The Economics of Climate Change

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Stern Review

- « Climate Change is the greatest **Market Failure** the World has ever seen, and it interacts with other market imperfections » (Sir Nicholas)
- « Climate Stabilization is the greatest **Global Public Good** the world has ever seen, and it interacts with other public goods » (Sir Philippe!)

Stern Review

- The greatest contribution from the report is **not** its methodology (Integrated Assessment, macroeconomic models, Economics of uncertainty) but the numbers provided and the report's salience (former Chief economist of the World Bank backed by UK Government)
- The $ numbers for early action jibe with IPCC numbers
  - But low end for stabilization at 550 ppm
- Call for deeper early action than received economic opinion
- Uncertainty for impacts can be replaced by risk to some extent
- There is no other $ number for the impacts against which one can comnare them
- Extremes of temparature scale have been taken into account

Climate change is first and foremost an externality problem (Stern Review)

- The emissions of greenhouse gases (GHG) by one individual or firm inflict
  - Long-lasting
  - global damages through
  - GHG **concentrations (stock)**
  - without going through the market, damages for which the victims are not compensated

Social cost of carbon

- The marginal damage increases over time because concentrations form a stock and, therefore, emissions must decrease over time faster and faster as concentrations increase
- The **monetary estimate of these global damages** is the social cost of carbon, i.e.
  - « the present value of the worldwide damage caused by an additional tonne of carbon emitted to the atmosphere, throughout its lifetime in the atmosphere”, which is to be compared with the marginal abatement cost:
  - $ 85 for Business as Usual (BAU) (Stern)

3 Public Policy Issues (T.M. Saloranta, 2001)

- **What portion of Climate Change (CC) is**
  - man-made, i.e. can be mitigated (prevented) against or possibly adapted to, vs.
  - natural, i.e. can be possibly adapted to only?
- **What Climate Change (CC) consequences or "key vulnerabilities", i.e. potentially severe impacts (IPCC, WG II), are we able to predict and control?**
  - Disappearance of glaciers in British-Columbia and Alberta with, as a consequence, acute water shortages for irrigation in Prairie Agriculture
  - Mountain Pine Beetle and Spruce Budworm more significant outbreaks in B.C. and Central Ontario respectively, affecting timber supply
  - Flooding of coastal areas in the Atlantic Provinces
- **What policies should be selected?**

The Economic Perspective: **Benefit/Cost Analysis** (BCA)

- When economists look at a state of the world (e. g. changed climate), to which another feasible one is preferred (e. g. a stable climate), they fundamentally compare the benefits to the costs of moving (of adopting a **policy**) from the current state or trajectory (Business As Usual (BAU)) to the preferred state or trajectory (a time sequence of states)
  - If the **net benefits are positive**, i.e. the benefits of the policy exceed its costs, the policy is to be adopted. Stern estimates the net benefit of acting now to reach 550 ppm. concentrations by 2050 to be $2.5 trillions
  - Economic evaluation of environmental benefits (e. g. of a stable climate) and costs (e. g. key vulnerabilities) is **uncertain**.

The Economic Perspective (M. Obersteiner, IIASA 2001)

- Economists look at mitigation and adaptation (taking the climate change risk as given or as if it had already occurred and reducing its impacts), in the context of a
  - **Sequential decision problem ,** i.e. not a one-shot decision, in which one chooses both a level (concentration) and a rate of increase of Greenhouse Gas (GHG) emissions
  - **Under uncertainty,** by opposition to risk, i.e. where probabilities are difficult to assign to states
  - **With possibility of learning, through better modelling**
    - Other learning opportunities are not significant in the medium-run
  - **Over an unusually long horizon** (for economic decisions), e. g. involving future generations
  - **With time-lags,** since emissions affect concentrations only slowly
  - With **irreversible** (for both the **climate system** and **manufactured capital**) and possibly **disastrous consequences** (key vulnerabilities materialize)

Economic Perspective

- **Benefits are collected late** on the horizon and **costs are incurred early**
- **Inter- and intra-generational equity issues** are more **significant** than in many other economic decision problems

Reduction of a dynamic problem to a sequence of static ones

- Optimization of this sequential decision problem can be reduced to a static decion problem such that**, in each time period,**
  - **the incremental benefits over the entire horizon of adopting a policy during that time period, must equate the incremental costs (including the social cost of carbon) at the time the policy is adopted.**
  - **Done by Stern**
- This equality guarantees that the economic solution is **efficient** (maximizes soceity's welfare), is **cost-effective** (least-cost), and is targeted (**optimum emission path**)

Climate Policy

- A climate policy, i.e. moving from the current state to a preferred state or trajectory, would definitely contain at least **three possible options:**
  - **Mitigation**, i.e. reducing the risk of climate change,
  - **Anticipatory (planned) adaptation,** and
  - **Business As Usual (BAU), i. e. inaction**

