Climate Change Economics and Policy: Mitigation and Adaptation

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IPROMO Mountain Environment and Global Change Course
What I Hope Everyone Remembers When I’m Done

- The difference between mitigation and adaptation in climate policy
- The kinds of actions governments can take to lower GHG emissions
- Carbon trading, offsets, and developing countries
Bare Essentials - Science

- Make policy based on the probability distribution of peer-reviewed climate science
  - High probability of human-induced climate change
  - Significant expected damages that are an increasing function of
    - Atmospheric concentration
    - Rate of Change
Current net increase - 1.5 - 2 ppm/year

GHGs leaving atmosphere

380 ppm

GHG emissions
It’s a Stock

- Location of Emissions Does Not Matter
- Timing of Emissions Matters, but very little within a decade or so
- Stabilizing Concentrations is very difficult - freezing or cutting emissions by 50% won’t do it
Climate Policy: Mitigation and Adaptation

**Mitigation** is the jargon for reducing the risks of climate change by reducing anthropogenic climate forcings

- Reduced CO2 emissions
- Increased carbon sequestration
- Reduced emissions of methane, nitrous oxide, and other GHGs
Climate Policy: Mitigation and Adaptation

- Adaptation is what people do to react to climate change

- any adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. The objective of adaptation is to reduce vulnerability to climatic change and variability, thereby reducing their negative impacts.
Climate Policy: Mitigation and Adaptation

- Mitigation is a global public good – reducing emissions in one location benefits the entire world.

- Adaptation is much more local – reducing vulnerability to negative effects benefits the people that make the investment.
Climate Policy: Mitigation and Adaptation

- Mitigation has gotten the greatest share of attention – the Kyoto Annex 1 caps, the European Trading System, the US legislative proposals
- Adaptation is widely agreed to be essential – but little actual money has been spent nor specific policies considered
Climate Policy: Mitigation and Adaptation

- Mitigation policy takes place at all levels
- Adaptation policies are much more place-specific
Mitigation Basics

- Basic tasks are well understood
  - Change economic incentives and technical standards to reduce GHGs
  - Change behavior and attitudes towards energy use and GHG emissions
  - Drastically increase research and development into low- and zero-carbon energy technology

=> easy to list, very hard to do politically at all levels
It’s the Long Run That Matters

Energy systems take a long time to change
Mitigation Basics

- Risks are a function of atmospheric GHG concentrations and rate of change, so
  - Mitigation is not a 0/1 proposition – more mitigation means lower risks
  - Starting NOW makes sense
- Huge literature
- Enormous amount of public attention
- Clearly defined metrics (although their meaning is far from clear)
Mitigation Goals – Emissions Targets

- Annual and Long-term limits on GHG emissions
  - International targets
  - National targets

=> Everyone agrees they are needed; no one knows how to bring them about or what they should be
What can international agreements / policy do?

- Encourage commitments to national policies
- Coordinate national policies
  - Equity
  - Efficiency
- Transfer technology, capacity, and resources
What can international agreements / policy NOT do?

- Mandate specific actions
- Create legally enforceable commitments
- Coerce or require particular policies
- Enforce treaty provisions with the force of law
The Framework Convention

- Ratified by 188 Countries, including the US
- Sets forth aspirational goals and basic principles
- Framework for coordinating international actions and negotiating specific agreements
The Kyoto Protocol

- Negotiated under the framework convention
- Rich countries and EITs take on quantitative GHG limits for 2008-2012
- Limits based on 1990 emissions
- Poor countries make no binding commitments
The Kyoto Protocol

- Emissions trading architecture
- Some Opt-ins for Sequestration and Developing Countries
- No direct mandating of specific policies and measures
- No binding quantitative commitments to R&D Expenditures
Policy Toward Kyoto under Clinton

- Administration support for the “right” rules that limit economic costs and engage developing countries
  - Unfettered flexibility mechanisms
  - Expansive reading of sinks provisions
  - Non-Draconian compliance / liability system
Negotiating Kyoto

- 1997 - 2000: serious disagreements about
  - emissions trading limits
  - measurement of carbon sequestration
  - penalty/compliance procedures

The man responsible for overcoming these to achieve ratification was…
US Withdrawal

• Created unity through anger
• EC made major concessions
• Expected emissions allowance price dropped sharply
Current Status of Kyoto

