Climate Change: Overview of the Economics

ESCAP/WTO ARTNeT Capacity-Building Workshop
for Trade Research

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Main Topics

- Philosophy and background considerations
- Growth and climate change
- Climate change as an externality
- Discounting
- Inter-temporal distribution
- Risk and uncertainty

Philosophy and economics in climate Δ debates

- Utilitiarianism: Hume, Bentham, Mill
  - Utility as the summation of societal welfare
  - Anthropocentric utility
- Utilitarianism as a consequentialist theory
  - Only consequences or outcomes matter
- Motivism – only motives count (Kant)
- Deontological theory – actions are inherently right or wrong

Criticisms of utilitarianism

- Rawlsian criticism of summated utilities, the motivist arguments and his “original position” behind a “veil of ignorance” for building a social contract
- Utility maximization as only satisfying personal consumption
- Personal perceptions of maximized utilities and bounded rationality

Some Background to Policy and Economic Analysis

- Early concerns about the environment – growth of the literature in the early 1970s
- The link to trade and resurgence of the debate in the early 1990s
- Localized environmental challenges versus concerns about the commons
- The geographical indivisibility of the climate change debate

Some Background (2)

- The great global externality ⇒ CΔ
- Short-term actions against long-term consequences (costs now, benefits later)
- Public policy inertia in the face of uncertainty about the gravity and time-specificity of adverse effects
- The delayed consequences of inaction
- Technology to the rescue – what we don't know now will save us later

Growth and Climate Change

- Growth :

$$q = \alpha \,.\, L^x \,.\, K^y$$

Where :

q = Output (GDP); L = Labour; K = Capital; α = Productivity (efficiency and technology)

- Total factor productivity:

$$\alpha = q / L^x . K^y$$

Changes in total factor productivity (α) arise from sources other than increases capital or labour inputs.

- Over time α, L and K can all change exogenously, thereby affecting q, including as a result of climate change. They may also be affected by policy.

Integrated Assessment Models

<u>Elements to consider</u>:

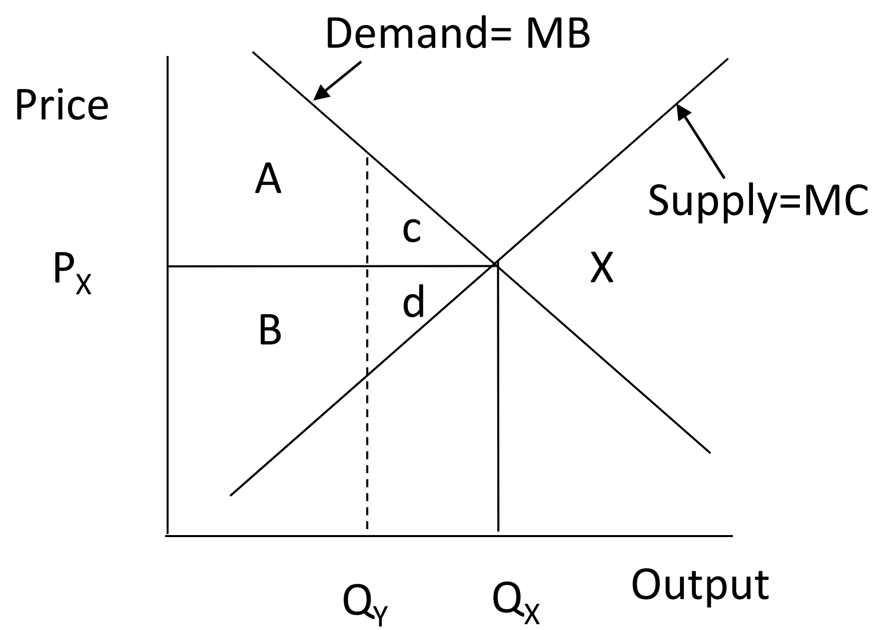
- Time path of emissions (population and technology)
- Cost and damage functions
- Land use
- Atmosphere and the oceans
- Ecological interactions
- Socio-economic impacts
- Uncertainty
- Discount rate
- Social price of carbon
- Policy stance

Climate change as an externality

- An externality: unintended and “unpriced” effect on the utility or profit of one agent as a result of a consumption or production decision of another agent
- Analytical challenges
  – Role of marginal analysis over long time periods
  – Degree of uncertainty and risk
  – Non-marginality of changes
  – Distributional issues, including
    - Historical overhang
    - Vulnerability as a function of location and activities
    - “Natural” distributional justice

GHGs as an externality

Competition and economic welfare: normal competitive case



Demand price is the same as marginal benefit and supply shows marginal cost.

