

Risk Analysis and Management for Climate Change: An Economic Perspective

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“ Economists are people who know
the price of everything and the value
of nothing ” (G.B. Shaw)

If this were true, i.e. that economists know the price of everything, there would be no problem for environmental conservation and for climate and health protection

Unfortunately, economists do not
know the price of everything,
including the price of
environmental services

Despite these failings, economic logic, i.e. logic applied to utilitarian ethic, is still useful to debunk everyday statements about needed policies to protect climate and health

Economists can derive these missing prices through optimization models

- The rent associated with a constraint is a price
- There are other empirical methods

The term 'economist' is understood widely: it includes anybody who subscribes, at least in part, to the utilitarian ethics, e.g. benefit cost analysis

- It, therefore, includes integrated assessment, risk management, policy analysis, some sociology and political science, etc.

Economic Perspective on Public Policy towards CC

- Sequential decision problem under uncertainty ('cascade of uncertainties' (S.H. Schneider)) and learning
- Hysteresis (stock, concentration) effect: temperatures depend on C concentrations and not on C emissions; tends to slow down emissions
- With irreversible and possibly ominous consequences
- Precautionary principle is an ethical/legal principle that can be deducted from first economic principles for specific utility functions only (sufficient conditions) ; in other words, it is not a general economic principle
- Over a very long time horizon

Economic Perspective on Public Policy towards CC

- Benefits are collected late and costs are incurred early
- Climate itself is a public good, i.e. its collective level of protection will be insufficient without full cooperation among its beneficiaries; tends to accelerate emissions
- Equity issues are important both temporally and spatially
- ‘Urgency’ and ‘Danger’ are neither economic nor natural science concepts but social constructs depending also on perception and framing issues, i.e. public policy issues which have a wide stakeholder support and which climate policy can be tagged on.

Dangerous

- Dimensions
 - External
 - Internal
- External for policy
 - Top down: expert assessment of physical vulnerability
 - Bottom-up assessment: of social and individual vulnerability
- Internal for perception
 - Social science
 - Dynamic path-dependent concept evolving from one risk class to another

UNFCCC

- calls for stabilization of GHG concentrations in the atmosphere at a level that would prevent “**dangerous**” anthropogenic interference with the climate system

“Dangerous” means (external dimension):

- ecosystems are unable to adapt naturally given too short a time-frame
- food production is threatened
- sustainable economic development is unfeasible

Copenhagen Consensus (B. Lomborg, 2005)

- Hypothetical budget of US \$ 50 billion
- Climate change at bottom of issues related to UN Millenium Goals, with costs likely to exceed benefits
- Climate benefits are estimated by damages avoided
- Catastrophic losses are estimated by willingness to pay to reduce global temperature and its expected damage

Project rating Challenge

Opportunity

1	Diseases	Control of HIV/AIDS
2	Malnutrition	Providing micro nutrients
3	Subsidies and Trade	Trade liberalisation
Very Good		
4	Diseases	Control of malaria
5	Malnutrition	Development of new agricultural technologies
6	Sanitation & Water	Small-scale water technology for livelihoods
7	Sanitation & Water	Community-managed water supply and sanitation
8	Sanitation & Water	Research on water productivity in food production

Good

- | | | |
|----|--------------|--|
| 9 | Government | Lowering the cost of starting a new business |
| 10 | Migration | Lowering barriers to migration for skilled workers |
| 11 | Malnutrition | Improving infant and child nutrition |
| 12 | Malnutrition | Reducing the prevalence of low birth weight |

Fair

- | | | |
|----|-----------|---|
| 13 | Diseases | Scaled-up basic health services |
| 14 | Migration | Guest worker programs for the unskilled |
| 15 | Climate | Optimal carbon tax |
| 16 | Climate | The Kyoto Protocol |

Bad

- | | | |
|----|---------|--------------------------|
| 17 | Climate | Value-at-risk carbon tax |
|----|---------|--------------------------|

Copenhagen Consensus

- W. Cline compares total benefits and total costs over a very long horizon, while R. Mendelsohn argues that only current actions matter for 'danger' and their level is determined by comparison of marginal benefits and costs over a relatively short horizon