- Ratified
- European countries have made significant efforts in non-transportation sectors
- Other rich countries have mainly talked about doing something (Canada, Japan)
- The only way targets will be met is with significant use of Russian allowances
Problems with Kyoto

- Short time horizon “too little, too fast”
- Enforcement
- Non-universal participation in mandatory reductions
- Very little about adaptation
- Very little engagement of developing countries
Virtues of Kyoto

** It’s a Start **
- Concrete steps
- Institution building
- Policy learning
- Creates expectations of more stringent future limitations
- Explicit recognition of cost and efficiency issues
Centrality of the US

- As the largest emitter and the largest economy, international progress requires US participation.
- As a critic of Kyoto, the most constructive step the US could take is a strong national GHG mitigation policy.
The Road to Copenhagen

- There is tremendous desire to have an agreement reached in the December 2009
  - Rich country targets
  - Developing country actions
- Right now no one knows whether there will be an agreement, and what it will consist of
National Policies – Rich Countries

- Putting a price on emissions
  - Taxes
  - Cap-and-trade
- Policies and measures
  - Mandates and standards
  - Information
- Technology development
Putting a price on emissions

- GHG emissions are an *externality* – people do not take the risks of climate change into account when they decide to burn fossil fuels, emit methane, etc.

- If people have to pay when they emit, they will do less
GHG Taxes

- Some experience *for some sectors* in Europe
- Comprehensive tax in British Columbia, Canada
- Politically difficult to implement
**Cap and Trade**
(Emissions Trading, Carbon trading)

- Set an overall limit on GHG Emissions
- Create a system of permits (allowances) consistent with this cap
- To emit a unit of GHGs, you must possess and surrender a permit
- Permits can be bought and sold for whatever price is agreed upon between buyers and sellers
Cap and Trade (Emissions Trading)

- Works by creating a price for CO2 emissions
- This price increases the cost of fossil energy use, both directly and in product markets
- “Making the market tell the truth”
- Program details determine what “truth” we put into practice
Cap and Trade
(Emissions Trading)

- Allows cost-effective reductions and flexibility
- Gives clear incentives and price information
- Has been very successful in programs to limit sulfur dioxide and nitrogen oxides
- Central to the Kyoto Protocol and EU policy
- Has wide support among industry and environmentalists in Europe and the US
Emissions Trading is a tool - What it Accomplishes Depends on Its Design

- What is the Cap?
  - **How stringent** - determines how much GHGs will be reduced
  - Can be based on
    - Emissions History
    - Emissions Intensity
    - External criteria (international agreements)

- More stringent caps => higher permit prices => higher energy costs
Coverage

- The more of the economy that is covered by the system
  - The more emissions are brought under the control of quantitative regulation
  - The lower the cost of any given level of emissions reductions
  - Key factor is coverage of transportation (something the EU has yet to do)
Non-CO2 GHGs

- Methane and N2O are significant contributors to climate forcing in the atmosphere
- Cost-effective opportunities exist to reduce these emissions
Offsets and Emissions Trading

- Emissions trading limits the *covered* companies and sectors to a particular cap.
- **Offsets** allow the covered entities to exceed the cap by offsetting these emissions with reductions from *non-covered companies and sectors.*
Offsets: Example

- Electric Utilities are allowed 200 million metric tons of CO2 per year
- Brazil invest in a carbon sequestration project that takes 10 million tons of CO2 out of the atmosphere
- Some recognized entity approves and certifies the Brazilian sequestration
Offsets: Example

- Brazil sells 10 million tons of CO2 credits to US utilities for a mutually agreed upon price
  - Which may or may not be identical to the domestic CO2 price, depending on market rules and limitations
Offsets: Example

- US utilities now emit $200\text{ million} + 10\text{ million} = 210\text{ million tons}$ of CO2
- Brazil reduces atmospheric carbon by 10 million tons
- Net emissions are identical
- Overall costs go down as long as the Brazilian sequestration is less expensive than further utility emissions reductions
Sources of Offsets

- Biological and terrestrial sequestration
  - Domestic
  - Foreign
- Non-CO2 gases
  - Methane
  - Nitrogen oxides
Sources of Offsets

- Non-covered CO2 emissions
  - Foreign energy projects
  - Domestic non-covered sectors (e.g. transportation)
  - Early action credits
Virtues of Offsets