At price P_X and output Q_X,

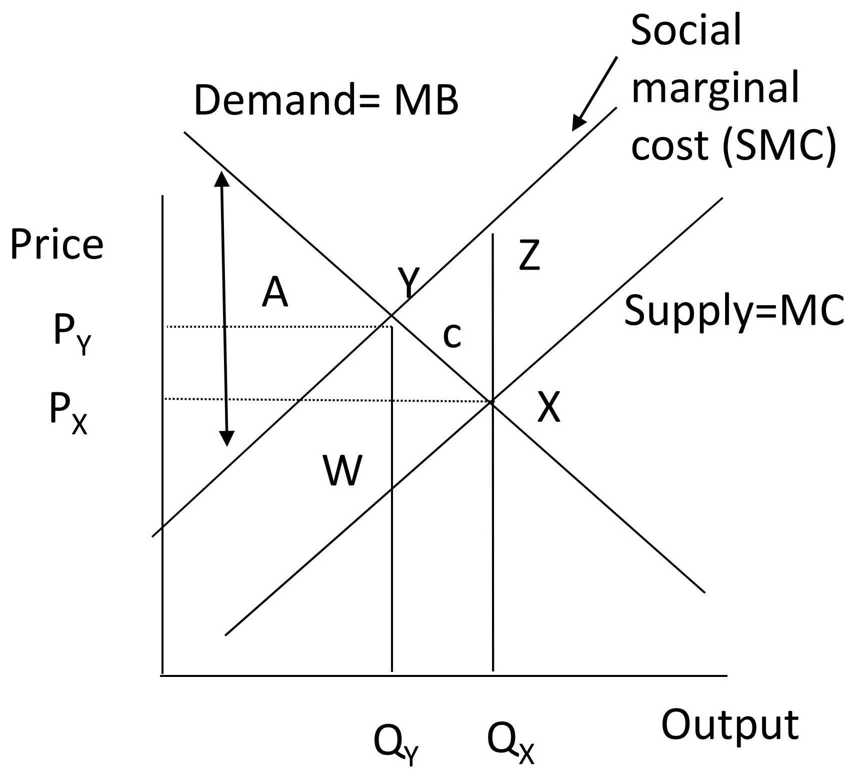
consumers' surplus = A

producers' surplus = B

Output Q_X, makes area A plus area B, equal to total welfare, as high as it can be.

At output Q_Y, MB is larger than MC and we have lost welfare equal to c+d.

Competitive case with externalities



We now add a social marginal cost curve, adding on the marginal pollution cost to the private cost faced by producers. The marginal pollution cost at any output level is just the vertical distance between MC and SMC.

<u>Optimal</u> output is Q_Y, where MB=SMC, and this makes social welfare A as big as it can be (add up the gaps between MB and SMC as indicated by the arrow).

<u>Competitive equilibrium</u> output Q_X entails a welfare loss, relative to the optimum, equal to triangle c. Between Q_Y and Q_X, SMC exceeds MB and the vertical gaps add up to c.

Four aspects of the GHG Externality

1. Global

- Because CO_2 emitted anywhere in the world has the same effect and the effects are themselves global, GHG policy must also be global. Compare the case of a factory polluting a river. There a local solution will suffice -- what is being done in other places about pollution is irrelevant.

Four aspects of the GHG Externality

2. Long-term

- The stock-flow aspect of the issue means that the externality is fundamentally inter-temporal, and over a very long time horizon. So:
- (a) The need to compare costs now with benefits 100 years means that much depends on the choice of the *discount rate* applied to future benefits (but note Foley's critique below)
- (b) We cannot consider the problem on a period-by-period basis (see below). The whole path of emissions through time must be analysed at once.
- Again, consider the river case. If the effects of pollution this year all occur this year (this year's pollutants then disappear), then (a) discounting the future doesn't come into it, (b) we can work out the optimal amount of pollution this year without reference to the future. In effect, this is what the figures on slides 2 and 3 do.