Mitigation, Adaptation, BAU

- The equality of incremental benefits means that, in each time period, mitigation and adaptation must be conducted to the point where their respective incremental net benefits are equal;
- The latter must equal the marginal cost of carbon under BAU, i.e. $ 85 (for Stern)
- Therefore, both mitigation and adaptation are generally complementary components of a climate policy unless BAU turns out to be preferable

UNFCCC (Art. 2, 1992)

- Calls for stabilization of GHG emissions at a level which avoids « Dangerous Anthropogenic Interference » (DAI)
- Stabilization is elusive because climate is
  - Dynamic
  - Non-linear (jerky)
  - Subject to large uncertainties
- Stabilization may not correspond to the best decision in terms of welfare maximization because
  - Stabilization may not be feasible because of technological, economic and social constraints
    - E. g, emission reductions by, at least, 50 % by 2050 (IPCC) may not be feasible
  - Stabilization level, which corresponds to the maximum welfare, may not be unique

Optimizing what?

- What do we optimize over a very long horizon, which involves several generations whose notion of welfare may be at variance with ours?
- Similarly, what guarantees that what we consider dangerous to-day will still be considered dangerous to-morrow since the concept of danger has social and behavioral dimensions?
- Optimization is usually carried out on a highly stylized model like DICE (R. Nordhaus)

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)
- This is not sufficient to invalidate the whole CBA approach to CC

Risk Analysis and Management(RAM)

- Complements CBA
- Relies on:
  - the precautionary principle,
  - adaptation
    - early warning systems
    - incentives for relocation
    - incentives to purchase insurance
  - managing residual risks (disaster relief, reinsurance)
  - technologies which
    - reduce key vulnerabilities
    - increase carbon sequestration
  - social resilience (strong institutions)

Uncertainty

- I can make the assumption that reactive adaptation is generally more expensive than anticipatory adaptation because climate change is **fraught with “a cascade” (S. Schneider) of uncertainties** about
  - the physical phenomenon itself,
  - the chain of causality, and
  - the economics of the phenomenon
- Under reactive adaptation, I deprive myself of the benefits of risk-hedging
- Moreover, anticipatory adaptation has co-benefits in terms of adaptation to climate variability

Risk of Climate Change

- The risk of climate change is an endogenous risk, risk against which one can never insure completely.
- This is why we need mitigation policies (e.g. reduce GHG emissions) and societal and individual behaviors (e.g. driving less polluting vehicles), which will reduce the likelihood of “dangerous anthropogenic interference” with climate change and of falling into a dangerous state of climate change (high climate sensitivity, D. Harvey).
- Again, “dangerous” is a societal outcome.
- One needs a regime to deal with the public good aspect of climate change avoidance because danger is not limited to oneself

Global Public Good Nature of a CC Prevention Regime

- A **regime** is a set of shared principles, norms, rules, rights, decision-making procedures, ways of defining problems and of handling relevant artifacts and persons, all embedded in institutions and infrastructures, which favor cooperation.
- While climate tends to be overused (excessive GHG concentrations) because of its natural availability as a resource whose access is open to all, free of charge, dangerous CC prevention tends to be underprovided.

Prisonners' Dilemma

- Since regime benefits are
  - spatially indivisible,
  - freely available to all (non-excludability), whether one is willing to assume the regime costs or not, and
  - their consumption by one individual (nation) does not diminish their availability to others (non-rivalry),
- one is unable to enforce binding agreements about them.

Global Public Good Nature of a CC Regime

- Mitigation costs are exclusive to the extent that they may be borne by some individuals (nations) while others succeed in evading them while enjoying mitigation benefits (free-riding).
- The incentive to evade increases with
  - the substitutability among individual mitigation efforts (mitigation is largely additive) and
  - the inequality of the distribution of net benefits among participants.
- Because mitigation efforts are additive, the larger the number of participants, the smaller the individual cost of providing the public good, i.e., GHG stabilization.
  - Market-based instruments are more competitive the more participants there are (Kyoto Mechanisms)

Global Public Good Nature of a CC Regime

- The **unequal distribution** of
  - (a) stable climate benefits (skewed towards the least-developed countries) and
  - (b) the ability to pay (skewed towards industrialized countries)

  may deter participation from the least well off net beneficiaries or from the least wealthy ones with different spending priorities, unless these distributional inequalities are addressed through information sharing and compensation.
- In a strategic environment, **leadership from a significant** player (**GHG emitter**) provides incentives for others to follow suit by lowering their costs.

Mitigative and adaptive capacities are public goods as well

- Since these are non-exclusive and non-rival.
  - Without a concerted effort to shore them up, their national provision (based on net national benefit only) will be insufficient as well, despite the fact that they have international repercussions: a made in Canada climate policy is non-sense
- However, individual mitigation efforts (costs) decrease with efficient mitigation actions undertaken by others.