The long horizon: Copenhagen Consensus

- The significant horizon is the one which leads to the prevention of dangerous climate change and not to the complete reversal of climate change
- This shorter horizon requires a level of prevention which is smaller initially than the complete horizon problem

J. Sachs' Critique

(Nature, Aug 4, 2004)

- Sachs claims that \$ 50 billion budget flawed the approach by biasing it towards projects which are too small.
- It should have been based on the Monterrey consensus of .7 % of GNP or about US \$ 210 billions
- This would have allowed bold/comprehensive approaches: focus on health delivery systems rather than on specific diseases

Sachs' Critique

- Similarly for climate change
- Need a multidisciplinary approach
- Papers were too narrow and the process too short for a true consensus to emerge; one such consensus could have emerged on a carbon tax

The irreversibility effect

- The relatively irreversible nature of some policies or actions leads to a lower level of the irreversible action than if full reversibility were possible if future information may favor the more reversible course of action .
- e.g. a fossil fuel-based energy policy will be adopted at a lower level, because of the relative irreversible impact of the emissions on C concentrations, than if emissions were reversible
- Irreversibility is related to the hysteresis (stock) effect and to learning
- This irreversibility effect was identified in the early 70's

The irreversibility effect is not general and depends on very specific features of the cost function of the irreversible action

- There is no condition under which emissions will unambiguously decrease when information increases in the future and the irreversibility constraint bites
- Unambiguous results (the irreversibility effect) *may* be obtained if the irreversibility constraint does bite or if either the marginal damage curve or the marginal abatement curve is convex (Baker, 2005)
- Therefore, the fact that emissions are relatively irreversible does not affect policy much.

The precautionary principle

- It is an ethical /legal concept which prescribes a behavioral attitude towards risk which leads to an irreversibility effect, i.e.the adoption of preventative measures or of a less irreversible course of action
- It is also related to learning
- Only very specific utility functions satisfy the precautionary principle (Gollier et al., 2000)
- Being simply risk-averse is not sufficient to generate the precautionary principle but may be necessary
- A positive third derivative (prudence) is required

Stabilization of concentrations is elusive because

- climate is a dynamic system
- climate is a non-linear system with different possible equilibrium concentrations
- climate is subject to large uncertainties

Stabilization of concentrations is elusive because

- stabilized concentrations may not correspond to society's maximum welfare
 - marginal cost of CC = marginal cost of mitigation = marginal cost of adaptation
 - society's welfare function may evolve over time as well as perceptions of danger
- desired stabilized concentrations may not be unique
- there may be techno-economic constraints preventing stabilization

Accordingly, finding an optimal emission path is elusive as well

- risk-hedging strategies will be required in any case.
- “Therefore, mankind is unlikely to face the real hazards arising from CC in a targeted [stabilization], effective [least cost], and efficient [welfare maximizing] manner although it wants to benefit from the opportunities associated with risk-taking.” (M. Obersteiner, 2001)

Risk-hedging strategies

- Adaptation
 - Reduction of CC impacts
 - Financial
- Real options
 - Hardware
 - Software
 - Orgware

Adaptation

- reduction of average and extreme CC impacts
 - reactive manner: social resilience
 - anticipatory manner (reduces the cost of adaptation and provides ancillary benefits as it protects against current climate variability):
 - early warning systems
 - incentives for relocation
 - incentives to purchase insurance

Adaptation

- financial
 - risk-sharing of residual risks
 - disaster relief
 - re-insurance

Real options

- Hardware
 - technologies that remove GHG's
 - technologies that constrain hazards
 - technologies that reduce vulnerability
- Software
 - science that models risks and risk-hedging strategies
- Orgware
 - strong institutions