Four aspects of the GHG Externality

3. Uncertainty

- There are three key uncertainties regarding emission cuts:
  - The effect on average wellbeing (say consumption per capita) in 100 years time
  - How well off the average person will be in 100 years time
  - How any benefit in 100 years time will be shared between rich and poor
- The bigger the effect on average consumption per capita, the more we should abate now
- The better-off the average person is going to be in 100 years time, the less we should abate now.
- The more those benefits are going to accrue to the poor in 100 years time, the more we should abate now
- How the burden of abatement costs today is distributed also matters, of course, but this doesn't really come under the 'uncertainty' heading

Four aspects of the GHG Externality

4. Likely to produce non-marginal changes

- Ordinarily, in considering the benefits of a public project like the construction of a new road, we assess the benefits in relation to the status quo. So, for example, if the road will reduce individual journey times, we ask how much it would be worth to an individual to reduce his or her journey time by one minute. Then we multiply that value by the total number of minutes saved and compare with cost.
- Climate change may be different because, 50 or 100 years into the future, the 'business-as-usual' (BAU) baseline may be very different (i.e. much worse) than the present. To take an extreme example, the benefit of preventing a rise of 1cm in sea level from the present level might be much smaller than the benefit measured from the (probably much higher) BAU level in 100 years time.
- So it would be a mistake to confuse the BAU baseline (which in any case is a path through time) with the status quo in 2010.

The Analytics of Discounting

The Ramsey equation

The pure rate of time preference

Discount rates

Objective/subjective discounting

Elasticity of marginal utility of consumption

Projected consumption growth

The Ramsey equation and inter-temporal resource allocation

$$r = s = \delta + \eta g$$

Where:

r = the market interest rate

s = social discount rate, or the social rate of time preference

δ = pure time preference

η = elasticity of marginal utility of consumption

g = growth

$r = s$ because we assume: a single, infinitely lived agent; no taxes; and no externalities

Pure time preference

- The discount rate δ is the individual's value of postponed consumption (present v. future consumption)
- Call the interest rate r
- The discount rate δ varies by individual, depending on <u>pure time preference</u> and reflects a willingness to borrow or lend
- If $\delta > r$, you borrow, and if $\delta < r$, you lend

Simplifying assumptions

- In the first instance, we neglect inter-generational income distribution, assuming a “representative individual” at each date
- Risk and uncertainty are disregarded
- Assume single consumption good
- Mostly think in terms of two periods

The value of δ

- Stern argues for a value of δ of 0.1. This value would have been zero, implying that we value the future equally to the present, with the exception of the risk of extinction of the human race, which adds 0.1. This implies a one in ten chance that we will be extinct in 100 years.
- Main criticism of Stern's zero discount rate relates to observed behaviour in the market, plus the issue of internal consistency

Interest rates versus social discount rates

Stern's discount rate estimate for the next century is 2.1%, arguably much less than a market rate of return

BUT: actual market rates are many, and they are distorted by taxes, imperfect competition, externalities, sub-optimal Y distribution and are not necessarily society's "shadow price"

AND:

- social risk < individuals' risk
- "citizen" versus individual attitudes to discounting
- markets express short-term preferences and expectations
- big differences in individual rates of time preference

So we have "revealed ethics" of the market place versus "philosopher king", elitist pronouncements. Who is right?

Inter-Temporal Distribution: Does Pareto Optimality Help?

- Pareto optimality is attained when gainers could potentially compensate losers and remain better off (Kaldor) or when losers could not pay the gainers to prevent an outcome (Hicks)
- These are potential payoffs, and in "moral" terms it is supposed they are realized by governments taking care of distributional aspects
- Dynamic effects ("swings and roundabouts")

The Limits of Pareto Optimality

- BUT compensation possibilities do not exist across generations:
  - Future beneficiaries cannot compensate today's losers
  - No inter-temporal government exists to manage distribution

- Stern and others have opted for an impersonal approach – equalize utility across generations.

Inter- and intra-generational considerations with discounting

- Should we discriminate against the unborn through positive discounting?
- If future generations are richer than us, poor people today might be paying for the rich tomorrow. Inequality aversion would lead to positive discounting
- But what about intra-generational inequality? Mitigation today is paid for by the rich, with benefits accruing to the poor in the future (avoided climate damage). Then no case for positive discounting on grounds of inequality aversion.

The value of η

- The η value is the elasticity of the marginal utility of consumption. Stern assigns a value of unity implying that given proportionate increments in consumption generate the same utility for the rich and poor.
- This means that $1 is 10x more valuable at one-tenth of the income. If $\eta = 2$ then $1 is 100x more valuable at one-tenth of the income.