- Creates a price for emissions in otherwise uncovered sectors
- Funds sequestration projects with a revenue source from outside government
- Reduces overall costs of emissions reductions
Issues with Offsets

- Additionality
- Leakage
- Permanence
- System Evolution
Additionality

- Does the offset actually represent reduced emissions relative to what would have been observed without the offset system?
  - Baseline - including policy?
  - Profitability tests and measures
  - Proving the counterfactual
Leakage

- Does the offset bring about greater emissions somewhere else
  - Example of forest sequestration - does harvest move elsewhere
  - Energy Example - if a country builds a wind farm and also builds a coal plant, do you credit the wind farm?
- The easiest solution for leakage is comprehensive coverage
Permanence

- Particularly a concern for sequestration - does sequestered carbon remain sequestered?
- If not, how is it accounted for in the trading system
Offsets: Example

- Electric Utilities are allowed 200 million metric tons of CO2 per year.
- Brazil invest in a carbon sequestration project that takes 10 million tons of CO2 out of the atmosphere.
- Ten years later, Brazil cuts down most of the forest and releases 9 million tons of CO2.
Offsets: Example

- US utilities now emit $200 \text{ million} + 10 \text{ million} = 210 \text{ million tons of CO2}$
- Brazil reduces atmospheric carbon by 10 million tons now
- Net emissions are identical, then releases 9 tons in the future
- Net emissions are now $210 - 10 + 9 = 209 \text{ million tons}$ - the offsets have allowed the US utilities to increase CO2 emissions by 9 million tons
System Evolution

- Sectors that are covered by offsets are in a position where they profit by being on the outside of the system.
- It will be difficult to move them inside the system to have obligations to reduce GHGs.
- This is a concern for GHG emissions more than for sequestration projects.
Implications for Land Managers

- High payoff to documentation and quantification of BAU
- PLA issues are endemic and require policy and technical innovation to solve
- Economic development and environmental protection benefits *likely, but not certain* to be a plus
- Offsets are particularly important for sequestration
Cap and Trade - Summary

- Cap and trade is a good policy design for implementing GHG reduction incentives
- How strong and how broad these incentives are depends on program parameters
European Union

- Emissions trading energy activities (including electric power), iron & steel, minerals, pulp and paper
- ~12,000 installations covering 46% of CO₂ emissions
- 25 Member States (MS) propose cap-level and allocation in National Allocation Plans (NAP)
Canada

- Emissions trading for Large Final Emitters (LFE): oil & gas, electricity, mining, manufacturing.
- *Intensity*-cap: emission limit indexed to output.
- Safety valve: extra allowances at C$15/tCO$_2$
- With new government, program is on hold
- Carbon tax in British Columbia
New Zealand

- Carbon tax at NZ$15-25 / tCO₂ in 2007, aligned to international carbon price.
- Vulnerable energy intensive industries can opt for voluntary agreement instead.
- Agricultural methane and N₂O (more than half NZ emissions) excluded.
- Abandoned 12/05. May pursue emissions trading.
- Increased interest in international purchases
Japan

- Existing efficiency and renewable programs.
- Voluntary emissions trading.
- Discussed possibility of ¥2,500-3,000 / tC tax ($5-6 / tCO₂).
- Public and private programs to buy offsets.
- International investments...
Australia

- Did not ratify Kyoto
- Announced future national cap-and-trade July 2007
- New South Wales trading program since 2003 for power plants; AU$10-14 / tCO₂.
USA

- Cap and trade system for electricity in northeastern states
- Multiple bills in Congress
- Waiting for presidential election results for action
Energy Efficiency Standards

Standards

- Appliances - relatively successful, cooperation of manufacturers
  - Allow for exceptions and heterogeneity

- Information - Energy Star (USA), energy consumption labels
Standards - Vehicles

- Effectiveness is inherently limited by
  - Inability to control VMT
  - Bounceback

- Energy efficiency standards work together with energy pricing
Other Issues: Research, Development, and Innovation of low- or zero-carbon energy

- Strong economic rationale for dramatically increased government funding
- Funding should go to a portfolio of approaches
- Willingness to try low probability approaches, show patience, and tolerate failure
- Prizes?

