions → widespread famine, land degradation, and conflict
  - Series of localized extreme weather events → larger-scale economic disruptions, reduced remittances, refugee problems, and conflict
- Mostly speculation at this point – little has been done on such risks

Literature on Global Catastrophe Valuation – Very Limited

- Weitzman simulations; Nordhaus, Pindyck
- Growth theory models with uncertain arrival or large GDP shock – Nordhaus, Pizer, Gjerde et al
- IAM work – FUND (sea level rise and cities, change in thermohaline circulation); PAGE
- More has been done on sub-global extreme events:
  - Nordhaus, Emanuel, Mendelsohn, FEEM – hurricanes and other extreme weather events
  - Episodically incurred costs are large in absolute terms; relationship to income less clear

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Standard Rational Choice Approaches

- Integrated economy-climate models calculate "optimal" (dynamic PV-maximizing) emissions paths
- Catastrophes represented as large, permanent drop in welfare with endogenous risk
  - Risk rises with atmospheric GHG concentration
- Approach assumes risks and impacts can be characterized quantitatively

Implications of Standard Approaches

- "Optimal" near-term abatement increases with magnitude of catastrophe risk; **but,**
- The effect generally is fairly small unless
  - catastrophe is VERY large and fairly near-term relative to discount rate used; **Or**
  - discount rate is low
- Familiar positive and normative arguments for various discounting approaches inconclusive

Challenges to Standard Approaches

- Risk vs. uncertainty vs. ignorance
  - Probabilities and even possible states of the world remain very poorly or largely unknown
- "Fat tails" versus expected utility
  - Deep uncertainty looms over standard CBA
  - Expected utility does not adequately reflect risk preferences
  - Traditional risk management analytical tools have limited effectiveness in this situation

Issues Raised by Behavioral Economics

- Risk assessments "anchored" by particular frames of reference
- Difficulty in interpreting small probabilities
- Aversion to extremes or to ambiguity

Implication is possibility of systematic assessment errors by general public

Implications for Catastrophe Risk Assessment

- Assessment "biases" by public could imply more or less, faster or slower action
  - Normal technocratic view is provide more information
- How much can further research on catastrophes do to reduce such biases?
  - Considerable uncertainty on possibility of catastrophe seems likely to persist for some time

Implications for Catastrophe Risk Assessment

- Improving knowledge remains useful; **but**,
- Sound policy decisions cannot simply be based on what revealed public preferences; **however,**
- This is **not** an argument for decision makers to abandon systematic comparison of gains and losses!
- Decision makers need to exercise their judgment as agents of the general public in evaluations
  - Political economy challenge: myopia, high personal discount rates, risk aversion

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Evaluation criteria

- Aim is a reasoned comparison of benefits and costs (broadly defined)
- Given deep uncertainties and several dimensions of public concerns, multiple criteria can be useful
  - Certainly does not preclude economic metrics!
  - Practical difficulties to quantify many risk characteristics in a single common metric
  - Use of several metrics can reflect complex risk attitudes
  - Given tradeoffs will be made in political give and take, evaluating multiple criteria adds information

Evaluation Criteria: Example

- Effectiveness in mitigating risk
  - Several possible ways to quantify
- Cost of implementation
- Robustness – ability to be effective even with surprises in evolution of climate change threats
- Flexibility – ability to modify response as information about risks changes

Illustrative Application

1. Drastic and rapid global emission reduction
2. Global-scale anticipatory adaptation to mitigate prospective consequences of catastrophes
3. Putting particulates into upper atmosphere (form of geo-engineering to reflect incoming radiation)

Drastic and Rapid GHG Reduction

- Effective for "unfolding" and "cascading" catastrophes
- Costs would be very high unless/until there are major technology advances for mitigation
- High need for international participation
  - More difficult the higher are the costs
- Robust to surprises in nature of risks
  - Unless (BIG) surprise is risks are low
- Inflexible – requires sustained commitment to decarbonization

Global-Scale Anticipatory Adaptation

- Purchase land for mass relocation and begin preventative relocation
- Drastically limit development in ecosystems and increase buffer areas to improve resilience
- Massive structural controls against sea-level rise

Global-Scale Anticipatory Adaptation

- Effectiveness would vary with action
  - Land acquisition for relocation could sharply limit natural hazard risks
  - Ecosystem protections would have positive impacts, but magnitude hard to judge
  - Structural barriers could be ***brittle***, not performing well for more severe impacts
  - Large-scale adaptation could be particularly effective for short-circuiting potential cascading catastrophes

Global-Scale Anticipatory Adaptation

- Costs depend on action but could be very high
  - Win-win disaster risk reduction policies, ecological systems protection
- Costlier options have little flexibility
- Portfolio of actions needed to have robustness
  - Hazards of sea level rise versus ecosystem collapse

Particulates in Upper Atmosphere

- Successful implementation would be effective and robust in blunting impacts of GHG accumulation
- Direct costs could well be less than drastic GHG mitigation, but further R&D costs could be considerable; **but,**
- Highly uncertain side effects could create very large overall costs, non-robust solutions
- Significant RD&D costs needed to establish large scale feasibility and some confidence in safety