The value of η

The parameter η embodies different dimensions

- A higher η means greater risk aversion because a consumption loss reduces utility more than an equivalent consumption gain, and it also means a more risk-averse climate policy, meaning more spending now
- Since social welfare is the sum of utilities, η is also a measure of society's aversion to inequality, so higher η also means more concern for the poor
- When utilities are additive over time periods, η also governs attitudes to inequality in consumption over time. A high η implies less paid by current poor to future rich, so less CΔ policy

The value of η

- Because η simultaneously affects:
  - aversion to risk,
  - spatial inequality, and
  - inter-temporal inequality,

  it is not obvious whether a higher η means an increase or decrease in the present value of climate impacts
- Many proposals have been made in the literature on the appropriate value of η

Other views on the value of η

- Cowell and Gardiner (1999) say 0.5 – 4 is reasonable
- Pearce (2003) argues for 0.5 – 1.2 on the grounds that higher values are inconsistent with social egalitarianism
- DasGupta (2006) thinks $\eta = 1$ is not egalitarian enough
- Gollier (2006) thinks η should be 2 – 4, based on revealed preferences in gambling
- Weizman (2007) says $\eta = 2$ is consistent with thought experiments
- Nordhaus (2006) says with a low pure time preference (δ), η should be higher, at 2.25 in order to be consistent with observed rates of return on investment and savings rates
- Atkinson and Brandolini (2006) think that η should not be constant through time, but should rise and then fall as income and consumption rise

The Ramsey Equation Value

- Stern's growth assumptions for the next three centuries are 2.0%, 1.8% and 1.3 % (and henceforth)

So with $s = \delta + \eta g$

And $\delta = 0.1$; $\eta = 1$, we have

$s = 2.1$ in century 1

$s = 1.9$ in century 2

$s = 1.4$ in century 3 onwards

Foley's Critique of Discounting

- It has been assumed in mainstream analysis that climate policy entails losses to current persons and gains to future persons. If so, we must decide how to weight these gains and losses via the discount rate

- But externalities involve unambiguous losses and standard economics suggest we could make everyone better off when the externality is corrected.

- Foley thus argues that even for an inter-temporal externality, we can make everyone better off. To do this we must pay for GHG abatement, not out of current consumption but out of current (conventional) investment.

- Foley's analysis is technically correct – if mitigation investments were entirely financed by reducing non-mitigation investments, the burden of mitigation *could* be shifted to the future beneficiaries (through borrowing and a reduction in future benefits from conventional investment,) so there would be no costs for the present generation. Stern and others say that full inter-temporal compensation is impossible on practical grounds

Risk and uncertainty

- Risk: based on objective knowledge, can be estimated (e.g. tossing a coin, gambling)
- Uncertainty: subjective "guesstimates"
- Moving from uncertainty to risk: establishing probabilities
- Uncertainty in climate change: scientific, social, political
- Risk minimization: say no; obtain information; diversify; insure

More on Risk and Uncertainty

Much analysis is on the consequences of decisions with known certainty and reversibility. But we cannot <u>know</u> the future or whether what we do is reversible.

- Risk: possible consequences can be enumerated and probabilities be assigned to each possibility – in other words to each "state of the world"
- Uncertainty: if you cannot assign probabilities to all "states of the world" you are dealing with uncertainty
- <u>We have two kinds of uncertainty</u>
- a) possible consequences can be enumerated but probabilities cannot be assigned
- b) all possible consequences cannot be enumerated, let alone probabilities assigned – radical uncertainty

Known and unknown probabilities: catastrophes

Utility calculus requires that we are provided with probabilities relating to the uncertain outcomes.

What are we to do if we do not have these?

Perhaps we can estimate them.

For instance, one might use cross-section evidence on the relationship between agricultural productivity and temperature to estimate not only the mean effect of temperature on productivity, but also its standard deviation.

However, such estimates must make some assumptions about the form of the probability distribution, typically that it is normal.

This is particularly a difficulty in relation to catastrophes – large irreversible 'tipping points' such as melting of ice sheets and permafrost. (Dasgupta, Weitzman; Heal for examples).

The "*Precautionary principle*" says that if, at 'reasonable' cost, the probability of catastrophe can be reduced from some unknown positive number to zero, then this should be done.

This is a long way away from the mechanics of expected utility maximization.

Uncertain returns versus the uncertain future

Assume we give up some consumption today in order to engage in abatement.

- The returns to our abatement activity are uncertain, so we need a model to trace consequences of lower GHGs for temperature and economic/social outcomes.
- Such projections are very uncertain.
- It is also uncertain in what future will any consumption benefits be received
- In general, **uncertain *returns* make us *less* likely to invest and the uncertain *future* makes us *more* likely to invest**.

Insurance: Is it an option for CΔ?

- Insurance: a premium paid to spread/transfer quantifiable risk
  - Problem of moral hazard
  - Problem of adverse selection

Insurance and CΔ

- Cannot spread risk – everyone effected by uncertain event
  - Relevance of risk premium: expenditure to reduce likelihood of an event, does not transfer risk or pay out
- Quantifiability limited, subjective assessments