Pricing carbon guides innovation but is not enough
Developing Countries and GHG Emissions

Developing countries

- Didn’t cause the problem
- Have low GDP/person AND low GHG/person compared to rich countries

BUT

- Account for a large and growing share of emissions
- Are absolutely essential if concentrations are to be limited
Cumulative CO2 Emissions 1850-2002

Per Capita CO2 Emissions 2000

Source: World Resources Institute 2006
International Expectations of Developing countries

- History of “common but differentiated responsibility”
- Use of poor countries as an excuse for inaction
- General recognition that action requires resources
- Heterogeneity of developing countries
- Don’t directly depend on government transfers
Transfers from rich country mitigation programs

- Have a history in international and national programs
- Don’t directly depend on government transfers
Experience with the CDM

- High transactions costs
- Concentration of benefits to a few countries and sectors miss huge opportunities
- Large changes have been proposed
3 Central Issues

- What do developing countries gain by participating in transfers?
- What do the rich countries gain by participating in transfers?
- What is the effect on “the climate”? 
Developing countries and mitigation

- Cost-effective and verifiable mitigation
  - More of interest to rich countries
- Transformation of energy systems
  - Emphasis on infrastructure and technology
  - Context of expansion of transportation and electricity
- Land use and environmental concerns
Developing country priorities

- Progress toward adaptation
  - Of interest and increasing focus, but still difficult to target resources effectively

- Increases in wealth and capacity
  - Of great interest to developing countries, and a key determinant of adaptive capacity
Rich country interest in transfers

- Lower cost of meeting commitments
  - International
  - Domestic
- Technology markets / standards
- Engaging developing countries in mitigation
  - Path dependency of mitigation efforts
  - Creating conditions where self-interest leads to integration
- Interest in adaptation and economic development
The Climate

- Cost-effective mitigation in the short run
- Cost-effective mitigation in the long run
- Inducing participation / commitment by developing countries to an international process
Mechanisms

- ton-for-ton accounting (CDM)
- fund for addressing climate change in developing countries (World Bank, bilateral)
- tax on transactions
- BAU targets
Criteria

- Measurable mitigation
- Accountability
- Cost-effectiveness
- Progress toward commitments and integration
Institutional Structure for Transfer Decisions and Evaluation

- Build on existing organizations
  - Likely forums: World Bank, Climate Secretariat
- Composition
- Authority
  - Enforcement, adjustment, liability
Developing Countries and GHG Emissions

- Technology Transfer
- Capacity Transfer
- Incentives through offset markets (Clean Development Mechanism)
- No-Risk Targets?

Needs to be approached as part of economic development strategy
A very challenging diplomatic, technological, political, and economic problem!
Developing Countries

- How are commitments differentiated by economic status?
- What incentives for participation?
- What kinds of resource transfers and accountability/evaluation mechanisms?
- What kind of graduation criteria?
Focus of Impacts Literature

- Human Actions
- Impacts
- Climate Change

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Necessary Complexity for Studying Adaptation

Human Actions —> Impacts

Climate Change

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Adaptation options

- Bear the loss
- Share the loss
- Alter resource use
- Change location
- Do research on potential responses
- Modify effects
- Provide information to bring about behavioral change
Adaptation

- Adaptation economics
  - Individuals and private companies will find it in their interest to spend money on adaptation
  - Some adaptation expenditures will have to be public
  - Costs of anticipating in some areas will be much lower than costs of waiting
  - Multiple paths to the same outcome – hard to make efficient decisions
Economics and Adaptation

Economic modeling focuses on choices

- By individuals
- By institutions

that depend on

- Natural resource flows
- Disaster risk
- Other climate related factors

in a system of relationships
Economics and Adaptation

- Economic choice depends on
  - Assumptions about individual behavior
  - Institutional setting, values, and strategy

- Useful knowledge gained from economic studies of adaptation depend on some key questions
Three Issues

- How do individuals make choices about adaptation under uncertainty in a complex environment?
- In what ways is it useful to approach adaptation policy as different than economic development policy?
- How should international resource transfers affect adaptation decisions?
Issue 1: Mix of Autonomous and Policy-Driven Adaptation

In what ways is adaptation driven by autonomous response, and in what ways is it – or should it be – a result of deliberate policy decisions?
Issue 1a: use of information

- How well will economic agents use information?
  - “dumb” farmers do not change
  - “smart” farmers are fully knowledgeable and forward-looking
  - Real world encompasses a variety of in-between behaviors
    - Partly knowledgeable
    - Knowledgeable but delayed

- How well people use information is key to the mix of adaptation policies and investments
Issue 1b: Substitutes or complements?