Particulates in Upper Atmosphere

- Could use flexibly, to complement GHG abatement or responding to warning signs; **but,**
- This requires adequate capacity to detect risks of looming catastrophe in time; **and,**
- Highly inflexible once deployed
- Significant international coordination needed to deter unilateral use with strong negative spillovers

Summary of Evaluations

Evaluation Criteria	**Drastic Global GHG Reduction**	**Massive Anticipatory Adaptation**	**Particulate Injection to Upper Atmosphere**
Effectiveness	High	Medium	Potentially High
Cost	High w/o major innovation for mitigation; Low post-mitigation	Low (with high co-benefits) to High (very disruptive changes)	Potentially Very High
Robustness	High	Low (individual measures) to Medium (for portfolios)	Potentially High for dampening CC; Low for side effects
Flexibility	Low	Low	Extremely Low (absent drastic mitigation later)

Summary of Evaluations

- Certainly potential for effectiveness, robustness
- All options have high cost unless there is massive advance in low-carbon technology
  - All the more if action needed more quickly
- All options have low flexibility once implemented

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Implications for Social Cost of Carbon

- Cost Benefit Analysis provides much important info needed to assess expected GHG accumulation cost
  - Need also to consider its variance, and its incidence
- Standard CBA provides considerably less help for evaluating potential impacts of catastrophes and economic value of mitigation measures
- But the principle of carefully weighing benefits and costs remains valid; instead we need to consider different approaches to this assessment
  - Problematic nature of vague "precautionary principle"

Implications for Social Cost of Carbon

- Need to consider SCC vis-à-vis catastrophe risks in terms of the willingness of public today to bear costs in an effort to mitigate such risks
  - Variety of motivations possible – but for this purpose the magnitude is the most important to understand
  - Willingness to bear costs is not fixed; strongly depends on individual values, social norms, understanding

Implications for Social Cost of Carbon

- Willingness to bear costs for reducing prospect of future catastrophes depends on many unknowns:
  - Baseline hazards, public attitudes and values
  - Innovation in GHG mitigation that lowers future cost of rapid, deep emissions cuts
  - Ability of large-scale anticipatory adaptation to lower risks from extreme events
  - Possibilities and risks associated with geo-engineering

Thought Experiment for One Approach to Catastrophe Mitigation

- Define a provisional long-term climate protection goal (X ppm, or Y° C, or…..)
- Simulate backwards a set of feasible approach paths
- Evaluate implementation costs and other attributes of different paths
  - Dependence on certain technical advances
  - Dependence on certain assumptions

Thought Experiment for One Approach to Catastrophe Mitigation

- Form expert judgments on alternatives:
  - How large would long term risk reduction benefits have to be to justify mitigation costs?
  - How could mitigation costs be reduced by less ambitious targets or more aggressive adaptation?
  - What are the types as well as sizes of residual risks?
- Put the options into the public domain for debate
  - Help public understand options and accept choices
  - Public feedback helps decision makers refine their judgments about what protection costs are acceptable

Implications for strengthening response options

- Uncertainties with all three options imply very high value of information with larger R&D funding
  - New options for drastic decarbonization
  - Stronger options for large-scale adaptation
  - More research on various types of geo-engineering to clarify their risks before they are used unilaterally
- Investigation of nature and prospects for "cascading" catastrophes is needed to evaluate their seriousness

Implications for International Assistance Measures

- Actions to reducing catastrophe risks need to be approached at strategic level
  - Carbon "shadow price" on a few fossil energy projects will have minimal impacts
  - Same with non-coordinated adaptation
- Priorities for sector – level responses need to be set (energy, food, water, coastal zones, public safety…)
- Political economy of financing-related "carrots and sticks" is very complex but needs to be addressed

Implications for International Cooperation

- Once conditions begin to deteriorate it might be easier to get international cooperation; **but,**
- Greater developing country vulnerability may cause developed countries to turn inward
- Reduction of "adaptation gap" is an urgent priority with large co-benefits

Thank you!

Comments welcome.

International Cooperation

- Experimental economics show people value fairness and cooperation giving hope that international climate agreements can be successful
- Yet consequences are asymmetrically distributed
  - Impacts vary by region
  - Different populations, among and within countries, will have highly varying ability to cope with such outcomes.
  - Poorer countries or those with closed economies are least capable of adaptation, and will have to rely on the other countries to bear the risk.
  - Migration and international trade may function to diversity risks, especially if the effects of a catastrophe are geographically concentrated.
  - Concerns about equality of outcomes affect social welfare functions
  - Even if rich countries decisions agree to bear global costs of CC, it is unclear how to square that policy decision with policies of foreign aid.

Implications for International Cooperation

- Prospects for major global actions are limited when seen as costly, with distant/uncertain payoff
- Without cooperation in risk assessment as well as implementation, benefits of careful weighing of options can be negated by others' actions