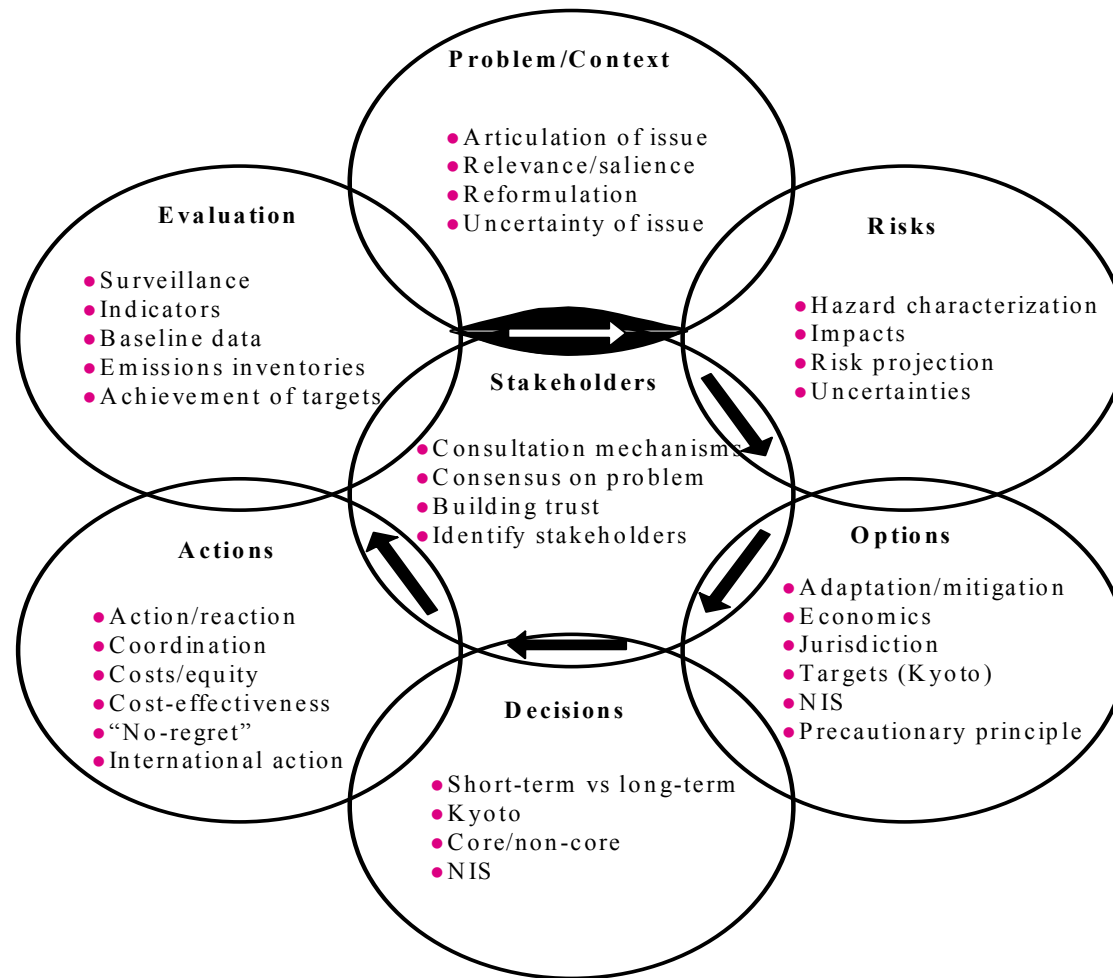
IPCC, TAR, WG III

- “Owing to fundamental uncertainties, it is impossible to predict or forecast the long-range global future. Even with the most sophisticated methods, long-range indeterminism implies that probabilities cannot be rigorously assigned for either a given set of driving assumptions or the likelihood of structural shifts in societies and natural systems”
- Therefore, need for scenarios

Uncertainties and Risk Analysis/Management (RAM)

- Systems Approach, IA and RAM share the same holistic perspective and, therefore, mesh well with storylines/scenarios.
- “The entire process of risk assessment and management is essentially a synthesis and amalgamation of the empirical and the normative, the quantitative and the qualitative, and objective and subjective evidence” (Y.Y. Haines, 2001)

Figure 1. Recommended Risk Management Framework for Climate Change



Risk management is not separable from risk assessment (S. Kane and J. Shogren, 2000)

- This is because, in an imperfect world in which one cannot insure against all risks, adaptation cannot generally be separated from mitigation.
- Risk assessment is, therefore, not exclusively a natural science problem