- Are autonomous and policy actions substitutes or complements?
- Example - Water stress
  - can change crops or technology (autonomous)
  - can improve water storage (policy)

- Understanding the interaction of autonomous and policy responses is essential
Issue 1c: Infrastructure vs. technology and institutions

- What are the relative roles of investing in infrastructure vs. other adaptive activities?
  - Infrastructure can ideally make big contributions to promoting adaptation, but it requires *ex-ante decisions* – there is an unavoidable element of placing a bet.
  - Knowledge tends to increase the ability of systems to adapt in real time and *ex-post*.
  - Institutions can produce useable knowledge and coordinate real-time and ex-post responses.

- The role of *ex-ante* bets vs. *ex-post* capacity to adapt under uncertainty is central.
Issue 2: How are adaptation and development connected?

- Broad recognition that adaptation policy must be “mainstreamed” and pursued in the context of development objectives
- Question remains of how specific measures to adapt to climate change should be prioritized to increased economic development
Issue 2: How are adaptation and development connected?

- How do strategies for adapting to climate change differ from a general strategy of economic development?
- Depends on the uniqueness / substitutability of the environmental services altered by climate change
- Matters for framing policy questions and for the complexity of research and policy responses
Issue 2b: Who gets helped?

- What is the role of adaptation policy on the distribution of benefits?
  - Does it help the most vulnerable or the most able?
  - Does it favor particular regions?
Issue 3: Adaptation, Mitigation, and Resource Transfers

- How should international resource transfers affect adaptation decisions?
  - Likely that larger resource flows will be available for GHG mitigation
  - Mitigation likely does less good per $ spent in poor countries than does adaptation

To what extent can mitigation and adaptation be joined to gain access to resources?
How do we learn more?

- How do we learn about what works best in different contexts?
  - Study individual behavior in places where significant adaptation has taken place
  - Study policy choice in these environments with specific attention to uncertainty and institutions
  - Build models around the natural resource flows that are affected by climate change
Economic Incentives and Adaptation

- Insurance
- Environmental Markets
- Public private partnerships
Insurance

Long history in dealing with weather

- E.g. hurricanes, crop failure

Moral hazard – spreading risk while retaining incentives for protective (adaptive) behavior

- If I know insurance will provide resources if my crops fail, I will
  - plant fewer drought-resistant crops
  - try less hard to find alternative ways of producing wealth
Insurance

- Private insurance can provide some of this coverage, but much weather-risk coverage has required government participation
- Subsidized insurance prevents adequate adaptation response
- Index-based insurance – you get a payout based on events, not on your own damage (gets around moral hazard)
Insurance

- Catastrophe bonds – investors get high yields but forfeit capital if there is a payout event
- Improve hazard information – probabilities and damage
Prices as Adaptation Policy

- Water pricing – encourage optimal use and conservation
  - Most important in agriculture

- Water markets – one way to do this that can get around wealth effects, but remains intensely controversial
Water – adaptation costs strictly due to CC estimated at USD 225 billion thru 2030 – mostly in Africa and Asia

Water would be a tremendous challenge even without CC
Payment for Ecosystem Services (PES)

- Currently *en vogue*
  - Watershed protection
  - Carbon sequestration
  - Biodiversity protection
  - Landscape and cultural preservation
- CDM is an example
- Requires a funding mechanism to work
Healthy ecosystems have adaptive value

- Downstream payments to upstream actors for water quality and quantity protection
- Mangrove forests / coastal ecosystems as weather protection
- Wildlife corridors
- *Somebody has to pay for this*
Public Private Partnerships

- Private sector involvement in infrastructure and other public responses to CC adaptation
  - E.g. large scale flood protection financed by government but carried out by private companies
  - Virtue is the availability of capital in constrained environments
Role of Science

- Adaptation actions and policy are directly informed by improvements in
  - Knowledge about localized climatic effects
  - Knowledge about ecosystem and species response
  - Assessment of strategies to reduce risk, reduce damage, or compensate losses

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