International Regime

- International cooperation is required for effective and cost-effective environmental action
- **The policy architecture of Kyoto is functioning;**
  - **Rebuilding it from scratch will be extremely difficult.**

Need to mitigate now

- There is a consensus among economists, based on simulation models, that we need, because of the uncertainty (Yohe et al., 2004), to mitigate immediately but not necessarily deeply.
  - Uncertainty can never be an excuse for inaction
  - The novelty of the Stern Review is that we need to cut deeply now.
- The cost of delaying mitigation is increasing the discounted (real) cost of future mitigation or closing long-term climate options (Yohe et al., 2004)
  - This is because one will have later to mitigate significantly deeper and faster to reach a given temperature target (concentration) by a given date
  - Unless technology can be expected to compensate for the rising real cost
    - Requiring early investment to induce technological change or learning by doing

Figure 1.5. *Two example sets of global emissions pathways to achieve different target stabilisation levels. Note: These only represent two possible pathways to achieve stabilisation. Grey shaded rows show stabilisation pathways with approximately equal CO_2 concentration.*

Scenario Name	Final Stabilised Concentration of CO_2 only	Global Emissions Pathway		
		Year When Global Emissions Fall below 1990 levels	Change in Global Emissions in 2050 relative to 1990 levels	Change in Global Emissions in 2050 relative to business-as-usual*
IPCC 2001 Stabilisation Scenarios: CO_2 only				
450ppm CO_2	450	2000 – 2040	-5% to –60%	-60% to –85%
550ppm CO_2	550	2030 – 2100	-10% to +70%	-30% to –65%
650ppm CO_2	650	2055 – 2145	+10% to +110%	-15% to –55%
2005 Stabilisation Scenarios: all major greenhouse gases included, and expressed as CO_2 equivalent (CO_2e)				
400ppm CO_2e	350 - 375	2020 - 2030	-40% to -55%	-75% to -85%
450ppm CO_2e	400 - 420	2030 - 2040	-15% to -40%	-65% to -75%
500ppm CO_2e	440 - 460	2035 - 2055	Up to -25%	-60% to -70%
550ppm CO_2e	475 - 500	2045 - 2065	-10% to +10%	-50% to -60%

*Business-as-usual is represented by the IPCC A2 Scenario

Source: Based on IPCC (2001) and den Elzen and Meinhausen (2005). Assumptions underpinning calculations are explained in detail in Figure A4 in the Technical Annex.

Incentives for technological change

- Technology is also a public good
- Demand push:
  - Requires a technological regime (e.g. government financial support and regulations) with long-term targets
- Demand pull:
  - Short-term carbon price incentives
  - For US $25-30/tCO_2$, one can effect major technological shifts (IPCC)
  - Alone, demand pull is not sufficient to bring about technological change

Removal of barriers to behavioral changes (Stern)

- Minimum standards for buildings and appliances
- Information
- Eliminating transaction costs
- Product labeling
- Financing of consumers’ durables

Multipollutants Trading (E. Haites)

- **Multiple pollutants trading programs allow the sources to**
  - **Choose the lowest cost strategy for limiting emissions of all of the pollutants and**
  - **Give more flexibility in the choice of control strategies and the timing of emissions control investments.**

Relatively low cost of mitigation (IPCC)

- For 550 ppm, cost 1-5 % of GDP in 2050, i.e. from .03 to .1 % in terms of growth rates.
- For 650 ppm, cost of less than 2 % GDP in 2050.
- Great low-cost mitigation potential between now and 2030.
  - At less than US $ 20/t, reduction potential is 8 - 12Gt (1/4). Currently, we are at about 40 Gt CO2eq worldwide.
- To reach 450-550 ppm stabilization requires costlier measures and government policies but not dramatically expensive.
  - At less than US $ 100/t, reduction potential of 18-25 Gt (1/2).

Immediate mitigation generates co-benefits

- in terms of
  - **Energy conservation (availability and costs) and**
  - **Health**

Voluntary measures

- **Generally ineffective unless they are components of a whole policy regime**
  - **Not cheap**
- **Require a well-defined BAU for additionality, must affect individual companies (free-riding otherwise), and require monitoring and sanctions**
- Stern does not mention them

Competitiveness issues

- Kyoto has triggered a slate of measures in both
  - Developed countries (e.g. European Emissions Trading)
    - While the EU has grown 32 % from 1990 and reduced emissions a little bit, the US has grown 52 % and its emissions have grown by 16 % (Fortune)
  - and Developing countries (broad sustainable development agenda; e.g. energy efficiency gains).
- Ignoring these initiatives will be costly for competitiveness

Economic Growth Issues (Stern Review)

- Direct effect of environmental degradation on output,
  - e. g. because agricultural productivity is reduced. In the short run, this will tend to reduce the output obtainable from each additional unit of physical capital unless there is an offsetting increase in the rates of saving and investment;
  - Therefore, a deteriorating environment corresponds to a lower rate of growth than a stable environment;
- Increased depreciation of capital, because of both
  - Direct impacts from CC (e. g. because of the need to replace sea defences) and
  - Accelerated economic obsolescence due to the need to change technologies (e. g. switching from heating installations to air conditioning);
- Adverse effects through the impact on people's skills and health, especially in poor communities, so that a given rate of population growth is associated with lower GDP growth.

Conclusion

- Stern's approach is maintstream economics
- His figures seem to jibe with IPCC for mitigation