Uncertainties

- Uncertainty is the imperfect knowledge of an event's probability, magnitude, timing, and location, and of its very existence
- Uncertainty management does not imply risk removal

Uncertainties

- The precautionary principle suggests that the greater our uncertainty, the more cautious and reversible our management actions should be
- Some uncertainties cannot be removed or can be but at great costs only

Alternative classification of uncertainty types (German Advisory Council on Global Change, 1998)

- Normal area (risk analysis)
- Transition area
- Prohibited area

Classification of risk classes (GACGC, 1998)

- Damocles: Low probability P, High hazard H, both with high certainty
- Cyclops: P is uncertain, High H with high certainty
- Pythia: both P and H are uncertain
- Pandora: same?
- Cassandra: High P with uncertainty, high H with certainty
- Medusa: Low P with uncertainty, low H but high exposure with certainty

Risk dynamics

- Risk can move from one class to another
- Risk exposure is path-dependent
- The purpose of risk management is to move risks from the prohibited to the normal area
- Each risk class has relatively specific options

Sources of uncertainties

- Climate
- Impacts
- Responses

What policies should be selected?

- Optimization models do not work except in reduced form models to explore promising policy choices
- Reduced form models are the ones for which the values of the endogenous variables can be found as function of the exogenous variables only

Results from the optimization literature:

- Assumptions: modest economic (and population) growth and significant exogenous technological innovations
- Modest current controls are optimal, i.e. current emission reduction by 5-10% or US \$ 5-10 per ton of carbon; this result is robust to many uncertainties
- Heaviest reductions occur in later years
- If economic growth is large, or innovations are slow or rate of discount is low, control rates have to be increased.

Results of the optimization literature

- If passive learning is allowed, controls are still modest but the cost of delaying action by a couple of decades is small
- Learning possibilities have no impact on current actions unless current actions reduce the (certain) marginal abatement or damage cost in the future
- Adaptive strategies are preferable to certainty equivalent policies
- Learning benefits are small

Proxies for optimization

- Robustness
- Social resilience

Robustness

- Selection of strategies which are relatively insensitive (minimax expected regret) to uncertainty against many possible futures
- Through exploratory modelling which uses simulation models to create a large ensemble of plausible future scenarios coupled with one policy each.
 - Exploratory modelling allows for probabilities and non-linearities.

Robustness

- Need to identify
 - Signposts, i.e. observations needed for drastic action
 - Current actions which make large reductions in the future less costly
 - Actions which can be reduced if the problem turns out to be minor

Robustness

- Most robust strategies are innovation sensitive i.e. sensitive to small reductions in abatement costs or to large reductions in damages
- Adaptive strategies are preferable to certainty-equivalent ones
- Learning about climate variability is much less valuable than learning about long-run climate parameters

Resilience

- Resilience maintains overall system persistence, adaptive capacity, flexibility, ability to exploit positive opportunities
- Modify systems to enable them to respond to short-term changes without passing a threshold which flips them into an alternative quasi-stable state

Resilience

- Therefore, mitigation and adaptation have to be considered together but one may have strong mitigative capacity and weak adaptive capacity
- Capacity depends upon
 - technological options,
 - policy instruments,
 - institutions,
 - resources (and their distribution)
 - stock of human capital,
 - stock of social capital (including property rights, risk-spreading),
 - the ability of decision-makers to manage information

Resilience

- Capacity to adapt or to mitigate is part of the capacity to cope with other stresses.
- Capacity to adapt is not identical with capacity to mitigate because there may be distributional differences and differences in interactions

Conclusion

- Welfare optimization is elusive and useful only in reduced form models
- Learning is useful in order to manage uncertainties to move risks from the unacceptable zone to the normal one but does not, generally, affect current actions drastically
- Mitigation and adaptation must be looked at concurrently and not successively

Conclusion

- Robustness AND resilience are the best current strategies but must be examined in their context of other stresses
- RAM is useful as an overall framework involving stakeholders and for managing uncertainties
- Focusing on GHG concentrations may turn out to require a very sophisticated system of risk-hedging strategies.